

## **24 Water Environment**

This chapter describes and assesses the potential impacts of the proposed scheme on the existing water environment for the Southern Leg section of the AWPR. It describes the impacts of the proposed scheme on the relevant water features and outlines measures for avoiding or mitigating these impacts wherever possible.

The study area for the assessment includes the River Dee, approximately 19 other watercourses or field ditches, one loch, several small ponds and two moss features. Potential impacts on these water features include: realignments, installation of culverts, bridging as well as changes to hydrological, sediment and quality regimes as a result of receiving road drainage.

Potential impacts, pre-mitigation, on Kingcausie Burn were assessed as being of Substantial significance. With the effective implementation of appropriate mitigation, the overall significance of residual impacts would be reduced to Slight/Negligible significance during the operational phase. During the construction phase, residual impacts would remain at Moderate significance as a result of the potential impacts to the geomorphology of the burn and the potential for interruption to hydrological pathways. For Burnhead Burn and Blaikiewell Burn, residual impacts during operation and construction would be reduced to Slight/Negligible significance following the application of mitigation.

Impacts on the River Dee would be reduced to Slight/Negligible significance for construction and operation, with the implementation of appropriate mitigation. Hydrodynamic modelling indicates that the proposed bridge design would not increase flood risk upstream for 0.5%AEP flow levels. Water quality modelling indicated that the cumulative operational impact of the scheme on the water quality of the Dee and other SAC tributaries would be reduced to Slight/Negligible as a result of effective mitigation. During the construction phase, impacts would be reduced to Negligible with the effective implementation of mitigation and detailed construction method statements that would be agreed with SEPA prior to the commencement of works. Residual impacts on Crynoch Burn sub-catchment were assessed as being of Slight/Negligible significance.

### **24.1 Introduction**

- 24.1.1 This chapter assesses the potential impacts of the proposed scheme on the water environment within the study area of the Southern Leg section of the AWPR. Technical assessment reports supporting this chapter are provided as appendices in Volume 8, Part C.
- 24.1.2 Cumulative impacts, combining the potential impacts on the water environment study area for the entire AWPR proposed route are described in Part E (Cumulative Impact Assessment), Volume 5 of the Environmental Statement (ES).
- 24.1.3 This chapter describes the baseline surface water environment, assesses the potential impacts of the proposed scheme and proposes mitigation, as appropriate. The assessment considers the potential direct and indirect impacts of the proposed scheme in terms of surface water hydrology and flood risk (which includes a hydrodynamic modelling assessment for the River Dee), water quality (which includes the cumulative catchment assessment of impacts to water quality by the construction of a stochastic model) and fluvial geomorphology. The results of the assessment on groundwater and fisheries/aquatic habitat are reported in Chapter 23 (Geology, Contaminated Land and Groundwater) and Chapter 25 (Ecology and Nature Conservation).
- 24.1.4 Water is a resource that is essential to all animal and plant life. It is also necessary for industry, agriculture, waste disposal, many forms of transport, recreation and sport. The maintenance and improvement of the quality of our drinking water, watercourses, groundwater resources and coastal waters is central to Government and European policy.

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- 24.1.5 The 2000/60/EC 'Water Framework Directive' (WFD) which is transposed into Scottish law by the 'Water Environment and Water Services (Scotland) Act 2003' (WEWS Act), aims to classify surface waters according to their ecological status and sets targets for restoring/improving the ecological status of water bodies. This is a radical departure from the traditional methods of measuring water quality using only chemical parameters. Under the WFD, the status of water is assessed using a range of parameters including chemical, ecological, physical, morphological and hydrological measures to give a holistic assessment of aquatic ecological health. Furthermore, there is a requirement under the WFD that natural water features must attain 'good ecological status' by 2015. Certain waterbodies may be designated as artificial/heavily modified and will have less stringent targets to meet, however these will still need to demonstrate 'good ecological potential' by the year 2015 (SEPA, 2004).
- 24.1.6 In addition to the WEWS Act, the Water Environment (Controlled Activity) Regulations (Scotland) 2005 (CAR) control all engineering activity in or near watercourses, reinforcing the requirements of the WFD. There are three different types of authorisation under CAR: General Binding Rules (GBR), Registration and Licence (both simple and complex). The level of regulation increases as the activity poses a progressively deleterious impact on the water environment. The level of authorisation required for the AWPR is dependent on the activity proposed but is likely to range from GBR, covering some construction activities and outfalls, to licences required for outfalls (draining over 1km of road in length), culverting and watercourse realignment. The applications will require baseline environmental information of the watercourse, details of the proposed design, a construction method statement and details of the proposed mitigation. These will be developed prior to construction and will require approval from SEPA prior to construction commencing.

## **24.2 Approach and Methods**

### **Structure of Assessment**

- 24.2.1 As noted above, under the WFD the status of waterbodies is assessed using a range of parameters including hydrology, morphology, water quality and ecology. In line with this approach and recommended best practice, the assessment of potential impacts on the water environment in this chapter includes:
- Surface water hydrology and flood risk: the assessment of potential impacts on the flow of water on or near the land surface, which is intrinsically linked to hydrogeology, water quality, geomorphology and ecology. This includes a hydrodynamic modelling assessment of flood conditions of the River Dee;
  - Fluvial geomorphology: the assessment of landforms associated with river channels and the sediment transport processes which form them. Fluvial processes create a wide range of morphological forms which provide a variety of habitats within and around river channels; and
  - Water quality: the assessment of the chemical and biological status of various parameters within the water column and their interactions such as dissolved oxygen, indicator metals such as dissolved copper, or suspended solids.
- 24.2.2 The following technical reports are the supporting appendices to the Southern Leg Water Environment chapter:
- Appendix A24.1: Surface Water Hydrology;
  - Appendix A24.2: Hydrodynamic Modelling Assessment (River Dee only);
  - Appendix A24.3: Fluvial Geomorphology Report, plus the technical annex Fluvial Geomorphological Study of the River Dee;
  - Appendix A24.4: Water Quality Report;
  - Appendix A24.5: SIMCAT Modelling Assessment of the Operational Phase of the AWPR affecting the River Dee and its Tributaries; and

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- Appendix A24.6: Sediment Modelling Assessment of the Construction of the River Dee Mainline Approach Road .

24.2.3 Appendix A24.7 contains 29 Annexes, which support the technical reports, referenced as appropriate in Appendices A24.1 to A24.4.

24.2.4 The information contained in these detailed technical reports has been summarised for the overall assessment presented in this chapter, as appropriate. In addition to consultation with SEPA throughout the EIA process, the methods for each of the technical assessments were agreed with SEPA prior to commencement.

24.2.5 The potential impacts on groundwater and associated potable water are considered in detail in Chapter 23 (Geology, Contaminated Land and Groundwater). Impacts on riparian amenity and riparian landscape are considered in detail within Chapter 26 (Landscape), Chapter 27 (Visual) and Chapter 31 (Pedestrians, Cyclists, Equestrians and Community Effects).

24.2.6 The water environment in the Aberdeen area supports a number of aquatic species that have been identified as scarce in Europe and the UK. One of these species is the Atlantic salmon, which is present in the River Dee and its major tributaries and is typically used as a biological indicator of high quality water (Hendry and Cragg-Hine, 2003). While the relevant fisheries designations have been considered within this chapter, potential impacts on freshwater ecology are assessed in detail in Chapter 25 (Ecology and Nature Conservation).

24.2.7 In order to undertake this impact assessment, the Water Environment, Geology/Groundwater and Freshwater Ecology Teams worked together throughout the assessment process to ensure that the interaction of the physical processes, and the habitats which they support, were sufficiently represented. It should be noted that impacts on freshwater ecology have not formed part of the assessment within this chapter, as they are dealt with entirely within the Ecology report (Chapter 25) to minimise double counting of impacts.

#### Baseline Conditions

24.2.8 The study area for the assessment includes the River Dee, approximately 19 other watercourses or field ditches, one loch, several small ponds and two moss features. Only water features that would be directly affected or have the potential to be indirectly affected by the proposed scheme have been considered in this assessment. Watercourses were considered up to a distance of 500m either side of the centreline of the proposed route. The sensitivities assigned to each watercourse are relevant to the surveyed reach and not the entire catchment of the watercourse. Baseline conditions were identified through site visits, review of existing information and detailed technical studies.

24.2.9 Extensive consultations, as described in Chapter 6 (Scoping and Consultation), were also undertaken with regulatory bodies and key stakeholders such as:

- Scottish Environment Protection Agency (SEPA) (water quality monitoring data, designated fisheries stretches, areas of flood risk, licensed point source discharges and abstractions, agreed assessment methodologies);
- Scottish Natural Heritage (SNH) (key areas for sensitive species, i.e. salmonids),
- Aberdeen City and Aberdeenshire Councils (floodplain identification, areas with historical flood problems); and
- Dee District Salmon Fisheries Board.

24.2.10 Desk-based studies followed the guidance of the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10: Road Drainage and the Water Environment and relevant legislation and regulations as referred to within the chapter.

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- 24.2.11 Due to its importance within the study corridor, the River Dee was considered in detail for potential impacts on surface water hydrology, hydrodynamic modelling, geomorphology, water quality, sediment modelling and water quality modelling. The rest of the watercourses affected by the route were assessed for surface water hydrology, geomorphology and water quality. Hydrodynamic models were not constructed for watercourses other than the River Dee owing to their lesser size and importance. However, flood risk issues are addressed in Appendix A24.1 (Surface Water Hydrology).
- 24.2.12 One small pond along the route was scoped out of the Water Environment assessment due to its size. Several ecology surveys assessed these ponds for their potential habitat and the findings are presented in Chapter 25 (Ecology and Nature Conservation). The results of the ecological assessment of the pond are included in this chapter for completeness, however it should be noted that it does not form part of the assessment.
- 24.2.13 Baseline water features are graphically presented in Figures 24.1a-h.

#### **Impact Assessment**

- 24.2.14 The general approach to the assessment and a description of the methods used for each of the supporting technical reports is provided below. Detailed descriptions for each assessment presented in the technical reports are provided in the respective appendices.
- 24.2.15 Due to the outline nature of the scheme design at this stage, specific impacts on watercourses as a result of extensive realignments have been treated in a conservative manner and have taken a precautionary approach. Further assessments of these proposals will be required for the Controlled Activity Regulation (CAR) licences, which must be agreed with SEPA prior to construction.
- 24.2.16 As described in Chapter 5 (Overview of Assessment Process), impact significance was determined with respect to the sensitivity/importance of the baseline conditions and the magnitude of potential impact. This is described below.

#### Sensitivity/Importance

- 24.2.17 The criteria used to assess the sensitivity of surface water features are summarised in Table 24.1. In defining these criteria, guidance such as the DMRB, Transport Analysis Guidance (TAG) and Scottish Transport Appraisal Guidance (STAG) have been consulted to ensure a holistic approach.
- 24.2.18 Each discipline (surface water hydrology, fluvial geomorphology, water quality, and where appropriate, hydrodynamic, sediment and water quality modelling) has evaluated the sensitivity or vulnerability of each watercourse or feature by a separate set of criteria. These are listed in Table 24.1. For the purposes of summarising the impacts on the surface water environment, this chapter then assigns an overall sensitivity to the feature, which defaults to the highest sensitivity identified by the separate disciplines.

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**Table 24.1 – Criteria to Assess the Sensitivity of Water Features**

Sensitivity	Surface Water Hydrology	Hydrodynamic Modelling (River Dee assessment)	Fluvial Geomorphology Vulnerability	Water Quality (Chemistry and Biological indicators)
<b>High</b>	<p>A watercourse/hydrological feature with hydrological importance to:</p> <ul style="list-style-type: none"> <li>i) sensitive and protected ecosystems;</li> <li>ii) critical economic and social uses (e.g. water supply, navigation, recreation, amenity etc);</li> <li>iii) the flooding of property (or land use of great value) that has been susceptible to flooding in the past.</li> </ul> <p>Or a watercourse/floodplain/hydrological feature that provides critical flood alleviation benefits.</p> <p>Or any property that is at risk of flooding due to the proposed road scheme.</p>	<p>A watercourse with direct flood risk to the adjacent populated areas and/or presence of critical infrastructure units such as hospitals, schools, safe shelters, etc.</p> <p>In this scenario, the watercourse with any new development is highly sensitive to increase in flood risk by the possible increase in the water levels.</p>	<p><u>Sediment regime</u>  A watercourse supporting a range of species and habitats sensitive to a change in suspended sediment concentrations and turbidity such as migratory salmon or freshwater pearl mussels. Includes sites with international and European nature conservation designations due to water dependent ecosystems.</p> <p><u>Channel morphology</u>  Watercourses exhibiting a range of morphological features such as pools and riffles.</p> <p><u>Natural fluvial processes</u>  Dynamic rivers, those which show evidence of channel migration and other morphological changes such as bar evolution.</p>	<p>Large or medium watercourse with pristine/near pristine water quality, SEPA Class A1, A2 and B respectively. Water quality not significantly anthropogenically affected. Water quality complies with Dangerous Substances Directive (DSD) Environmental Quality Standards (EQS). Water quality does not affect species diversity. Natural or semi-natural ecosystem with sensitive habitats and sustainable fish population.</p> <p>International and European nature conservation sites designated due to water dependent ecosystems, e.g. Special Protection Area and EC designated freshwater fisheries. Includes all nature conservation sites of national and regional importance designated by statute including Sites of Special Scientific Interest, National Nature Reserves and Natural Areas (part of the Regional Biodiversity Action Plans).</p>
<b>Medium</b>	<p>A watercourse/hydrological feature with some but limited hydrological importance to:</p> <ul style="list-style-type: none"> <li>i) sensitive or protected ecosystems;</li> <li>ii) economic and social uses (e.g. water supply, navigation, recreation, amenity etc);</li> <li>iii) the flooding of property (or land use of value) that may potentially be susceptible to flooding.</li> </ul> <p>Or a watercourse/floodplain/hydrological feature that provides some flood alleviation benefits.</p>	<p>A watercourse with a possibility of direct flood risk to less populated areas without any critical social infrastructure units such as hospitals, schools, safe shelters and/or utilisable agricultural fields.</p> <p>In this scenario, the watercourse with any new development is moderately sensitive to increase in flood risk by the possible increase in the water levels.</p>	<p><u>Sediment regime</u>  A watercourse supporting limited species sensitive to a change in suspended sediment concentrations or turbidity. Includes non-statutory sites of regional or local importance designated for water dependent ecosystems.</p> <p><u>Channel morphology</u>  Watercourses exhibiting limited morphological features such as pools and riffles.</p> <p><u>Natural fluvial processes</u>  Rivers, which may be vulnerable to changes in fluvial processes.</p>	<p>Medium or small watercourse with a measurable degradation in its water quality as a result of anthropogenic factors (may receive road drainage water), Class A2 or B. Ecosystem modified resulting in impacts on the species diversity of flora and fauna in the watercourse. Moderately sensitive habitats.</p> <p>Includes non-statutory sites of regional or local importance designated for water dependent ecosystems.</p>
<b>Low</b>	<p>A watercourse with minimal hydrological importance to:</p> <ul style="list-style-type: none"> <li>i) sensitive or protected ecosystems;</li> <li>ii) economic and social uses (e.g. water supply, navigation, recreation, amenity etc);</li> <li>iii) the flooding of property (or land use of</li> </ul>	<p>A watercourse passing through uncultivated agricultural land.</p> <p>In this scenario, the watercourse with any new development would be less sensitive to increase in the flood risk by the possible</p>	<p><u>Sediment regime</u>  A watercourse that does not support any significant species sensitive to changes to suspended solids concentration or turbidity.</p> <p><u>Channel morphology</u>  Watercourses exhibiting no morphological diversity;</p>	<p>Heavily modified watercourses or drainage channel with poor water quality, resulting from anthropogenic factors, corresponding to Classes A2, B, C and D. Major change in the species diversity of flora and fauna due to the significant water quality degradation. May receive road drainage water. Fish sporadically present. Low</p>

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Sensitivity	Surface Water Hydrology	Hydrodynamic Modelling (River Dee assessment)	Fluvial Geomorphology Vulnerability	Water Quality (Chemistry and Biological indicators)
	value). Or a watercourse/floodplain/hydrological feature that provides minimal flood alleviation benefits.	increase in the water levels.	flow is uniform gravel bars absent and bank types uniform and stable. <u>Natural fluvial processes</u> Watercourse which shows no evidence of active fluvial processes and which is not likely to be affected by modification to boundary conditions.	sensitivity ecosystem of local and less than local importance.

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##### *Interaction with Ecology*

- 24.2.19 In line with the WFD and as mentioned in paragraph 24.2.7, the individual discipline sensitivities and the overall water environment sensitivities assigned to each watercourse were discussed with the project team's ecological specialists to take into consideration the links between physical processes and their dependent habitats.
- 24.2.20 To avoid double counting during the assessment, all direct assessments of freshwater ecology are reported in Chapter 25 (Ecology and Nature Conservation). However, as part of the criteria to assess sensitivity, the ecological designations of the watercourses and the surrounding area have been considered where they indicate potential water quality. This provides a comprehensive evaluation of the baseline conditions and creates a close link with the freshwater ecology assessment. Consequently, this chapter evaluates sensitivity or vulnerability of the watercourse in terms of the physical attributes and processes encompassed by surface water hydrology (and flood risk), fluvial geomorphology and water quality.
- 24.2.21 Direct impacts on the flow and sediment regime, morphological diversity and water quality of watercourses can cause indirect ecological impacts. For ease of interpretation, Table 24.2 illustrates how the water environment sensitivity categories described in this section relate to those used in the assessment of baseline aquatic ecology (refer to Chapter 25: Ecology and Nature Conservation).

**Table 24.2 – Classification of Watercourse Sensitivity (Water Environment in relation to Ecology)**

Water Classification	Ecological Classification
High	International
High	National
High	Regional
High/Medium	County
Medium/Low	Local
Low	Less than Local

##### Impact Magnitude

- 24.2.22 The magnitude of potential impact was determined in accordance with the criteria shown in Table 24.3. In a similar manner to the sensitivity assessment presented above, each discipline (surface water hydrology, fluvial geomorphology, water quality and where appropriate hydrodynamic modelling) evaluated the potential impacts according to a defined set of criteria as listed in Table 24.3. Where quantifiable thresholds or accepted standards were not available, magnitude of impact was determined using professional judgement. The assessment of magnitude of impacts for this chapter then collates this information and assigns an overall impact magnitude for the water feature. This followed a precautionary approach by assigning magnitude based on the highest potential impact from each discipline.
- 24.2.23 Where appropriate, potential catchment impacts have been considered in this assessment. This has been completed on a qualitative basis only, with the exception of cumulative catchment operational impacts upon the water quality of the River Dee SAC and its associated tributaries. These have been quantified using a stochastic model and are reported in detail in Appendix A24.5 (Water Quality Modelling).

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**Table 24.3 – Criteria to Assess the Magnitude of the Potential Impact on Water Features**

Magnitude	Surface Water Hydrology	Hydrodynamic Modelling (River Dee assessment)	Fluvial Geomorphology (Specific Criteria for Sediment Modelling Assessment Provided in Appendix A24.6)	Water Quality and Water Quality Modelling
<b>High</b>	<p><u>General Impact</u>  Major shift away from baseline conditions and major changes to the flow regime (low, mean and or high flows – at the site, upstream and/or downstream). An alteration to a catchment area in excess of a 25% reduction or increase in area.  The extent of “medium to high risk” areas [classified by the Risk Framework of Scottish Planning Policy Guidance 7 (SPP7)] will be significantly increased. This means there will be significantly more areas/properties at risk from flooding by the 0.5% (1 in 200 year) or greater annual exceedance probability (AEP).</p>	<p><u>General Impact</u>  Major shift away from baseline conditions.  Increase in the predicted peak water levels in the watercourse is greater than 100mm at locations immediately upstream of the area.</p>	<p><u>General Impact</u>  Major shift away from baseline conditions.  <u>Sediment regime</u>  Major impacts on the river bed over this area due to deposition or erosion. Major impacts on sensitive species or habitats as a result of changes to suspended sediment load or turbidity.  <u>Channel morphology</u>  Major impacts on channel morphology over this area leading to a reduction in morphological diversity with consequences for ecological quality.  <u>Natural fluvial processes</u>  Major interruption to fluvial processes such as channel planform evolution or erosion and deposition.</p>	<p><u>General Impact</u>  Major shift away from the baseline conditions, fundamental change to water quality condition either by a relatively high amount over a long-term period or by a very high amount over an episode such that watercourse ecology is greatly changed from the baseline situation. Equivalent to downgrading from Class B to D or any change that downgrades a site from good status as this does not comply with the Water Framework Directive.  <u>Routine Runoff</u>  An increase to copper or zinc concentrations of 100% or greater over the baseline situation, plus/or a failure of EQS for either pollutant.  <u>Accidental Spillage</u>  An accidental spillage risk below the probability threshold level of 1 in 100 or 1 in 50 years (see the Impact Assessment Methodology section below).</p>
<b>Medium</b>	<p><u>General Impact</u>  Moderate shift away from baseline conditions and moderate changes to the flow regime. An alteration to a catchment area in excess of a 10% but less than 25% reduction or increase in area.  The extent of “medium to high risk” areas [classified by the Risk Framework of Scottish Planning Policy Guidance 7 (SPP7)] will be moderately increased.</p>	<p><u>General Impact</u>  Moderate shift away from the baseline conditions.  Increase in the predicted peak water levels in the watercourse varies between 50mm and 100mm at locations immediately upstream of the area.</p>	<p><u>General Impact</u>  Moderate shift away from the baseline conditions.  <u>Sediment regime</u>  Moderate impacts on the river bed and sediment patterns over this area due to either erosion or deposition. Changes to suspended sediment load or turbidity resulting in a moderate impact on sensitive habitats or species.  <u>Channel morphology</u>  Moderate impact on channel morphology.  <u>Natural fluvial processes</u>  Moderate interruption to fluvial processes such as channel planform evolution or erosion.</p>	<p><u>General Impact</u>  A moderate shift from the baseline conditions that may be long-term or temporary. Results in a change in the ecological status of the watercourse. Equivalent to downgrading one class, for example from C to D.  <u>Routine Runoff</u>  An increase to copper or zinc concentrations of 60-99% over the baseline situation, plus/or a failure of Environmental Quality Standards EQS for either pollutant.  <u>Accidental Spillage</u>  An accidental spillage risk above the probability threshold level of 1 in 100 or 1 in 50 years (see the Impact Assessment Methodology section below) with up to 1 in 200 years.</p>

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Magnitude	Surface Water Hydrology	Hydrodynamic Modelling (River Dee assessment)	Fluvial Geomorphology (Specific Criteria for Sediment Modelling Assessment Provided in Appendix A24.6)	Water Quality and Water Quality Modelling
<b>Low</b>	<p><u>General Impact</u>            Minor shift away from baseline conditions and minimum changes to the flow regime. An alteration to a catchment area in excess of a 1% but less than 10% reduction or increase in area.            The extent of “medium to high risk” areas [classified by the Risk Framework of Scottish Planning Policy Guidance 7 (SPP7)] will be similar to the magnitude of the errors attached to the estimate of the extent.</p>	<p><u>General Impact</u>            Minor shift away from the baseline conditions.            Increase in predicted peak water levels in the watercourse varies between 10mm and 50mm at locations immediately upstream of the area.</p>	<p><u>General Impact</u>            Minor shift away from the baseline conditions.  <u>Sediment regime</u>            Minimal changes to sediment transport resulting in minimal impacts on species or habitats as a result of changes to suspended sediment concentration or turbidity. Minor impacts on sediment patterns over this area due to either erosion or deposition.  <u>Channel morphology</u>            Limited impact on channel morphology.  <u>Natural fluvial processes</u>            Minimal change in fluvial processes operating in the river; any change is likely to be highly localised.</p>	<p><u>General Impact</u>            Minor shift away from the baseline conditions. Changes in water quality are likely to be relatively small, or be of a minor temporary nature such that watercourse ecology is slightly affected. Equivalent to minor, but measurable change within a class.  <u>Routine Runoff</u>            Specifically for the purposes of the soluble pollution assessment a medium impact will be classed as an increase to copper or zinc concentrations of 25-59% from the baseline situation but all EQS levels are met.  <u>Accidental Spillage</u>            For the purposes of this assessment, a high impact will be classed as an accidental spillage risk above the probability threshold level of 1 in 100 or 1 in 50 years (see the Impact Assessment Methodology section below) and between 1 in 200 and 1 in 1000 years.</p>
<b>Negligible</b>	<p><u>General Impact</u>            Slight shift away from baseline conditions and negligible changes to the flow regime (i.e. changes that are within the monitoring errors). An alteration to a catchment area in excess of a 1% reduction or increase in area.            The extent of “medium to high risk” areas [classified by the Risk Framework of Scottish Planning Policy Guidance 7 (SPP7)] will be much smaller than the errors attached to the estimate of the extent.</p>	<p><u>General Impact</u>            Negligible shift away from the baseline conditions.            Increase in predicted peak water levels in the watercourse is less than 10mm at locations immediately upstream of the area.</p>	<p><u>General Impact</u>            Slight change to the baseline conditions.  <u>Sediment regime</u>            Negligible changes to sediment transport resulting in negligible impacts on species or habitats as a result of changes to suspended sediment concentration or turbidity. No discernible impact to sediment patterns and behaviour over the development area due to either erosion or deposition.  <u>Channel morphology</u>            No significant impact on channel morphology in the local vicinity of the proposed site.  <u>Natural fluvial processes</u>            No change in fluvial processes operating in the river; any change is likely to be localised.</p>	<p><u>General Impact</u>            Slight change from the baseline conditions such that no discernible effect on the watercourse’s ecology results. No change in classification.  <u>Routine Runoff</u>            A negligible impact will be classed as an increase to copper or zinc concentrations of 24% or less over the baseline situation but all EQS levels are met.  <u>Accidental Spillage</u>            A negligible impact will be classed as an accidental spillage risk above the probability threshold level of 1 in 100 or 1 in 50 years (see the Impact Assessment Methodology section below) and over 1 in 1000 years.</p>

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#### Impact Significance

- 24.2.24 The significance of impacts was determined by reference to the overall sensitivity of the waterbody and the overall magnitude of impact, according to the matrix shown in Table 24.4.

**Table 24.4 – Significance of Impacts on the Water Environment**

Sensitivity	Magnitude			
	High	Medium	Low	Negligible
High	Substantial	Moderate/Substantial	Moderate	Slight/Negligible
Medium	Moderate/Substantial	Moderate	Slight	Negligible
Low	Moderate	Slight	Negligible	Negligible

#### **Specific Methodologies**

- 24.2.25 The technical reports (Appendices A24.1 to A24.4) set out the specific methodologies that were adopted to assess the sensitivity or vulnerability of each watercourse and potential impacts. This is summarised below for each discipline.

#### Surface Water Hydrology

- 24.2.26 The impact assessment of hydrology and flood risk included baseline estimates of seasonal flow duration curves, 95-percentile flow ( $Q_{95}$ ), mean flow ( $Q_{\text{mean}}$ ), bankfull and embankment full flow ( $Q_{\text{BF}}$ ,  $Q_{\text{EBF}}$ ), median annual maximum flood ( $Q_{\text{MED}}$ ), mean annual maximum flood ( $Q_{\text{BAR}}$ ) and flood design peak flows including the 1% and 0.5% annual exceedence probability (AEP) flows (also known as the 100-year and 200-year flood design peak flows). Necessary hydrological catchment characteristics were obtained from Ordnance Survey, soils, geological and land use maps as well as the Flood Estimation Handbook CD-ROM.
- 24.2.27 Flood risk and conveyance assessment for the AWPR crossing points included a review of SEPA 'Indicative River and Coastal Flood Map (Scotland)'. These flood risk maps have been designed to show the flood extent from watercourses and the sea of the 0.5% AEP (1:200 year flood) event. The maps, however, do not show the flood risk for watercourses smaller than 3km<sup>2</sup>. Further information regarding the methods undertaken can be found in Appendix A24.1 (Surface Water Hydrology). Baseline surface water catchments are shown on Figures 24.2a-e.

#### *Allowance for Climate Change in Hydrological Parameters*

- 24.2.28 Guidance on allowance for climate change has been taken from a scoping study regarding climate change and hydrological parameters (SEPA, 2005c). SEPA do not define a specific value as an allowance for climate change, but suggests that the sensitivity of flows within flood risk analysis could be carried out up to a 20% increase in flows for the East of Scotland. This is considered the maximum change and evidence suggests that by 2050 there is more likely to be an increase of approximately 15% in the East of Scotland (Price and McKenna, 2003).
- 24.2.29 The Scottish Executive (2004) states in the SPP7 Planning and Flooding Report that the threshold annual probability floods 0.5% (200 year) and 0.1% (1000 year) include an allowance for climate change. The Scottish Executive also indicates that developments should now be designed to the 0.5% annual probability design flood event instead of the 1% annual probability event in an allowance for possible future climate change increases.
- 24.2.30 Instead of designing to the 1% AEP (100 year design event), which historically has been standard practice, the 0.5% AEP (200 year) design flood event has been adopted which includes an allowance for climate change, as stated in SPP7. No guidance on the other hydrological parameters has been published by SEPA. Research work to date on these parameters indicates no clear regional patterns. No climate change factor is therefore suggested for these parameters, rather the guidance set out in SPP7, which is specific for Scotland, is followed.

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##### Hydrodynamic Modelling

- 24.2.31 The flood risk assessment study required the collation and review of the historic information available, relevant to the modelled reaches, including the hydrological information relating to the River Dee catchment and the channel cross-section information.
- 24.2.32 The hydrological analysis of the annual maxima series flow data at the Park Gauging Station on the River Dee established a flood frequency curve for a range of % Annual Exceedance Probability (AEP) flood events (50% – 0.5% AEP or 2 year to 200 year return period). This was based on the methodology set up by the Flood Estimation Handbook (IH, 1999).
- 24.2.33 To assess the risk of flooding, a one-dimensional (1-D), unsteady state, ISIS river modelling software platform-based mathematical model of the watercourse was developed. Data from channel cross-section surveys carried out in 2004 and 2006 were used to construct the model. Low flow calibration of the mathematical model was undertaken using water levels measured during channel cross-section survey.
- 24.2.34 Design event simulations for a range of %AEP flood events were carried out. Consequent flood risk was determined in the vicinity of the proposed river crossing for both the existing scenario and for the proposed crossing option.

##### Fluvial Geomorphology

- 24.2.35 The approach adopted for the geomorphology assessment differs from that followed in the surface water hydrology and water quality assessments. Fluvial geomorphology is not considered to have direct receptors (such as species or ecosystems) that are susceptible to adverse effects of impacts. Geomorphological change is the mechanism (pathway) by which receptors such as water quality and freshwater ecology are affected by the scheme. However, the geomorphological processes and forms associated with each watercourse are vulnerable to change as a result of the proposed scheme.
- 24.2.36 Baseline conditions were identified through desk study and field investigation. The desk study utilised existing data sources to provide an insight into current geomorphological conditions and trends in river behaviour. The field study built on the findings of the desk study in order to determine the geomorphological forms and processes at each site.
- 24.2.37 The potential impacts assessed by evaluating the potential change in baseline conditions (sediment regime, channel morphology and natural fluvial processes) that could result from the proposed scheme. As DMRB does not outline a specific methodology to enable the geomorphological impacts to be evaluated, the method adopted in this appraisal was developed using the guidelines from Research and Development Programmes of the National Rivers Authority, Environment Agency and Scottish Natural Heritage (SNH). These guidelines are outlined in the DEFRA/Environment Agency R&D Report FD1914 Guide Book of Fluvial Geomorphology (Sear et al., 2003). Potential impacts during construction and operational phases have been assessed. Further details of the assessment method can be found in Appendix A24.3 (Fluvial Geomorphology).

##### *River Dee*

- 24.2.38 Due to the designation of the River Dee as an SAC and the sensitivity of two of the SAC's qualifying species to changes in sediment loading (i.e. freshwater pearl mussels and salmon), an additional geomorphological study was undertaken. The combination of geomorphological mapping of the river channel, analysis of past channel change and review of the flood history of the river provided an understanding of the controls on channel morphology and improved understanding of the current baseline conditions. This enabled a more in depth assessment of the potential impacts of the road crossing over the River Dee. Further details are provided in Appendix A24.7, Annex 25.

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##### *Kingcausie Burn*

- 24.2.39 Due to the proximity of Kingcausie Burn to the River Dee SAC and the nature of the proposed engineering works, additional geomorphological investigations were requested by SEPA. These investigations consisted of a fluvial audit of the catchment to provide an increased understanding of the catchment-scale sediment processes, Conveyance Estimation Software (CES) Analysis and further review of the ground investigation data.
- 24.2.40 The Fluvial Audit supplemented the desk study that was undertaken to review the land use in the catchment, the hydrology of the watercourse and the additional catchment-wide site survey that was designed to record the sediment sources (erosion) and sinks (deposits). A detailed review of ground investigation data was also undertaken to assess the potential for erosion along the realigned channel.
- 24.2.41 Conveyance Estimation Software is designed to provide estimates water levels and flow velocities, in open channels, for define return period discharges derived using Flood Estimation Handbook (FEH) software (refer Appendix A24.1). The software generates levels and velocities by combining channel cross-sectional form, channel gradient, channel sinuosity and channel roughness data. CES software provides outputs based on current knowledge of river resistance and flow processes. Water level information was then used to design the cross-sectional form of the channel. Flow velocity information was combined with empirical relationships between flow velocity and sediment transport to determine the most appropriate sediment calibre to be installed within the channel.

##### Water Quality

##### *Baseline Assessment*

- 24.2.42 Baseline water quality conditions for watercourses were identified through consultation with statutory consultees, review of relevant published literature, site visits and freshwater habitat sampling undertaken in 2004/2005.
- 24.2.43 Baseline conditions for watercourses are reported by SEPA in accordance with their River Classification Scheme (Appendix A24.7, Annex 26 SEPA Classification Scheme). This categorises watercourses through the monitoring of water chemistry, biology, nutrient status, aesthetic condition and concentration of toxic substances (Annex 26 SEPA Classification Scheme). There are five classes comprising A1, A2, B, C and D in decreasing order of quality. Class A1 is excellent and Class D is seriously polluted. The class allocated to a particular reach of watercourse defaults to the poorest class determined from the water chemistry, biology, nutrient, aesthetics and toxicity assessments.

##### *Impact Assessment*

- 24.2.44 The water quality impact assessment was carried out in accordance with the methods set out in DMRB Volume 11, Section 3, Part 10, taking cognisance of more recent research such as 'Pollutant Build up and Runoff on Highways; Expanding the Current Methodology for Additional Determinants' (Patel and Drieu, 2005).
- 24.2.45 The impacts of road drainage on the quality of the receiving waters were quantified (by assessing accidental spillage and potential pollution from dissolved copper and total zinc). Copper and zinc are used as indicators of the level of impact as they are generally the main metallic pollutants associated with road drainage and can be toxic to aquatic life in certain concentrations. The assessment method for ascertaining likely pollutant levels in receiving watercourses or likely potential risks follows DMRB methods. Two separate calculations are undertaken:
- pollution calculations (routine runoff assessment); and
  - accidental spillage risk calculations.

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##### *Pollution Calculations (Operational Impacts)*

- 24.2.46 Routine runoff is surface water collected as a result of rain falling on the road and draining into the highway drainage system and contains some of the pollutants deposited on the road surface but does not include seriously major pollution events resulting from vehicular collision (addressed in accidental spillage risk assessment).
- 24.2.47 Pollution calculations were undertaken following the methods set out in DMRB Volume 11, Section 3, Part 10. These specify that the potential pollution in the receiving watercourse should be calculated assuming a high rainfall event coinciding with a low flow event in the receiving watercourse ( $Q_{95}$  low flow parameter). The DMRB states that this calculated concentration can then be compared to the statutory Environmental Quality Standards (EQS) that exist for the Freshwater Fisheries Directive (FWFD). These are expressed as 95th percentile values.
- 24.2.48 In addition to the Freshwater Fisheries Directive (FWFD), the Dangerous Substance Directive (DSD) sets statutory EQS for dissolved copper and total zinc. These are expressed as annual average values. To ensure that the drainage proposals conform to the Dangerous Substances Directive, in addition to the Freshwater Fisheries Directive, the DMRB methodology requires a modification to predict a likely annual average concentration in the receiving watercourse. Consultation and ongoing discussion with SEPA, for this and other projects, resulted in an agreed modification to predict potential, indicative, annual average values in the receiving watercourse (SEPA, pers.comm., 2004b and SEPA, pers.comm., 2005b). The modified methodology specifies that the potential pollution in the receiving watercourse is calculated assuming the annual average rainfall occurs on one day coinciding with a mean flow event in the receiving watercourse ( $Q_{\text{mean}}$  average flow in the watercourse).
- 24.2.49 As a precautionary approach has been adopted for the assessment of water quality along the route, both calculations were performed for all receiving watercourses with the more conservative results presented. These predicted concentrations were then used to inform the impact assessment. More information on the methodology and the EQS used (as advised by SEPA (SEPA, pers.comm., 2005) and contained in Statutory Instrument (Circular No34/1985)) are detailed in Appendix A24.4 (Water Quality).

##### *Spillage Calculations (Operational Impacts)*

- 24.2.50 Along any road, there is a risk of vehicular collision that could result in the spillage of fuels, oils or chemicals, particularly if tankers are involved. A risk assessment of a serious spillage causing pollution was undertaken using the methodology outlined in the DMRB guidance. Appendix A24.4 (Water Quality) provides detailed accidental spillage calculation results.

##### Water Quality Modelling

- 24.2.51 Potential impacts on the water quality of all small watercourses along the proposed route are presented in Appendix A24.4 (Water Quality). Due to the sensitivity of the Dee SAC, a cumulative catchment assessment of the potential impacts to water quality on a catchment basis was also undertaken. This assessment involved a more complex procedure than the point source methodology set out in the DMRB, Volume 11, Section 3, Part 10 (The Highways Agency et al., 2006) and used in Appendix 24.4, to reflect the interaction of the River Dee and its tributaries. The assessment of potential impacts on the SAC watercourses was completed using the Environment Agency (EA) model SIMCAT (SIMulation of CATchments). SIMCAT is a 1-D stochastic, steady state, deterministic model which represents inputs from point-source effluent discharges and the behaviour of solutes in the river (Cox, 2003).
- 24.2.52 SIMCAT is able to simulate a statistical distribution of discharge and water quality data for multiple effluent inputs along a network of watercourses. Through randomly modelling up to 2500 different boundary conditions (also known as the Monte Carlo approach) based on the input data, SIMCAT produces a distribution of results. These can be used to assess impacts from the predicted mean and 95 percentile concentrations.

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- 24.2.53 Quantification of the impacts of road drainage on water quality is based on the predicted concentrations of dissolved copper and total zinc in the receiving waters in the design year (2025) of the proposed scheme with and without designed mitigation. These metals are used as indicators of the level of impact as they are generally the main metallic pollutants associated with road drainage and can be toxic to aquatic life in certain concentrations (Highways Agency et al., 1993). In addition to dissolved copper and total zinc, suspended solids have been incorporated to the model to assess the cumulative catchment impact on the River Dee SAC area during operation.

#### Sediment Modelling

- 24.2.54 The purposes of the sediment modelling was to assess the potential for changes to suspended sediment concentration levels in the River Dee as a result of sediment laden runoff released into the river during construction of the mainline approach road. This was undertaken using mathematical sediment modelling to investigate potential impacts on sediment sensitive species such as migratory salmonids (e.g. *Salmo salar*) and freshwater pearl mussels (*Margaritifera margaritifera*). Appendix A24.6 details the methodology undertaken for this assessment.

#### Limitations to Assessment

##### *Hydrological Limitations*

- 24.2.55 The only continuous monitoring of hydrological data available near Aberdeen is for the River Dee and the River Don (Northern Leg). No hydrometric data was available for the remainder of the water features considered in the hydrology assessment (the watercourses are ungauged). Although suitable methodologies have been applied to these ungauged catchments, the absence of site specific monitoring data inevitably means that larger uncertainties must be attached to these estimates. Where possible, site visits and one-off measurements have been taken to improve the robustness of the estimates.

##### *Hydrodynamic Modelling Limitations*

- 24.2.56 Water level predictions from the hydrodynamic modelling study are from a 1-D mathematical model of the River Dee which does not include effects such as variation of water surface across the channel cross-section, local effects and fluctuations or elevation of water surface due to wind induced turbulence during flood events, etc. The reaches of the River Dee used for the assessment have been calibrated to low flows measured during channel cross-section surveys and may not be entirely representative of the conditions during high flow events.

##### *Geomorphological Limitations*

- 24.2.57 Mathematical modelling of sediment input, transfer or deposition, during road operation or construction, was beyond the scope of this assessment for all watercourses (other than the River Dee) due to the lack of available data around which to build the models for the majority of watercourses. Due to their small size, little additional information would be gained by modelling these watercourses.
- 24.2.58 The paucity of historical data (flow variation, channel morphology measurements, sediment concentrations in flow) and archive maps for many of the watercourses meant that the baseline conditions were judged on field observations during one site visit, providing an indication of character at a snap-shot of time rather than over a period of time. In addition, only one site visit means that the watercourses were observed under one flow condition (often low flow) rather than under several flow conditions. Watercourses are less dynamic (active) at low flow.

##### *Water Quality Limitations*

- 24.2.59 The water quality assessment is limited to a certain extent by the amount of available data and by the predictive methods available to complete a more rigorous assessment. The baseline water quality assessment was conducted using chemical (for the period 1988 to 2005) and biological (for the period 2000 to 2005) data provided by SEPA (SEPA, 2004/5) and spot sampling

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measurements conducted by Jacobs in the summer of 2006. Zinc and copper monitoring data for the River Dee, Crynoch Burn, Culter Burn and Brodiach Burn was provided by SEPA. At the time of this assessment, monitoring was not undertaken by SEPA for any other watercourses within the surveyed area. Spot sampling results provide only a snapshot of the water quality conditions in the watercourse at the time the sample was obtained. These results are not considered to be the equivalent of monitoring data and do not provide information in regards with the long-term health of the watercourse.

#### *Water Quality Modelling Limitations*

- 24.2.60 A number of assumptions are inherent in using a stochastic water quality model like SIMCAT. Mixing is assumed to take place downstream of the discharge points. A log normal distribution of determinants is also assumed, unless otherwise indicated by the provision of specific distribution data. Flows are generally represented using a non parametric distribution based on the flow duration curve.

#### *Sediment Modelling Limitations*

- 24.2.61 As mentioned above, one-dimensional (1-D) river models, such as ISIS, calculate a single average velocity and a single water level for each model cross section. However, in some areas the flow structure may be complex, particularly near structures where three-dimensional (3-D) effects may be dominant. Localised effects, such as bridge scours, effects of dunes and ripples cannot be simulated in one-dimensional models, which should be taken into account when using model predictions for sedimentation assessment purposes.
- 24.2.62 ISIS also assumes complete mixing across the channel and hence does not model the lateral spread of a sediment plume. Instead, it can only predict the passage of the plume downstream.

### **24.3 Baseline Conditions**

- 24.3.1 The River Dee and 19 smaller watercourses were identified within the study area, which would either be crossed by the Southern Leg section of the proposed scheme or would be potentially affected by the proposed scheme. In addition to the watercourses, one loch, several small ponds and two moss features were identified within the study area. Descriptions of each of the waterbodies are provided in Table 24.5. The assigned sensitivities of the waterbodies are explained below.
- 24.3.2 As some of the waterbodies within the study area were unnamed features, where required, these have been assigned names to aid clarity of the assessment (e.g. Whitestone Burn) and generally relate to adjacent named areas such as woodlands. Chainages are provided for the purposes of identifying the waterbodies shown on Figures 24.1a-h. This additional reference is necessarily approximate as certain features follow the route of the proposed scheme or cross it several times. Figures 24.2a-c indicate the surface water catchments of each watercourse in the study area that would be crossed by the proposed scheme. Figure 24.2d shows the hydrological catchment for Hare Moss.
- 24.3.3 Overall, the watercourses in the vicinity of the proposed scheme are considered to be of good quality from a hydromorphological and water quality perspective. Watercourses were evaluated as being between low and high sensitivity and each watercourse has been assessed in detail in the technical appendices. The sensitivity of the watercourse for each individual discipline (hydrology, geomorphology, water quality and, where appropriate, hydrodynamic modelling) is presented and then the overall sensitivity is discussed.
- 24.3.4 In line with the WFD and as mentioned previously, the individual discipline sensitivities and the overall water environment sensitivities assigned to each watercourse were discussed with the project team's ecological specialists to ensure a consistent approach between physical processes and their dependent habitats. A summarised version of the baseline ecological findings is provided in Table 24.5.

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**Table 24.5 – Water Feature Sensitivity**

Water Feature Catchment area upstream of the proposed road crossing (u/s); and Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
Loirston Burn/ Loch  3.5km <sup>2</sup> u/s  4.6km <sup>2</sup> total	n/a  D Impoverished	Loirston Burn flows in a north-easterly direction into Loirston Loch DWS where it is the dominant supply of water and important in maintaining water balance.  At the proposed road crossing points, the Indicative River and Coastal Flood Maps (Scotland) predict no risk of flooding at the 0.5% AEP (200-year return period event). Further desktop analysis of a 1:25,000 OS map indicates there is a potential flood risk to properties within 100m of the site of interest and within the 5m height resolution of the map.  The burn and associated loch are considered to be of medium sensitivity.	This is a straightened watercourse with a series of 90 degree bends. The banks are relatively high for the size of the watercourse, which results in an over deepened channel with no floodplain connectivity.  The heavily modified nature of the watercourse and limited flow means that active geomorphological processes are limited. Therefore, the watercourse is considered to be of low vulnerability to future modification.	The upper reaches of the catchment drain forested land while the middle and lower reaches pass through agricultural lands with field drainage systems.  Loirston Burn is currently not classified under the SEPA Water Quality Classification. Spot sampling (Jacobs, 2006) results for Loirston Burn indicated water quality class D (Impoverished). It is assumed this watercourse receives road runoff from the following roads: A956 Wellington Road, Cove Road (U168K), Craighill (Redmoss) Road (U168K) and A90 (T) Perth to Fraserburgh Trunk Road.  Due to its importance to the loch and despite poor water quality results, the burn is classed as a medium sensitivity watercourse.	The burn was sampled for macroinvertebrates at one location and was classified to be impoverished. The impoverished nature of the watercourse and the degree of modification has led to an evaluation of local value.	Overall, this watercourse is considered to be of medium sensitivity as its water quality and hydrology of Loirston Burn is important to Loirston Loch DWS.
Greenhowe Pond	n/a  n/a	A small round disused quarry (211m <sup>2</sup> ) surrounded by 12ft high sheer rock faces on two sides and a steep bank on the north side. Assessed by ecology only and surveyed for amphibians.			Considered to be of local value for amphibians.	Refer to Chapter 25 (Ecology and Nature Conservation)

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
Greengate Ditch  0.2km <sup>2</sup> u/s  0.3 km <sup>2</sup> total	n/a  n/a	Greengate Ditch is a small, possibly ephemeral field drain that is a tributary of Loirston Burn.  This watercourse does not appear to be connected to the hydrological regime of Hare Moss and is therefore unlikely to be important in the water balance of this sensitive environment.  This watercourse is considered to be of low sensitivity.	Overall, the channel has low morphological diversity and shows no evidence of significant erosion or deposition.  The modified nature of the channel and low morphological diversity means that the watercourse is of low vulnerability.	The catchment drains forested areas and agricultural lands.  Greengate Ditch is considered to be of low sensitivity.	Not explicitly assessed by freshwater ecology.	Overall, this watercourse is considered to be of low sensitivity.
Jameston Ditch  0.2km <sup>2</sup> u/s  0.7km <sup>2</sup> total	n/a  B Fair	Jameston Ditch is part of the Hare Moss drainage system. It runs along the northern boundary of Hare Moss, flowing in a north-westerly direction into the Burn of Ardoe. Connectivity between the moss and the ditch may be important in maintaining water levels in Hare Moss. The ditch may have a role to play at the confluence with the Burn of Ardoe in controlling water levels within the moss, particularly during periods of flood.  This watercourse is considered to be of high sensitivity.	This watercourse is an artificial field drain with a low gradient that is culverted under a farm track.  There are no active geomorphological processes and the artificial nature of the watercourse means that it has a low vulnerability to modification.	Jameston Ditch is currently not monitored by SEPA. It is likely to receive agricultural runoff. Spot sampling results (Jacobs, 2006) indicated that it is in fair biological condition.  The sensitivity of this burn is considered to be high due to its hydrological connectivity to Hare Moss.	Jameston Ditch was only assessed for macroinvertebrates as it would not be crossed by the proposed scheme. The highly modified ditch was assessed to be in fair biological status and has been evaluated as being of local value.	Overall, despite the degree of modification, this watercourse is considered to be of high sensitivity as the water quality and hydrological regime of the watercourse is of importance to Hare Moss.
Burn of Ardoe  0.1km <sup>2</sup> u/s  7.4km <sup>2</sup> total	n/a  n/a	The Burn of Ardoe is a tributary of the River Dee. It begins at the Hare Moss drainage system flowing in a north-westerly direction. Its connection with Heathfield Burn may be important in controlling the level of the burn, particularly during high flows.  This watercourse is considered to be of	In the upstream reaches, the stream is characterised by a narrow, low gradient channel. The channel was filled with vegetation which obscured the bed and traps fine sediment within the channel. The burn is relatively straight and appears to have been historically realigned. It does not show any	The Burn of Ardoe is crossed by Lochton-Auchlunies-Nigg Road (C5K), a farm track and the B9077.  The burn is currently not monitored by SEPA. It flows through agricultural land in its upper reaches and is likely to receive agricultural runoff. It is	Not explicitly assessed by freshwater ecology.  Identified as of regional importance to otters as a foraging route from the River Dee.	Overall, this watercourse is considered to be of high sensitivity as the water quality and hydrological regime of the watercourse is of importance to Hare Moss.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		high sensitivity.	evidence of significant natural fluvial processes and this appears to be related to the low channel gradient. The modified nature of this watercourse and lack of active fluvial processes means that this watercourse is of low vulnerability.	also considered to be part of the Hare Moss drainage system and so is considered to be of high sensitivity.		
Bishopston Ditch  0.2km <sup>2</sup> u/s  0.2km <sup>2</sup> total	n/a  n/a	Bishopston Ditch drains into Hare Moss flowing in a northerly direction. Although ephemeral, it is likely that this watercourse is an important supply of water for Hare Moss during winter months. From a hydrological perspective, the burn is considered to be of high sensitivity.	This is a straightened field drain with a low gradient and no perceptible flow. It is culverted under a farm track. There are no active geomorphological processes and the artificial nature of the watercourse means that it has a low vulnerability to modification.	Bishopton Ditch is currently not included in the SEPA Water Quality Classification Scheme. This watercourse flows through agricultural land and likely receives agricultural runoff. The sensitivity of Bishopton Ditch is considered to be high due to its hydrological connectivity with Hare Moss	Not explicitly assessed by freshwater ecology.	Overall, despite the degree of modification, this watercourse is considered to be of high sensitivity as the water quality and hydrological regime of the watercourse is of importance to Hare Moss.
Heathfield Burn  0.8km <sup>2</sup> u/s  1.2km <sup>2</sup> total	n/a  n/a	Heathfield Burn is part of a field ditch network to the south of Hare Moss and is a tributary of the Burn of Ardoe. The burn appears to have significant connectivity to Hare Moss and is considered to supply water to the moss throughout the year. Hydrologically, the burn is considered to be high sensitivity.	The channel is narrow, straight and artificially deepened with a low gradient. There are no active geomorphological processes and the artificial nature of the watercourse means that it has a low vulnerability to modification.	The burn drains predominantly agricultural land and is expected to receive agricultural and road drainage runoff. A private water supply was identified in the upper catchment area. The sensitivity of this burn is considered to be high due to its hydrological connectivity to Hare Moss.	Heathfield Burn was identified as being too small for macroinvertebrate sampling and as such was only assessed for habitat modification.. As such the burn has been evaluated as being of local value.	Overall, despite the degree of modification, this watercourse is considered to be of high sensitivity as the water quality and hydrological regime of the watercourse is of importance to Hare Moss.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
Hare Moss  -	n/a  n/a	Hare Moss is an area of degraded raised bog. Peat exposures just to the south of the moss suggest that at one time, the bog extended into an area to the south, which is now used for rough grazing. Direct rainfall falling on the moss is considered to be a significant supply of surface water to the moss area. The natural passage of flow through the moss is directed to the north-western corner of the moss. The main watercourse passing through the moss is the Burn of Ardoe. The central area of the moss is likely to receive water most prevalently during winter months when the Burn of Ardoe and Heathfield Ditch overtop their banks at the confluence during heavy periods of rainfall.  This water feature is considered to be high sensitivity.	Moss feature not relevant to geomorphology and scoped out of assessment.	The moss has been heavily modified through draining which has altered the local hydrology. Part of the moss has been converted to amenity grassland for recreational activity. The catchment of the moss is comprised predominantly of agricultural land. Flow draining through the moss will contain nutrient enriched runoff.  The moss system is considered to be of high sensitivity.	The moss is an area of lowland raised bog, which is a priority habitat in the UKBAP. Hare Moss is an important component of a network of sites in the region and integral to the viability of the region's habitat resource. Regional importance.	Overall, this watercourse is considered to be of high sensitivity.
Whitestone Burn  0.2km <sup>2</sup> u/s  0.3km <sup>2</sup> total	n/a  n/a	Whitestone Burn is a small tributary of Blaikiewell Burn, flowing in a south-westerly direction.  There is considered to be no existing flood risk at the site of interest.  This watercourse is considered to be of low sensitivity.	The channel of Whitestone Burn has been straightened and realigned to follow field boundaries. The channel is walled along much of its length.  The heavily modified nature of the watercourse and limited flow means that active geomorphological processes are limited and the watercourse is of low vulnerability to future modification.	The burn drains agricultural land and forested areas. Whitestone Burn is not included in the SEPA Water Quality Classification Scheme and is considered to be of low sensitivity.	Not explicitly assessed by freshwater ecology.	Overall, this watercourse is considered to be of low sensitivity.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
Burnhead Burn  4.2km <sup>2</sup> u/s  4.3km <sup>2</sup> total	n/a  A2 Good	Burnhead Burn is the main tributary of Blaikiewell Burn, which is a tributary of Crynoch Burn (part of the River Dee SAC).  Burnhead Burn is shown on the SEPA 'Indicative River and Coastal Flood Map (Scotland)' to be at risk of flooding at the 0.5% AEP (200-year return period event). At the site of the proposed crossing, flooding occurs on both the right and left river bank. However, the area inundated is shown to be less than 50m either side of the Burnhead Burn. There are no properties within 250m of the proposed crossing  This watercourse is considered to be of medium sensitivity.	The upper section of Burnhead Burn has a low gradient and is highly modified, has a low gradient and exhibits low morphological diversity. Consequently, from a geomorphological perspective, this is of low vulnerability to change. However, the lower section, which is steeper and exhibits good bed morphology, is of high vulnerability to future change.	Burnhead Burn drains areas of agricultural land and woodland. It is not monitored by SEPA. Recent spot sampling results (Jacobs, 2006) indicated good water quality (class A2). Burnhead Burn is considered to be of high sensitivity, as it is the main tributary of Blaikiewell Burn, which drains into Crynoch Burn.	The burn is able to support trout and is thus considered an important habitat that is sensitive to the supply of surface water.  The burn was sampled for macroinvertebrates near its confluence with Blaikiewell Burn and was found to be of excellent biological status. Despite the modified nature of this watercourse, the excellent biological conditions lead to an evaluation of county value.	Overall, this watercourse is considered to be of high sensitivity.
Blaikiewell Burn  4.5km <sup>2</sup> u/s  4.8km <sup>2</sup> total	n/a  A1 Excellent	Blaikiewell Burn is a small tributary of Crynoch Burn flowing in a north-westerly direction, outflowing into Crynoch Burn approximately 1km upstream of the confluence with the River Dee (SAC). The burn is known to support trout and thus is considered an important habitat sensitive to the supply of surface water.  At the proposed crossing point of the scheme, the SEPA 'Indicative River and Coastal Flood Map (Scotland)' predicts a risk of flooding at the 0.5% AEP (200-year return period event). Flooding of the site is not predicted to	The section of this watercourse that would be crossed by the proposed scheme is located within a 'u' shaped valley, which has gently sloping sides and contains a narrow strip of floodplain on both banks. The channel has a moderate gradient and appears to have been subject to straightening previously. The channel appears to have started to re-adjust and is developing a slightly sinuous planform.  The watercourse exhibits good morphological diversity.	In the middle and lower reaches the watercourse predominantly flows through woodland. Blaikiewell Burn is crossed by a class C (U63K) road and may therefore receive road drainage. Its confluence with the Crynoch Burn is within the River Dee SAC boundary.  Although Blaikiewell Burn is not currently monitored by SEPA, spot sampling results (Jacobs, 2006) indicated that it is of excellent quality (category A1). Consequently, the burn has been	Blaikiewell Burn was identified as being in excellent biological condition and therefore was evaluated as being of regional value.  Otter surveys concluded that the burn is of county importance.	Overall, this watercourse is considered to be of high sensitivity.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		<p>exceed 50m on the right or left river banks. No properties are predicted to be at risk of flooding in the area surrounding the proposed bridge location.</p> <p>This watercourse is considered to be of medium sensitivity.</p>	<p>Immediately before entering Crynoch Burn, the channel descends steeply over bedrock into the valley.</p> <p>As the watercourse exhibits good morphological diversity, the channel is highly vulnerable to modification.</p>	<p>classed as high sensitivity for the purposes of this assessment.</p>		
<p>Crynoch Burn</p> <p>31.7km<sup>2</sup> (to confluence with River Dee)</p>	<p>A2 Good</p> <p>A1 Excellent</p>	<p>Crynoch Burn is located in the vicinity of the study area and part of the River Dee SAC.</p> <p>The proposed scheme would not cross Crynoch Burn. However, it is included in this assessment as watercourses that would be affected by the proposed scheme are subcatchments within Crynoch Burn's overall catchment. The upstream catchment includes the highly sensitive Red Moss of Netherley SAC, from which Crynoch Burn flows in a northerly direction into the River Dee. The upper and middle reaches flow through farmland and have a floodplain on both banks. The lower reaches flow through woodland in a more defined valley.</p> <p>Existing flood risk has been assessed using the SEPA 'Indicative River and Coastal Flood Maps (Scotland). At present, the watercourse is predicted to flood up to 100m out of bank during the 0.5%AEP event (1 in 200-year</p>	<p>Crynoch Burn's headwater streams have relatively steep gradients, while the gradients of the central valleys decline progressively downstream.</p> <p>Downstream of Polston, the channel gradient increases as the stream enters a more confined gorge with frequent exposures of bedrock. This section of watercourse falls within the River Dee SAC. The channel exhibits excellent morphological diversity and evidence of active fluvial processes including erosion of both the stream banks. Locally, bedrock outcrops lead to steep waterfalls and associated deep pools. This gorge is considered to have originated as a glacial meltwater channel (British Geological Survey, 1980). The lower kilometre of Crynoch Burn has been subject to minor modification in the form of a</p>	<p>Crynoch Burn, part of the River Dee SAC, forms after the confluence of Cairnie Burn and Burn of Monquich, flowing north-east through Durris Forest and entering the River Dee near Culter camping site. Qualifying species of the SAC are freshwater pearl mussels, otter and atlantic salmon.</p> <p>SEPA monitoring data for Crynoch Burn show good (A2) water quality and the spot sampling results indicate class A1 (excellent) water conditions.</p> <p>The sensitivity of the burn is considered to be high.</p>	<p>Crynoch Burn was sampled for macroinvertebrates at two locations within the route corridor. The site furthest upstream was not assessed therefore evaluations are based on the biological status of the watercourse. The burn was found to be in excellent status and was evaluated as of regional value. Further downstream, the burn falls within the River Dee SAC boundary.. It was found to be in excellent biological status. Despite the degree of modification, the burn has been evaluated as of International value due to its excellent biological status and the fact that it falls within the boundary of the River Dee SAC.</p>	<p>Overall, this watercourse is considered to be of high sensitivity.</p>

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		flood event). Forestry and agricultural land are predominantly at risk, but there are properties within Kirkton of Maryculter and near the confluence with the River Dee that are predicted to flood.  This watercourse is considered to be of high sensitivity.	weir designed to supply water to a pond associated with a former mill. The watercourse is crossed by two existing bridges.  The watercourse exhibits excellent morphological diversity and the watercourse has high vulnerability to disturbance.			
Kingcausie Burn  1.6km <sup>2</sup> u/s  1.8km <sup>2</sup> total	n/a  B Fair	A small, fast flowing tributary of Crynoch Burn. Although its confluence with Crynoch Burn is close to the point that the Crynoch Burn discharges to the River Dee, it is considered Kingcausie Burn provides an important supply of water to Crynoch Burn. Kingcausie Burn is considered unlikely to directly maintain migratory salmon due to an impassable waterfall at its confluence with Crynoch Burn.  There is considered to be no existing flood risk at the point of interest.  This watercourse is considered to be of medium sensitivity.	Although Kingcausie Burn has been modified in a number of locations, the majority of the watercourse exhibits excellent morphological diversity and evidence of active fluvial processes.  The watercourse is highly vulnerable to future modification.	Kingcausie Burn drains a steep forestry catchment and some agricultural land.  Kingcausie Burn is not included in the SEPA water quality monitoring network. Spot sampling (Jacobs, 2006) indicated that water quality was fair (class B) quality. Private water supply wells were identified in the catchment area.  Kingcausie Burn is classed as high sensitivity watercourse due to its proximity to the SAC, private water supply wells, fair water quality and importance to sensitive species downstream.	The biological status of Kingcausie Burn was assessed as being fair, though it was found to support the notable weevil species <i>Litodactylus leucogaster</i> . Subsequently, the burn has been evaluated as being of Regional value.	Overall, this watercourse is considered to be of high sensitivity.
River Dee  2038km <sup>2</sup> u/s  2083km <sup>2</sup> total	A2 Good (2005) A2 Good	The catchment of the River Dee drains from the Grampian Mountains, flowing in an easterly direction through the south of Aberdeen city before discharging in to the North Sea.  The River Dee is a Salmon Fisheries River and a SAC, which has been	The River Dee is a large, fast flowing, cobble-bed river. The channel is characterised by high morphological diversity. It has a well defined large-scale pool and riffle sequence and numerous channel deposits including side bars and islands, covered by a	The section of the river that would be crossed by the proposed scheme flows through predominantly agricultural land, collecting water from several small tributaries. Water is abstracted from the river at the Inchgarth Reservoir to supply	Macroinvertebrate sampling indicated that the river was of good biological status supporting a diverse invertebrate assemblage. The river has been evaluated as being of International value.	Overall, this watercourse is considered to be of high sensitivity.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		<p>designated for freshwater pearl mussels, salmon and otters. It also has a status of DWS and SSSI. It provides important habitat for trout and lamprey.</p> <p>At the point where the proposed scheme would cross, the River Dee floodplain is relatively wide (almost 1 km in places).</p> <p>From predicted baseline flood extent maps, it is evident that there is an existing flood risk to properties along the banks of the river.</p> <p>The SEPA 'Indicative River and Coastal Flood Map (Scotland) and the baseline modelling indicate that the River Dee experiences out-of-bank flooding covering approximately 100m on the left bank and extensive flooding along the right bank of up to 800m. There are properties located in close proximity to the proposed bridge and the predicted 0.5% AEP flood inundation</p> <p>The River Dee is considered to be of high sensitivity.</p>	<p>range of vegetation types. The channel has a low gradient. However, flood flows that exceed <math>1000 \text{ m}^3\text{s}^{-1}</math> occur and these can move a range of sediment sizes. Fine sediment is generally absent from the bed of the river as this is moved by frequent high flows. The channel is in dynamic equilibrium with localised, slow, bank erosion on alternating banks. The main flow channel is partially connected to its floodplains which are inundated during large floods. The channel has been subject to small-scale modifications such as bridges and local bank protection works involving rip-rap.</p> <p>The high morphological diversity of the watercourse and absence of fine sediment on the riverbed means the River Dee is highly vulnerable to disturbance. In addition, the evidence of past channel changes, which appear to have been associated with floods, indicates that the river can alter its morphology significantly during large flood events.</p>	<p>drinking water to the Aberdeen area. The river provides exceptional natural habitat conditions and spot sampling (Jacobs, 2006) of water quality at Milltimber indicated category A2. SEPA monitoring indicates that the river is category A1/A2 within the SAC area.</p> <p>The sensitivity of the River Dee has been classed as high.</p>	<p>The River Dee is also considered to be of International value for otters, who use the river for foraging, commuting, lying up and breeding.</p>	
<p>Milltimber Burn  0.6km<sup>2</sup> u/s</p>	<p>n/a  B Fair</p>	<p>Milltimber Burn is a relatively small tributary of the River Dee. The watercourse flows in a south-easterly direction. Culverted through Milltimber, the burn emerges at the old railway</p>	<p>The channel is straight and ditch-like. In the upper reaches the bed is sandy and gravely, but silt becomes obvious further downstream due to some bank</p>	<p>Milltimber Burn drains a mixture of urban, forested and rural land throughout its catchment. The watercourse has been culverted in several locations and is</p>	<p>Milltimber Burn was assessed as possessing fair biological status. The modified nature and biological status led to an evaluation of local value.</p>	<p>Overall, this watercourse is considered to be of low sensitivity.</p>

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
2.4km <sup>2</sup> total		line to flow alongside the B979 and then across the River Dee's floodplain. This watercourse is considered to be of low sensitivity.	poaching by livestock. The low gradient section acts as a silt trap, preventing too much fine sediment from being transported through to the River Dee.  Past modification and the low gradient means that the watercourse has a low vulnerability to further modification.	crossed by the A93. It receives road and urban drainage via a small tributary that begins near Binghill, runs through Milltimber. Milltimber Burn is not monitored by SEPA. Spot sampling results (Jacobs, 2006) indicated water quality to be fair (B).  The burn is considered to be a watercourse of low sensitivity due to the road drainage it currently receives.		
Culter House Burn  0.1km <sup>2</sup> u/s  0.6km <sup>2</sup> total	n/a  n/a	Culter House Burn is field ditch that appears to be unconnected to any major watercourse. This watercourse is considered to be a site specific drainage ditch with no significant contribution to the surface runoff of the surrounding area.  This watercourse is considered to be of low sensitivity.	This watercourse has a narrow and ephemeral channel with a moderate gradient. It has been straightened, culverted under a road and is walled along one bank. The channel was obscured by vegetation at the time of the survey.  The heavily modified nature of the watercourse and limited flow means that active geomorphological processes are limited and the watercourse is of low vulnerability to future modification	Culter House Ditch is crossed by a class C road and may therefore receive road drainage.  Consequently, it is of low sensitivity.	Culter House burn was only assessed for habitat modification as the burn was dry at the time of sampling. The burn was identified to be severely modified with extensive re-sectioning and realignment. The burn was evaluated as being of less than local importance.	Overall, this watercourse is considered to be of low sensitivity.
Beans Burn  0.1km <sup>2</sup> u/s  0.9km <sup>2</sup> total	n/a  n/a	A tributary of Upper Beanshill Burn and Murtle Dam Reservoir, draining through Murtle Den DSW. The watercourse drains in a south-westerly direction from Beans Hill, following field boundaries for its entire length.  The section that would be crossed by	The channel has been straightened and is walled in several locations along the right bank.  There are no active geomorphological processes and the artificial nature of the watercourse means that it has a	Beans Burn flows through predominantly agricultural land and likely receives agricultural runoff.  Beans Burn was classed as low sensitivity.	Not explicitly assessed by freshwater ecology.  Local value for otters based on potential foraging habitat.	Overall, this watercourse is considered to be of low sensitivity.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		the proposed scheme is in the upper catchment and there is limited risk to the water balance of the reservoir. There is no flood risk evident along the length of the watercourse. This watercourse is considered to be of low sensitivity.	low vulnerability to modification			
Upper Beanshill Burn and Ponds  0.05km <sup>2</sup> u/s  1.8km <sup>2</sup> total	n/a  n/a	Upper Beanshill Burn is a small tributary of Murtle Burn, situated in its upper catchment. The watercourse rises near Gairn Burn and flows in a south-easterly direction into two ponds. The upper reaches of the burn were observed to be ephemeral. It is considered that this area of the catchment plays a limited role in the water balance of Murtle Dam Reservoir and the ponds downstream of the proposed crossing point of the scheme. This watercourse is considered to be of low sensitivity.	The channel appears to have been straightened as part of a field drainage system. There are no active geomorphological processes and the artificial nature of the watercourse means it has a low vulnerability to modification.	The burn drains forestry and agricultural lands. At present, Upper Beanshill Burn is crossed by Silverburn Road (C127). This watercourse likely receives local road drainage and agricultural runoff. Its water quality is not monitored by SEPA. Upper Beanshill Burn was classed as being of low sensitivity.	Upper Beanshill Burn was only assessed for habitat modification as flow levels were too low to allow macroinvertebrate sampling. The burn forms a straightened drainage channel and as such is evaluated as local value. County value for otters.	Overall, this watercourse is considered to be of low sensitivity.
Gairn Burn  0.8km <sup>2</sup> u/s  0.9km <sup>2</sup> total	n/a  B Fair	Gairn Burn is a small tributary of Silver Burn and part of the Brodiach Burn catchment (Brodiach Burn is a designated salmonid river). The burn flows in a south-westerly direction to Silver Burn. The catchment accounts for a small percentage of the Silver Dart Reservoir. However, the section that would be crossed by the proposed scheme is located in the upper catchment and thus plays only a minor	Gairn Burn is a short, narrow, gravel bed stream. In the upper reaches, the channel is steep and relatively natural, with varied flow and step-pool sequences over coarse block substrate. The channel is bridged by the Broomfold to Blacktop road along which the lower reach of the stream has been realigned and walled. The watercourse is considered to	The catchment drains agricultural land and Gairn Hill Woodland. A number of private water supply wells have been identified in the vicinity of the watercourse (refer to Chapter 23: Geology, Contaminated Land and Groundwater). Gairn Burn is not monitored by SEPA. Macroinvertebrate spot sampling carried out by Jacobs in	Gairn Burn was assessed for macroinvertebrates and identified as being of fair biological status. Evaluated as being of county value.	Overall, this watercourse is considered to be of medium sensitivity.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		role in maintaining the water balance of the reservoir. This watercourse is considered to be of medium sensitivity.	be relatively natural and has a medium vulnerability to future modification.	2006 indicated that water quality is of Class B (fair). Consequently, the burn is considered to be of medium sensitivity.		
Moss of Auchlea drainage system  0.2km <sup>2</sup> u/s  1.1km <sup>2</sup> total	n/a  n/a	This water feature constitutes the upper tributary of the Ord Burn and flows in a south-westerly direction. This feature is important to the supply of surface water to the Moss of Auchlea (DWS) throughout the year. This drainage system is also the smallest of four watercourses draining to the Silver Dart Reservoir and thus plays a minor role in maintaining the water balance of the reservoir.  There is a limited existing flood risk to properties to the south east of the Moss of Auchlea area.  This water feature is considered to be of high sensitivity.	The channel has a moderate to steep gradient and shows evidence of past straightening and realignment.  The small size of this water feature led to it being scoped out of the geomorphological assessment.	This water feature is considered to be important to the quality of the moss. A number of private water supply wells have been identified in the vicinity (refer to Chapter 23: Geology, Contaminate Land and Groundwater).  The Moss of Auchlea drainage system is considered to be of high sensitivity.	Moss of Auchlea DWS contains long-established UK BAP wet woodland with areas of swamp, marsh and fen underneath.  The biodiversity of the area, combined with the potential to augment and extend means this area is of Regional value.	Overall, this water feature is considered to be of high sensitivity based on the local hydrological and water quality importance of the moss and the local wells.
Moss of Auchlea  -	n/a  n/a	Moss of Auchlea is a designated DWS and, as such, is recognised as a place of wildlife importance.  It is approximately 6ha and surrounded by farmland. The site is located in a low lying basin crossed by the Silver Burn, a tributary of the River Dee. The low lying nature of the site has led to waterlogging and over many years, a build up of peat has occurred, creating a small basin mire. Most of the site is wet with peaty soils.	Moss feature is not relevant to geomorphology and has been scoped out of assessment.	The site supports valuable wetland habitats and a range of wetland plants, although none of the species present are particularly rare. The habitats of fen and rush pasture have declined significantly within the area due to drainage and agricultural intensification. Water quality is intrinsically linked to the health of the site.  The Moss of Auchlea is	Moss of Auchlea contains long-established UK BAP wet woodland with areas of swamp, marsh and fen underneath.  The biodiversity of the area, combined with the potential to augment and extend means this area is of Regional value.	Overall, this water feature is considered to be of high sensitivity based on the local hydrological and water quality importance of the moss and the local wells.

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
		<p>The supply of surface water is dominated by Silver Burn and augmented by several field drainage ditches in the local area to the moss. Connectivity to these ditches allows the moss to maintain high levels of surface water throughout the year. It is also considered that direct rainfall is an important source of water for the moss.</p> <p>This water feature is considered to be of high sensitivity.</p>		<p>considered to be of high sensitivity.</p>		
<p>Westholme Burn</p> <p>0.6km<sup>2</sup> u/s</p> <p>2.0km<sup>2</sup> total</p>	<p>n/a</p> <p>n/a</p>	<p>Westholme Burn is a small ephemeral tributary of Brodiach Burn, which is a designated salmonid river. The burn in a south-westerly direction.</p> <p>Brodiach Burn is the most significant watercourse supplying the Silver Dart Reservoir. Westholme Burn accounts for a 3% of the total catchment draining to the reservoir and thus only plays a minor role in maintaining the water balance of the reservoir.</p> <p>This watercourse is considered to be of low sensitivity.</p>	<p>The channel of Westholme Burn has been straightened and deepened, with a relatively low gradient. Locally, the banks top are raised and composed of boulders and cobbles which appear to have been dredged out of the channel. The banks were well vegetated and the channel showed no evidence of active erosion or deposition.</p> <p>The modified nature of the watercourse and lack of active fluvial processes means that this watercourse is of low vulnerability to future modification.</p>	<p>The landuse within the catchment of this watercourse includes agricultural and forestry land.</p> <p>Westholme Burn is not monitored by SEPA. SEPA monitoring points are located on Brodiach Burn upstream and downstream from the Westholme-Brodiach Burns confluence. Water quality results for Brodiach Burn above the confluence is classed as good (A2) quality. Downstream of the confluence, the results indicated poor (C) water quality due to high concentrations of iron (SEPA website, 2005). This indicates that Westholme Burn may be polluted as it has an adverse impact on Brodiach Burn water quality. It is therefore classed as of low sensitivity.</p>	<p>Not explicitly assessed by freshwater ecology.</p>	<p>Overall, this watercourse is considered to be of low sensitivity.</p>

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Water Feature Catchment area upstream of the proposed road crossing (u/s); and  Total catchment area (total)	SEPA Class (where classified) and Spot Sampling	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (Refer to Chapter 25 Ecology and Nature Conservation for more information)	Overall Sensitivity/ Vulnerability
Borrowstone Burn and Ponds  0.6km <sup>2</sup> u/s  1.1km <sup>2</sup> total	n/a  n/a	The catchment of Borrowstone Burn drains agricultural land and runs in a south-westerly direction. Much of the watercourse appears to have been modified as part of a field drainage system. The upper catchment of the burn drains Brimmond Hill and is important in maintaining the water balance in a large pond. There are no known abstractions from the watercourse.  This water feature is considered to be of low sensitivity.	Borrowstone Burn and ponds would not be crossed by the proposed scheme and have been scoped out of the geomorphology and water quality assessments.		Not explicitly assessed by freshwater ecology.  Local value for otters based on potential foraging habitat	Overall, this watercourse is considered to be of low sensitivity.

### **Summary of Watercourse Sensitivity**

#### Loirston Burn and Loch (ch205585)

- 24.3.5 Loirston Burn is a small predominantly modified watercourse, which feeds Loirston Loch District Wildlife Site (DWS). The watercourse flows in an over-deepened, straightened channel with a number of 90° angle turns, underneath the existing A90 and A956 before draining to Loirston Loch. Loirston Loch was previously designated as a SSSI due to the presence of nationally scarce thread rush (*Juncus filiformis*), which has progressively disappeared as a result of overall habitat degradation (eutrophication). In 1983, the SSSI status was removed. The importance of the watercourse on the health of the loch is reflected in the hydrological, geomorphological and water quality assessments of the burn. Overall, the watercourse and its associated downstream loch are considered to be of medium sensitivity.

#### Greengate Ditch (ch205050)

- 24.3.6 Greengate Ditch is a small watercourse, considered to be a modified tributary of Loirston Burn. Given its size, degree of modification and the fact that it is not considered to drain to Hare Moss, the burn is considered to be of low sensitivity by all disciplines.

#### Greenhowe Pond (ch206100)

- 24.3.7 Greenhowe Pond has not been explicitly assessed in this chapter as it was scoped out of the assessment based on its size. The pond has been surveyed for amphibians and is included in Chapter 25 (Ecology and Nature Conservation).

#### Jameston Ditch (ch204500), Burn of Ardoe (ch204000), Bishopston Ditch (ch203900), Heathfield Burn (ch203650), and Hare Moss (ch204500)

- 24.3.8 Burn of Ardoe, Bishopston Ditch and Heathfield Burn are located within the catchment of Hare Moss. It is considered likely that, in the area of interest, many of these watercourses were excavated to drain the surrounding land for agricultural purposes. While they are highly modified and straightened, these watercourses provide important connectivity to Hare Moss. From a hydrological and water quality perspective, the burns are considered to be of high sensitivity.
- 24.3.9 Jameston Ditch runs along the northern edge of the moss. Based on limited information, it is considered that Jameston Ditch is connected to the moss and appears to drain water from the moss. Connectivity between the moss and the ditch may be important with regard to water levels in the Hare Moss area. The ditch may also have an important role at the confluence with the Burn of Ardoe contributing to controlling water levels, particularly during periods of flood. From a water quality perspective, this burn is of similar importance as those considered above. Overall, the sensitivity of the watercourse is considered to be high.
- 24.3.10 Hare Moss has been identified as a degraded raised bog and is considered to have potential for restoration (Figure 24.2d). Peat exposures to the south of the moss suggest that at one time, the bog extended into an area now used as rough grazing. The moss is considered to be of high sensitivity.

#### Whitestone Burn (ch201000)

- 24.3.11 A small tributary of Blaikiewell Burn, Whitestone Burn has been heavily modified to follow field boundaries in its upper reaches. All three technical disciplines consider this burn to be of low sensitivity and therefore the overall sensitivity is low.

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##### Burnhead Burn (ch200100), Blaikiewell Burn (ch100150), and Crynoch Burn (outside of study area boundary)

- 24.3.12 Burnhead Burn is the main tributary of Blaikiewell Burn. It is heavily modified with a low gradient and has been previously straightened to follow field boundaries in the area of interest. In the lower section near its confluence with Blaikiewell Burn, the watercourse exhibits good bed morphology. Spot sampling indicated that water quality is good (A2). Burnhead Burn is suggested by the SEPA 'Indicative River and Coastal Flood Map (Scotland)' to be at risk of flooding at the 0.5% AEP (200-year return period event), however, it suggests that no properties are at risk. The watercourse is considered to be of high sensitivity.
- 24.3.13 Similarly, Blaikiewell Burn displays areas of modification, however downstream towards its confluence with Crynoch Burn, the watercourse possesses good morphological diversity. Spot sampling indicated that water quality is excellent (A1). The SEPA 'Indicative River and Coastal Flood Maps (Scotland)' suggest that no properties are predicted to be at risk of flooding in the proposed crossing location. Additionally, the watercourse is an important tributary of Crynoch Burn, which is located within the boundaries of the River Dee SAC. Due to the proximity of the burn to the SAC, the watercourse is considered to be of high sensitivity.
- 24.3.14 In addition to Crynoch Burn being part of the River Dee SAC, SEPA monitoring and spot sampling results indicate that the burn has good to excellent water quality in the area of interest. Geomorphologically, the watercourse exhibits excellent morphological diversity and displays evidence of active fluvial processes. The SEPA 'Indicative River and Coastal Flood Maps (Scotland)' suggest that during the 0.5%AEP event (1 in 200-year flood event), forestry and agricultural land are predominantly at risk. However, there are properties within Kirkton of Maryculter and near the confluence with the River Dee that are predicted to flood. Overall, the burn is considered to be of high sensitivity.

##### Kingcausie Burn (ch101500)

- 24.3.15 In a similar manner to Blaikiewell Burn, Kingcausie Burn is considered to be of high sensitivity based on its proximity and importance to the SAC, which is located downstream. The water quality of the burn was of fair quality during sampling in June 2006 and in sections the watercourse displays excellent morphological diversity.

##### River Dee (ch102000)

- 24.3.16 This major river drains the Grampian Mountains and discharges to the North Sea. The river is large and fast flowing with a cobble bed. The channel is characterised by high morphological diversity.
- 24.3.17 The section of the river directly relevant to the assessment is situated between Park Bridge and the Bridge of Dee. Within this section, the river flows through predominantly agricultural land collecting water from several relatively small tributaries: Culter Burn, Crynoch Burn, Milltimber Burn, Murtle Burn, Shanna Burn, Bielside Burn and Burn of Ardoe. On the north riverbank, a number of residential areas are present including Peterculter, Milltimber, Milton of Murtle, Bielside, Cults, Garthdee and Kairnhill. The River Dee and its surrounds are valued for recreational purposes. There is a campsite near Crynoch Burn, a golf course and a sports centre at Bielside. The area contains several riverside walks and the river is used for fishing and canoeing.
- 24.3.18 Water is abstracted from the river at the Inchgarth Reservoir to supply drinking water to the Aberdeen area. The average water abstraction is 89.9 megalitres per day (Aberdeen City Council et al., 2002, cited in Mouchel, 2002).
- 24.3.19 Historical flood extents and baseline flood modelling indicate that several properties are currently at risk from flooding on the southern floodplain. The SEPA 'Indicative River and Coastal Flood Map (Scotland)' and the baseline modelling indicates that the River Dee experiences out-of-bank

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flooding covering approximately 100m on the left bank and extensive flooding along the right bank of up to 800m. Existing properties are located in close proximity to the proposed bridge and the predicted 0.5% AEP flood inundation.

24.3.20 The river is well connected to its floodplains and they are inundated regularly in areas where agricultural flood defences allow.

24.3.21 The River Dee provides exceptional natural habitat conditions and water quality (spot sampling water quality at Milltimber Category A2 and SEPA Category A1/A2 within the SAC area) for populations of native brown, sea trout and migratory salmon (refer to Appendix A25.9: Freshwater Ecology). The overall sensitivity of the River Dee has been classed as high.

#### Milltimber Burn (ch102650) and Culter House Burn (ch103600)

24.3.22 Both of these burns are heavily modified and artificially straightened watercourses. Milltimber Burn currently receives road drainage from the existing B979. All three technical disciplines consider these burns to be of low sensitivity.

#### Beans Burn (ch105150) and Upper Beanshill Burn and Ponds (ch106500)

24.3.23 In the area of interest, both of these burns are heavily modified, straightened and ephemeral in their upper reaches. They both drain to Murtle reservoir downstream through the Murtle Burn District Wildlife Site (DWS). Ultimately, both burns drain to the River Dee, however Upper Beanshill Burn feeds two online ponds on its descent. The watercourses are considered to be of county importance to otters (refer to Chapter 25: Ecology and Nature Conservation). Overall, in their upper reaches, the burns are considered to be of low sensitivity.

#### Gairn Burn (ch106500)

24.3.24 Gairn Burn is a small tributary of Silver Burn and part of the Brodiach Burn catchment (Brodiach Burn is a designated salmonid river). It begins just east of Gairn Farm and flows south along field boundaries of pastureland of a moderate to steep gradient. A number of private water supply wells have been identified in the vicinity of the watercourse (refer to Chapter 23: Geology, Contaminated Land and Groundwater). Spot sampling indicated that water quality is fair. Consequently, the burn is considered to be of medium sensitivity for the water environment.

#### Moss of Auchlea Drainage System (ch107450) and Moss of Auchlea (ch107450)

24.3.25 The moss and its drainage system constitutes the upper tributary of Ord Burn flowing in a south-westerly direction. The burn drains an area of predominantly agricultural land, but also passes through the environmentally sensitive site of the Moss of Auchlea downstream of the proposed scheme. The drainage system is important to the supply of surface water to the Moss of Auchlea throughout the year.

24.3.26 The Moss of Auchlea is identified as having local value due to its valuable wetland habitats and is a designated DWS. As such, it is officially recognised as a place of wildlife importance. The moss is approximately 6ha in area and surrounded by farmland. The low lying nature of the site has led to waterlogging and over many years a build up of peat has occurred, creating a small basin mire. Most of the site is wet with peaty soils.

24.3.27 The supply of surface water is dominated by the upper reaches of the Silver Burn and augmented by several field drainage ditches in the local area to the moss. Connectivity to these ditches allows the moss to maintain high levels of surface water throughout the year. It is also considered that direct rainfall is an important source of water for the moss.

24.3.28 Overall, the moss is considered highly sensitive, therefore, the drainage system that feeds it (both in hydrological and water quality terms) is also considered to be highly sensitive.

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##### Westholme Burn (ch108650)

- 24.3.29 Westholme Burn is a small ephemeral tributary of Brodiach Burn, which is a designated salmonid river. It flows in a westerly direction through land of a relatively low gradient and follows the boundary of Blackhill Tip (West Kingsford, an industrial tip closed in 1991) before finally discharging into Brodiach Burn.
- 24.3.30 Westholme Burn is monitored by SEPA. There are SEPA monitoring points located on Brodiach Burn upstream and downstream from the confluence of Westholme and Brodiach Burns. This indicates that the Westholme Burn may be polluted as it has an adverse impact on the Brodiach Burn water quality. Upstream of the burn's confluence Brodiach Burn is considered by SEPA to be of A2 good water quality, while downstream of the confluence water quality is of C poor quality. The quality of Westholme Burn is considered to be in poor condition.
- 24.3.31 Overall, in combination with its ephemeral nature, straightened formed and poor water quality, Westholme Burn is considered to be of low sensitivity.

##### Borrowstone Burn and Ponds (ch110400)

- 24.3.32 Borrowstone Burn catchment drains agricultural land and runs in a southwesterly direction. The upper catchment of the burn drains Brimmond Hill and is important in maintaining the water balance in a large pond. There are no known abstractions from the watercourse and as such the burn and associated pond is considered to be of low sensitivity.

#### **Groundwater Baseline**

- 24.3.33 The details of the groundwater baseline assessment are provided in Chapter 23 (Geology, Contaminated Land and Groundwater). Chapter 23 provides information regarding wells and springs used for domestic and/or agricultural water supply and is of relevance to the Water Environment assessment. Chapter 23 also provides additional information regarding groundwater connectivity for Hare Moss and the Moss of Auchlea.

## **24.4 Potential Impacts**

- 24.4.1 Impacts on surface water features, as a result of road construction, are described for each of the four specialist disciplines described in Section 24.2 (Approach and Methods).
- 24.4.2 This section provides a description of the types of impacts that are likely to occur as a result of the proposed scheme, which then forms the basis for the specific impacts for each water feature identified in the baseline conditions.
- 24.4.3 It is emphasised that the potential impacts presented in this section are assessed assuming no mitigation and hence represent the worst case scenario for the water environment. It should be noted that these are identified with the principal purpose of designing appropriate mitigation and are not expected to be the final impacts of the scheme. Mitigation is described in Section 24.5 and the residual impacts of the scheme, following mitigation, are presented in Section 24.6.

#### **Generic Impacts**

- 24.4.4 Impacts may result from the following:
- road drainage: reduced infiltration, or transfer of water from one catchment to another and therefore increased discharge to receiving waters potentially increasing flood risk and pollutant/sediment release into receiving waters through normal runoff or accidental spillage;
  - watercourse crossings: constriction or severing of established flow paths leading to increased flood risk and changes to sediment regime via changes to gradient and size of watercourse, leading to impact on geomorphology and subsequently water quality;

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- watercourse realignments: often a result of the watercourse crossing design, these can change the catchment of the watercourse leading to increased local flood risk, or a reduction to flow as a result of severed catchments, or changes to sedimentation patterns along the watercourse and associated impacts on morphological diversity;
- network culverts: localised introduction of flood risk to areas where there is none currently;
- watercourse re-direction to pre-earthworks, or catchment severance: water transfer from one catchment to another; and
- construction: changes to surface water hydrology may lead to localised flood risk, potential for increased sediment release and changes to erosion/depositional patterns as a result of the construction of culverts/realignments and the potential for increased accidental spillage of pollutants such as concrete or oils during the construction process.

24.4.5 These impacts are discussed further below.

#### **Road Drainage Impacts**

##### *Surface Water Hydrology*

24.4.6 The proposed scheme would introduce new impermeable areas to the watercourse catchment. It is estimated that the road surface area for the Southern Leg section of the proposed scheme would be approximately 0.42km<sup>2</sup>. This would be likely to increase the overall volume of water reaching a watercourse as less would be lost to infiltration into the ground. Road runoff would also reach the receiving watercourse more quickly than previously, resulting in the flood response of the catchment becoming more 'flashy' (i.e. rapid, short duration increase in watercourse flow). Additionally, the road and its drainage system may act as a barrier to water movement within current catchments, with rain falling in one catchment potentially discharged to another via the road drainage system (referred to throughout this report as watercourse taken into pre-earthworks drainage ditches). This could increase flows to some watercourses while reducing flows in others.

24.4.7 These potential hydrological impacts are likely to alter flood risk and discharge, fundamentally altering the baseline flow regime of watercourses. Indirect impacts on aquatic ecology may also accrue. For example, a significant change to the discharge regime to Heathfield Burn could result in indirect impacts on Hare Moss. Potential ecological impacts are assessed in Chapter 25 (Ecology and Nature Conservation).

24.4.8 Changes to the surface water discharge regime may trigger riverbank erosion and affect water quality and geomorphology of the riverbed. These impacts are discussed below.

##### *Fluvial Geomorphology*

24.4.9 An increase in discharge (flow) along the watercourse as discussed above (surface water hydrology impacts), may increase the activity of geomorphological processes within the channel. This could result in:

- an increase in turbidity and a greater competence to entrain and transport sediment (fine and coarse material) downstream;
- increased erosion of the channel bed and banks. Morphological diversity could be reduced or improved depending on sediment supply; and
- a period of adjustment to different flow and sediment regimes.

24.4.10 The polluting load carried in road runoff may include fine sediment accumulations, which are washed from the road into the drainage system and discharged to receiving watercourses. Such increases to suspended sediment load may lead to:

- channel sedimentation, causing a reduction in dynamic processes. For example, the smothering of gravel surfaces, such as bars, by fine sediment can encourage vegetation

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colonisation increasing the stability of the feature and changing the nature of associated habitats;

- increased transportation (turbidity) and deposition of fine sediment (sedimentation); and
- a reduction of morphological and consequently, ecological diversity due to fine sediment deposition.

24.4.11 The volume of sediment generated by the operation of the road and discharged to a particular watercourse will vary depending on the area of road from which runoff will be directed.

24.4.12 There is potential for scour to occur at drainage outfalls. This may lead to increases in sediment supply/deposition, localised alterations to flow and changes to channel morphology. These impacts are likely to be highly localised and proportional to the size of the watercourse and can be minimised or avoided through appropriate outfall design, as described in Section 25.5 (Mitigation).

#### *Water Quality*

24.4.13 Impacts on water quality are principally caused by pollutants that are transported in road runoff from a number of sources. These include vehicles (e.g. tyre rubber, brake and clutch linings, fuel, oil and coolant), highway maintenance and general road surface degradation. There is a wide range of pollutants which may impact on the receiving water and its associated aquatic ecology, including:

- metals such as dissolved copper, total zinc, lead and other soluble pollutants;
- suspended solids and contaminants bound to them (such as metals, phosphorous and some organic compounds);
- organic compounds such as oils and other hydrocarbons;
- biodegradable organic material such as grass cuttings; and
- de-icing salt and alternative de-icing agents.

24.4.14 Metals in road runoff contaminants include copper, zinc, lead and nickel. As noted in section 24.2 (Approach and Methods), dissolved copper and total zinc concentrations are used as indicators to assess the pollution levels from road runoff. High levels of dissolved copper or total zinc within the water column may have deleterious impacts on aquatic organisms such as fish, due to bioaccumulation (build up of these trace metals within body tissue directly and by feeding on other organisms). Concentrations in receiving surface waters are legislatively controlled by the Dangerous Substance Directive (76/464/EEC) and the Freshwater Fisheries Directive (78/659/EEC).

24.4.15 Research has demonstrated that the fine fraction (< 63µm) of sediments is the most important source of pollution (Hamilton and Harrison, 1991). Fine sediments can adversely affect fish, invertebrates and plants by smothering them (DMRB). Sediment smothering could lead to die back of water organisms and in turn increased organic loading with associated adverse impacts such as lowered levels of dissolved oxygen. Suspended solids may also contain polluting contaminants which adsorb and bind on to particulate matter such as oils, heavy metals, pesticides, phosphorus, nitrogen and other organic and inorganic pollutants.

24.4.16 Oil and related compounds represent 70%-80% of hydrocarbons found in surface runoff. This contamination can have physical and chemical impacts. The most apparent impact is the coating of organisms and the water surface, which blocks respiration, photosynthesis and feeding. Additionally biodegradation of oils in aquatic systems can lead to oxygen depletion. Many mineral oils and other hydrocarbons are toxic, persistent and bio-accumulate in the environment.

24.4.17 Diffuse sources of biodegradable organic materials include debris and grass cuttings. These materials can contain high levels of nutrients (carbon, nitrogen, phosphorus and sulphur) and organic matter. They undergo rapid microbiological degradation, consuming oxygen present within the water (measured as their Biochemical Oxygen Demand), leading to oxygen sags. The rapid

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oxygen sag that occurs as biodegradable material is broken down within a waterbody can lead to fish and invertebrate fatalities. In the short-term, the material may smother the river bottom, also leading to the death of aquatic species.

24.4.18 De-icing salt, used during the winter months, can cause localised impacts on the environment, as increased chloride levels in the environment may have impacts on fish and freshwater invertebrates.

24.4.19 Appendix A24.4 (Water Quality) provides detailed pollution and accidental spillage calculation results.

#### Watercourse Crossing Impacts

##### *Surface Water Hydrology*

24.4.20 The proposed scheme coincides with (or is adjacent to) surface water features at a number of locations. This occurs mainly when crossing watercourses, but also environmental features critically dependent on the surface hydrology (for example, wetlands). Impacts of watercourse crossings on the surface hydrology could occur through alteration of the physical flow and water level regimes:

- potential for localised increased flood risk upstream as a result of changes to channel conveyance from the proposed crossing; or
- the severance of existing hydrological pathways, which may lead to an increase in flood risk.

##### *Fluvial Geomorphology*

24.4.21 Generally, culverts will be installed to convey watercourses underneath the road, although at certain locations a bridge or similar structure will be constructed. Where culverts are proposed, this assessment is based on the design where culverts are sized to convey a range of flows (designed for the 0.5% AEP) will be installed level, effectively providing artificial bed and banks.

24.4.22 The placement of an artificial bed such as a culvert in a watercourse can enhance sediment transfer at high flows. Conversely, under normal flows sediment could accumulate within the culvert, particularly where the culvert has a low gradient. Where culverts are designed to convey flood events with high return periods, they may have a greater width than the natural channel. This is likely to reduce stream power, which may lead to sedimentation within the culvert, therefore without proper maintenance this may reduce capacity over time. This may increase flood risk and lead to sediment starvation downstream. Where culverting increases the channel gradient, the scour of the bed and banks at culvert outlets often occurs, leading to an increase in the supply of sediment to the watercourse downstream.

24.4.23 The existing morphological diversity of a watercourse within the culvert is generally greatly reduced by the introduction of artificial bed and banks. The interruption of morphological continuity would also segment the watercourse. Culverts constrain the channel preventing lateral and vertical adjustment.

24.4.24 Where it is proposed to cross a watercourse through the use of a bridge or similar structure, geomorphological impacts are generally reduced when compared to culverts. A bridge will not constrain the bed in the same way that a culvert would, although banks may still be constrained, depending on the span of the structure. Bridging watercourses tends to allow for the continuity of the riparian zone along both sides of the watercourse, maintaining morphological diversity and channel sinuosity.

24.4.25 Similarly, buried bridge structures tend to allow for the continuity of bed through the structure and to some extent (dependent on length) the continuity of riparian zone. Buried structures tend to be lower than bridges, as they are often required to carry drainage pipes over the watercourse. Light penetration is often poor through longer structures, resulting in bare banks and poor bank stability which may affect the geomorphology of the watercourse. Consequently, banks may be more

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susceptible to erosion, where light deficiency limits the potential for roots to bind the bankside material.

#### *Water Quality*

- 24.4.26 Construction of the proposed scheme in the study area involves approximately 14 crossings of the previously identified watercourses (in addition to proposed bridges over the River Dee and Blaikiewell Burn). As noted above, culverting could potentially change the riverbed morphological diversity and sediment regime of the watercourses and this may have an associated impact on water quality by releasing previously locked contaminants into the water column. As bridge structures are likely to have a lesser geomorphological impact, they are also likely to have a reduced impact on water quality.
- 24.4.27 Culverts may also impact on water quality due to oxygen sags caused by the lack of light and rapid microbiological degradation of biodegradable matter. Bridge structures will tend to allow better light penetration and therefore have less impact on water quality.

#### Watercourse Realignment Impacts

#### *Surface Water Hydrology*

- 24.4.28 Realignment will change the discharge regime of watercourses. However, if designed correctly in terms of hydraulic considerations, these realignments would not affect surface water hydrology unless the realignment significantly changes the catchment of the watercourse. Any impacts on flood regime, as a result of erosion or deposition, are discussed in the fluvial geomorphology section below. Where catchments are severed, impacts may occur from the changes to the current response of the catchment and watercourse, leading to a potential increase to the flood risk of the affected watercourse.
- 24.4.29 At certain locations along the proposed scheme, drainage ditches have been designed to discharge directly to the drainage system, rather than installing a culvert to allow connectivity across the route. This will impact on the hydrology of the downstream watercourse, which will lose any input from the upstream catchment. However, this has only been proposed on smaller watercourses/drainage ditches, all of which are considered to be of low sensitivity and ecological value. This will be discussed and agreed with SEPA as part of the Controlled Activity Regulations (CAR) application consent process.

#### *Fluvial Geomorphology*

- 24.4.30 Watercourse realignment may lead to a change in the geomorphological behaviour of the watercourse over time. Realignment can result in changes to sediment supply, rate of sediment transfer downstream and deposition zones. Changes to watercourse bank materials through the realignment to more erodible types would be likely to increase the volume of sediment supplied to the channel. Increases in channel gradient as a result of realignment would result in an increase in stream power, leading to greater erosion rates, which generally reduces channel stability and promotes sedimentation downstream. Conversely, a reduction in channel gradient is likely to lead to increased deposition within the channel, leading to adverse impacts on morphological diversity and potential changes to flood regime.
- 24.4.31 Disruption to the channel bed may be temporary and realignment may lead to an improvement in channel morphology. In poor quality streams, realignment provides an opportunity to restore/rehabilitate the watercourse.

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##### *Water Quality*

- 24.4.32 As with the installation of culverts, the main impact of realignments on water quality would occur as a result of altered geomorphology. Changes to the sediment regime may re-entrain contaminated sediments and permit pollutants a pathway into the water column.

##### Network Culverts

- 24.4.33 At certain locations along the proposed scheme, network culverts would be installed to pass road drainage from one side of the road to the other. The main risk that arises as a result of network culverts is the potential for increased localised flood risk upstream if the culvert were to become blocked.

##### Re-direction of Watercourses into Pre-earthworks Drainage or Catchment Severance

- 24.4.34 Pre-earthworks ditches are a series of drains which run alongside the road, either at the toe of embankments or at the top of cuttings, collecting clean water runoff from the surrounding land. The ditches then discharge to a local larger watercourse. This can be thought of as a re-direction of predominantly ephemeral watercourses, or their severed catchments, into a newly dug realignment.
- 24.4.35 During construction, small or ephemeral watercourses may be re-directed into pre-earthworks drainage ditches. Alternatively, the severed catchments of small or ephemeral ditches may be directed into pre-earthworks ditches and the flow transferred into larger watercourses.

##### *Surface Water Hydrology*

- 24.4.36 Where watercourses, or the flow from severed catchments, would be redirected into pre-earthworks drainage, two main potential impacts may occur:
- loss of watercourse downstream due to change of channel; and
  - potential increase to flood risk (this may have an associated impact on watercourses receiving road drainage outfalls which is discussed under the road drainage section).

##### *Fluvial Geomorphology and Water Quality*

- 24.4.37 A few minor watercourses that currently exist would be lost due to re-direction into pre-earthworks drainage. Therefore, an assessment of the impact on the fluvial geomorphology and water quality of the channel is considered to be redundant. Consequently, these watercourses have been scoped out of the impact assessment for the operational phase. However, construction impacts are considered in detail.

##### Construction Impacts

##### *Surface Water Hydrology*

- 24.4.38 Construction impacts would include effects such as soil compaction due to works traffic, sedimentation and disturbance/unintentional changes to channel dimensions which may affect the hydraulic flow characteristics of a watercourse as well as on geomorphology, ecology and water quality.
- 24.4.39 During the construction phase other temporary works that potentially may affect surface hydrology include the following:
- Temporary watercourse diversions to facilitate culvert or bridge construction and any associated temporary works;
  - watercourse diversions and re-direction through constructed realignments or into pre-earthworks ditches;

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- temporary attenuation features at drainage outfalls; and
- temporary arrangements to control runoff.

#### *Fluvial Geomorphology*

- 24.4.40 Potential impacts during the construction phase are similar to those of the operational phase except they are short-term and generally more intense. There are a higher number of sources of potential impacts relating to suspended solids and include runoff from plant and vehicle washing, excavations and blasting and excavation of road drains. Vegetation near the watercourse will also be cleared for construction works, which will influence bank stability.
- 24.4.41 The magnitude of impact is dependent on the scale of excavations and need for blasting at each location (Chapter 23, Table 23.8). Blasting may be utilised by the contractor in areas where the ground investigation indicates hard ground conditions. The magnitude of impacts is also dependent on the scale of the works, for example if realignment and several culverts are required on one watercourse, the extensive nature of the works in one area will lead to an increased risk to the watercourse. Weather conditions will also influence the magnitude of impacts, as impacts will generally be far more severe if there are intense or prolonged rainfall events during the construction phase.
- 24.4.42 Table 24.6 summarises potential geomorphological impacts during construction. As discussed previously, geomorphological impacts will also affect water quality.

**Table 24.6 – Potential Construction Impacts on Fluvial Geomorphology**

Source of Impact	Potential Effects
<p><u>Suspended Solids</u> Can result from excavations, blasting, runoff from stockpiles, plant and wheel washing, runoff from site roads, runoff during earthworks and landscaping. The risk of release of suspended solids into watercourses or drainage ditches is greatest where the proposed road crosses such features.</p>	<p>A possible increase in turbidity and siltation may occur with a reduction in diversity due to increased fine sediment supply. The ecology of gravel bed rivers may also be severely affected. Loss of dynamic activity due to siltation may result.</p> <p>Sediments can cause damage to fish, aquatic invertebrates and plants through deposition resulting in a smothering effect or by interference with feeding and respiratory apparatus and if they also contain contaminants. More details are provided in Appendices A24.3 and A24.4 (Fluvial Geomorphology and Water Quality respectively).</p>
<p><u>Vegetation Clearance</u> May reduce the stability of the river channels, increasing the potential for erosion and associated sediment release. Sediment release is likely to be greatest where vegetation clearance is required on slopes and will be particularly significant where woodland clearance is required.</p>	<p>An increase in supply of fine sediment through bank instability, especially during the winter months is likely. Reduced morphological diversity due to bank collapse and sedimentation may occur. Bank instability due to bank erosion may increase. More details can be found in Appendix A24.3 (Fluvial Geomorphology).</p>
<p><u>Crossings and Diversions, Realignment of Watercourses and Outfall Construction</u> Construction of structures over, beside or in watercourses, such as culverts, outfalls and realignments are a potential source of pollution and construction debris can block land drains.</p>	<p>Increase to fine sediment supply may occur. Blockage of land drains could result in water logging of soils. Culverts may occasionally cause flooding problems upstream. Diversions could cause long-term impacts on the watercourse. More details can be found in Appendix A24.3 (Fluvial Geomorphology).</p>

#### *Water Quality*

- 24.4.43 In addition to sedimentation impacts on water quality identified in Table 24.6, construction activities may also affect water quality through accidental spillages or disturbance of contaminated land. Table 24.7 lists the potential sources and effects of construction activities on water quality. These impacts are likely to be short-term and may have minimal effect on water quality. However, impacts may have a longer term indirect effect on aquatic ecology (refer to Chapter 25: Ecology and Nature Conservation).

**Table 24.7 – Potential Water Quality Impacts During Construction**

<b>Source of Impact</b>	<b>Potential Effects</b>
<u>Oils, Fuels and Chemicals</u> Spillage from storage tanks or leakage from mobile or stationary plant.	Oils form a film on the water surface resulting in an adverse effect on water quality. These oils can interfere with the gills of fish and cause loss of buoyancy to water birds as well as toxicity to other organisms. The oils/chemicals may also enter groundwater, reducing the potential for local groundwater utilisation and affecting ecological habitats supported by groundwater.
<u>Concrete, Cement and Admixtures</u> Accidental release into watercourses of the materials or from the washings of plant and machinery or spillage during concrete pour.	Concrete/cement is highly alkaline and must not be allowed to enter any drain, watercourse or groundwater. Potential for adverse effects on aquatic organisms if pH elevated to/maintained above 8.5.
<u>Sewerage</u> Accidental/uncontrolled release of sewage from sewers through damage to pipelines during service diversion.	Pollution to watercourses/groundwater (refer to Chapter 23: Geology, Contaminated Land and Groundwater).
<u>Contaminated Land and Sediment</u> If not managed properly, disturbance of contaminated materials could lead to pollution of ground and surface waters.	Dependent on types and concentrations of contaminants. Potential loss of aquatic fauna and flora. Deterioration of groundwater quality reducing its resource potential and potentially affecting groundwater-supported habitats (refer to Chapter 23: Geology, Contaminated Land and Groundwater).

**Specific Impacts**

24.4.44 The proposed scheme has been considered in the context of the general discussion of potential impacts above. The following components of the proposals would affect the water environment.

Road Drainage Outfalls

24.4.45 There would be no outfall to Greengate Ditch, Greenhowe Pond, Burn of Ardoe, Bishopston Ditch, Heathfield Burn, Whitestone Burn, Blaikiewell Burn, Crynoch Burn, Kingcausie Burn, Milltimber Burn, Culter House Burn, Beans Burn, Upper Beanshill Burn, Borrowstone Burn and Moss of Auchlea drainage system. However, the proposed scheme would require the discharge of road drainage to:

- Loirston Burn;
- Jameston Ditch;
- Burnhead Burn;
- River Dee;
- Gairn Burn; and
- Westholme Burn.

24.4.46 Although there would be no direct outfall into Hare Moss, the potential impacts of the SUDS outfall into Jameston Ditch or changes to its surface water catchment of the moss are discussed further in Table 24.8. All drainage runs and their associated outfalls are shown on Figures 24.5a-h.

Watercourse Crossings

24.4.47 Bridges are proposed at the crossing over the River Dee and Blaikiewell Burn, due to the size of these watercourses and their environmental sensitivity. The River Dee would be bridged by a single structure, which would not require piers within the river. One buried structure is proposed for crossing Blaikiewell Burn, which would not require in-channel piers and would have abutments set back approximately 5m on each side of the watercourse. No realignment of the channel would be required. All crossings are shown on Figures 24.5a-h.

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24.4.48 At all other locations, a culvert is proposed. A total of 14 culverts would be required:

- one culvert each on Whitestone Burn, Heathfield Burn, Bishopston Ditch, Burn of Ardoe, Kingcausie Burn, Burnhead Burn, Milltimber Burn, and Moss of Auchlea drainage system;
- two new culverts on Gairn Burn; and
- two new culverts on Loirston Burn plus an extension to two existing culverts (A90 and A956).

#### Watercourse Realignments

24.4.49 The following watercourse realignments would be required:

- Whitestone Burn (one realignment of 123m, overall length maintained);
- Heathfield Burn (one realignment of 89m, overall length maintained);
- Bishopston Ditch (one realignment of 95m, overall length maintained);
- Burn of Ardoe (one realignment of 80m, overall length maintained);
- Loirston Burn (four realignments totalling 778m, overall length maintained);
- Burnhead Burn (one realignment of 118m overall length maintained);
- Kingcausie Burn (one extensive realignment of 404m, resulting in a 37m shortening of the channel);
- Milltimber Burn (one realignment of 107m overall length maintained);
- Gairn Burn (one realignment of 163m, resulting in a 13m shortening of the channel); and
- Moss of Auchlea drainage system (one realignment of 84m, resulting in a 9m shortening of the channel).

#### Pre-Earthworks Drainage and Catchment Severance

24.4.50 As noted in the general discussion of potential impacts, certain minor watercourses would not be culverted and would instead be routed into pre-earthworks ditches and then into the road drainage system. This is proposed for a limited number of small ephemeral ditches or watercourses in their extreme upper reaches, and for the following named burns or ditches:

- Greengate Ditch;
- Beans Burn; and
- Upper Beanshill Burn.

24.4.51 In addition, Greenhowe Pond would be drained and backfilled during road construction.

24.4.52 Although Culter House Burn would not be re-directed, it would lose 100% of its catchment through severance by the road. This would result in the loss of this watercourse as its source would be removed. Therefore, during construction, this watercourse would be drained and backfilled.

#### Network Culverts

24.4.53 The following network culverts are proposed:

- one network culvert near Loirston Burn at ch205955
- one network culvert near Gairn Burn at ch106175
- one network culvert near Moss of Auchlea at ch107305
- one network culvert near Westholme Burn at ch108585

### **Impact Assessment**

- 24.4.54 An overall sensitivity for each waterbody was assigned in the baseline section of this chapter. This section reports the potential impact magnitudes as presented by each discipline for each watercourse during construction and operation. An overall impact magnitude is then assigned to the watercourse for the construction and operation phases. The methodology adopted for assigning this impact is detailed in paragraph 24.2.23 and adopts a precautionary approach. Consequently, the overall impact magnitude would be assigned based on the highest potential impact of each of the technical disciplines. This overall impact is then combined with the overall sensitivity of the watercourse in order to provide an impact significance for each watercourse. Indirect impacts on ecological aspects of waterbodies are presented in Chapter 25 (Ecology and Nature Conservation). Where the impact on groundwater is considered to be of Moderate significance or above, it is summarised in this chapter under the groundwater section. Further information is detailed in Chapter 23 (Geology, Contaminated Land and Groundwater).
- 24.4.55 The potential impacts for the operation and construction phases are summarised in Table 24.8 and detailed in the relevant technical appendices of this chapter.

### Operational Impacts

#### *Loirston Burn and Loch (ch205585)*

- 24.4.56 The provision of two new culverts, the extension of two existing culverts, a drainage outfall and an extensive associated realignment (778m) is considered to have a medium magnitude of impact on the hydrology of the watercourse. These proposals may result in low magnitude impacts on the geomorphology of the watercourse as it is already heavily modified and straightened. Pollution and spillage risk calculations indicate that there is likely to be a high magnitude of impact on water quality in the receiving watercourse.
- 24.4.57 Given the medium sensitivity of the watercourse at this location and the overall high magnitude of impact, the resulting significance of impact is considered to be Moderate/Substantial.

#### *Network Culvert: Loirston (ch205955)*

- 24.4.58 At ch205955, road drainage would be passed from one side of the road to the other via network culvert approximately 63m long and 0.9m diameter. This culvert would only service the drainage network and therefore the geomorphological and water quality assessments have not considered potential impacts. However, the hydrological assessment has assessed the risk of flood risk as a result of potential culvert blockage, which is considered to be of medium magnitude given the wooded nature of the land surrounding the culvert.
- 24.4.59 Currently, no watercourse exists in this location and therefore no baseline assessment has been completed. However, the magnitude of impact is considered to be medium.

#### *Greengate Ditch (ch205050)*

- 24.4.60 This small, ephemeral ditch would be taken into pre-earthworks drainage ditches for the operational phase. As the watercourse would no longer exist, the impacts have been assessed by hydrology only. The outcome of this assessment suggests that there would be an impact of negligible magnitude and Negligible significance to the burn.

#### *Jameston Ditch (ch204500)*

- 24.4.61 During periods of high flow, this ditch is considered to play an important role in the hydrological function of the moss. The proposals include an outfall of road drainage, which will increase the volume of water reaching the ditch. The watercourse contributes to the hydrological connectivity of the moss during periods of high flows and controls water levels within the moss (Appendix A24.1,

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Table 24.5). Hydrologically, the potential impact on Jameston Ditch as a result of the proposed outfall is considered to be beneficial as proposals will provide more water to the moss.

24.4.62 From a water quality perspective, the proposed outfall is expected to present a high magnitude of impact, which would be a result of untreated road runoff draining to the watercourse and potentially polluting the moss. Calculations indicate increases of copper and zinc of over 100% over the baseline. Impacts on geomorphology are anticipated to be of low magnitude.

24.4.63 Overall, the potential impact on the water environment of the burn and potentially the moss is considered to be of high magnitude and Substantial significance.

#### *Burn of Ardoe (ch204000)*

24.4.64 This burn provides important hydraulic connectivity to Hare Moss. The introduction of a culvert and its potential to interrupt the geomorphology of the watercourse are considered to present a low impact magnitude. Impacts on water quality are anticipated as a result of the culvert blocking light from the channel and any potential diffuse pollution reaching the burn. This is considered to be of negligible magnitude.

24.4.65 Overall, the potential impact on the watercourse is considered to be of low magnitude leading to a prediction of Moderate significance.

#### *Bishopston Ditch (ch203900)*

24.4.66 The burn is understood to provide important hydraulic connectivity to the Hare Moss. Hydrologically, the construction of a culvert is considered to present a low magnitude of impact to the watercourse. A low magnitude of impact is expected on the geomorphology of the watercourse. This is likely to result from the culvert and its potential to interrupt morphology of the watercourse and increase stream power. Impacts on water quality are anticipated as a result of the culvert blocking light from the channel and any potential diffuse pollution reaching the burn. This is considered to be of negligible magnitude.

24.4.67 Overall, the impact on Bishopston Ditch is considered to be of low magnitude leading to Moderate significance of impact.

#### *Heathfield Burn (ch203650)*

24.4.68 The burn appears to provide important hydraulic connectivity to the Hare Moss. Hydrologically, the introduction of a culvert is considered to present a low magnitude of impact to the watercourse. However, a medium magnitude of impact is expected on the geomorphology of the watercourse. This is likely to result from the culvert and its potential to interrupt morphology of the watercourse and increase stream power. Impacts on water quality are anticipated as a result of the culvert blocking light from the channel and any potential diffuse pollution reaching the burn. This is considered to be of negligible magnitude.

24.4.69 Overall, the potential impact on the watercourse is considered to be of medium magnitude leading to Moderate/Substantial significance of impact.

#### *Hare Moss (ch204500)*

24.4.70 The proposed road would cross to the south of Hare Moss, upstream of the moss and all watercourses draining to it. Although the road would not have a direct impact on Hare Moss, there is potential for the road to alter the water balance of the moss through changes in the hydrological inputs to the moss area. There may be potential to increase the water flow to the moss as a result of the road drainage outfall, which could be beneficial from a hydrological perspective.

24.4.71 Impacts on the hydrological function of the moss are anticipated to be of high magnitude. The impact on water quality could be of high magnitude as a result of the direct outfall to Jameston Ditch. The impact on this feature is considered to be high magnitude and Substantial significance

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of impact. Impacts on the water environment in the area would have indirect impacts on the ecological habitats found within the moss, which are discussed in detail in Chapter 25 (Ecology and Nature Conservation).

#### *Whitestone Burn (ch201000)*

24.4.72 The provision of one culvert and an associated realignment of an already straightened channel is considered to impact on the hydrology of the burn to a medium magnitude and to a similar magnitude on geomorphology. No outfall is proposed to the burn, therefore the potential impact on water quality is considered to be of negligible magnitude.

24.4.73 Overall, potential impacts on the burn would be of medium magnitude and Slight significance.

#### *Burnhead Burn (ch200100)*

24.4.74 The impact of the proposed outfall, culvert and realignment is considered to have a medium magnitude of impact on the hydrology of the burn. This is mainly driven by the potential impact on the increased discharge potential from the road runoff.

24.4.75 Culverting the watercourse in this location is likely to result in medium magnitude of impact on the sinuosity of the burn as it is already straightened. Interruption to sediment continuity through the culvert and the potential for suspended sediment release is considered to have a potentially high magnitude of impact on the watercourse.

24.4.76 The proposed outfall would drain approximately nine hectares of road. This has the potential to increase baseline levels of copper and zinc over the EQS levels. Similarly, the potential for accidental spillage, in the absence of mitigation, would increase to unacceptable levels. Overall, the potential impact on water quality is considered to be of high magnitude.

24.4.77 Potential impacts on the water environment of Burnhead Burn would be of high magnitude and Substantial significance.

#### *Blaikiewell Burn (ch100150)*

24.4.78 The provision of a bridge is considered to have a low magnitude of impact on the hydrology of the watercourse or Crynoch Burn downstream. Potential impacts on geomorphology are assessed as high magnitude. This results from the potential of a crossing structure to increase discharge by cutting off the burn from its floodplain and hence the release of suspended solid release. This has a potential to impact not only the burn locally, but also geomorphology and habitats downstream which include the SAC. Direct impacts on water quality in this location are expected to be of negligible magnitude as a result of the buried structure and no direct outfall. Upstream of the proposed crossing, it is proposed to outfall road drainage into Burnhead Burn, which is likely to have a high magnitude of impact on the watercourse and hence an indirect impact on Blaikiewell Burn.

24.4.79 Overall, the impact on the water environment of Blaikiewell Burn is considered to be of high magnitude and Substantial significance. This is largely driven by the potential impact on geomorphology. However, indirect impacts on water quality upstream at Burnhead Burn may still have a direct impact on the water column in the area of interest.

#### *Kingcausie Burn (ch101500)*

24.4.80 The extensive realignment associated with a culvert proposed for this burn is likely to have medium magnitude of impact on the hydrology of the burn. The realignment would lead to a reduction in channel sinuosity, reducing the channel length and increasing the channel gradient. As a result, stream power would rise, increasing the potential for channel erosion and/or incision, which could lead to channel instability, increasing the volume of sediment transferred downstream, with potentially widespread reductions in channel morphology. The realignment may also lead to decline in the morphological quality of the watercourse. Instability resulting from realignment may

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lead to an increase in the sediment load of the stream, which would increase the supply of sediment to Crynoch Burn. This may lead to reductions in the morphological diversity and a decline in water quality in this watercourse. Consequently, the potential impacts on geomorphology are considered to be of high magnitude.

- 24.4.81 From a water quality perspective, no direct outfall is proposed to discharge to this burn. Overall, the impact on the burn is considered to be of high magnitude and Substantial significance. This is largely driven by the potential impacts on geomorphology.

#### *River Dee (ch102000)*

- 24.4.82 The long-term impact on hydrology as a result of the proposed bridge crossing and the presence of an outfall would have a low magnitude of impact. Detailed assessment of the potential change to flood risk in the vicinity of the crossing is reported in Appendix A24.2. The modelling indicates that there would be no change to flood water levels upstream of the proposed scheme as a result of the crossing. Consequently, impacts are considered to be of negligible magnitude.

- 24.4.83 Fine sediment in the River Dee appears to mainly be sourced from its tributaries rather than from local sources such as bank erosion. The new outfall would also be a source of sediment to the river. An increase in turbidity (high sediment loading) would have an adverse impact of bed morphology, such as affecting the large scale riffle-run sequences which are currently evident in the channel. These impacts would have high magnitude of impact on the watercourse.

- 24.4.84 A minor shift from current water quality conditions due to receiving road runoff would result in adverse impacts on water quality and ecology. A negligible magnitude of impact from routine runoff is calculated as the calculations show an increase of less than 24% over baseline for copper and zinc and complying with EQS for both pollutants; a consequence of the high dilution potential offered by the river. However, there is a potentially high magnitude of impact from accidental spillage, which would be increased. The probability of risk is considered to be below the accepted probability threshold of 1 in 100 years.

- 24.4.85 The water quality model, which investigated the cumulative impact of multiple sources of road drainage reaching the River Dee indicated a negligible impact to the river. This is a function of the dilution potential afforded.

- 24.4.86 Overall, the potential impact on the River Dee is considered likely to be of high magnitude and Substantial significance during the operational phase. This is largely driven by the potential for water quality and geomorphology impacts.

#### *Milltimber Burn (ch102650)*

- 24.4.87 The introduction of one culvert and the associated realignment of an already straightened channel would result in a medium impact magnitude on the hydrology and geomorphology of the burn. In its lower reach, the watercourse is susceptible to siltation caused by livestock poaching. Any further input would add to this, but would not alter the current quality of the watercourse. The upper reach has a sand and gravel bed and therefore fine sediment released in this area could reduce the quality of the bed substrate. The provision of a culvert would introduce an artificial bed and result in the loss of the gravel and sand bed. Due to the low gradient of the burn downstream, impacts on the River Dee are considered to be less likely than for other tributaries.

- 24.4.88 No outfall is proposed to the burn therefore the impact on water quality is considered to be of negligible magnitude. Overall, impacts on the burn would be of medium magnitude and Slight significance.

#### *Culter House Burn (ch103600)*

- 24.4.89 This small ditch would be drained and backfilled during construction. The watercourse would lose 100% of its catchment through severance by road and the catchment would be taken into pre-earthworks drainage ditches during operational. As the watercourse would no longer exist during

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operation, the potential impacts have been assessed in terms of hydrology only. The outcome of this assessment suggests that there would be an impact of negligible magnitude and significance to the burn.

##### *Beans Burn (ch105150)*

- 24.4.90 This small ditch, at the upstream of its catchment, would be taken into pre-earthworks drainage ditches for the operational phase. As the watercourse would no longer exist during operation, the impacts have been assessed in terms of hydrology only. The outcome of this assessment suggests that there would be an impact of medium magnitude and Slight significance to the burn.

##### *Upper Beanshill Burn and Ponds (ch106500)*

- 24.4.91 This small ditch, at the upstream of its catchment, would be taken into pre-earthworks drainage ditches for the operational phase. As the watercourse would no longer exist during operation, the impacts have been assessed in terms of hydrology only. The outcome of this assessment suggests that there would be an impact of negligible magnitude and significance to the burn.

##### *Gairn Burn (ch106500)*

- 24.4.92 Proposals for Gairn Burn include an outfall of approximately 4.8 hectares of road drainage, a culvert and associated realignment. Hydrologically, this is expected to have an impact of medium magnitude as a result of the potential change to flow regime from the additional water.
- 24.4.93 Geomorphologically, these proposals may result in a medium magnitude of impact on the watercourse. The gradient of the stream above the road crossing is quite high, therefore there is potential for the bed and banks to scour if the course and gradient are changed approaching the culverts. Straightening the channel may also reduce morphological diversity of the watercourse.
- 24.4.94 From a water quality perspective, calculations show that there is a likelihood for copper and zinc concentrations to increase by over 100% to levels above environmental quality standards. There would also be an associated increase to the risk of accidental spillage as a result of the new road. This results in a high magnitude of impact.
- 24.4.95 Overall, potential impacts on this watercourse would be of high magnitude and Moderate/Substantial significance. The impacts are largely driven by the potential impact of the untreated drainage outfall to the burn.

##### *Network Culvert: Gairn (ch106175)*

- 24.4.96 At ch106175, road drainage would be passed from one side of the road to the other via a network culvert approximately 62m long and 0.9m diameter. This culvert would only service the drainage network therefore, geomorphological and water quality assessments were not conducted. However, the hydrological assessment has assessed the risk of flood risk as a result of potential culvert blockage. This is considered to be of medium magnitude given the wooded nature of the land surrounding the culvert.
- 24.4.97 Currently, no watercourse exists in this location and therefore no baseline assessment has been completed. However, the magnitude of impact is considered to be medium.

##### *Moss of Auchlea Drainage System (ch107450)*

- 24.4.98 The proposed culvert below the main AWPR carriageway would have the potential to cause localised constriction of flow and flood risk affecting the hydrology of the watercourse. The realignment has the potential to cause a slight increase in channel gradient and any decrease in bank height may increase localised flood risk. Overall, hydrological impacts would be of medium magnitude and are considered to be of medium magnitude on geomorphology. There is no planned outfall to the watercourse and the magnitude of impacts on water quality is considered to be of negligible magnitude.

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- 24.4.99 Overall, the impact on the water environment at this site is considered to be of medium magnitude and Moderate/Substantial significance.

*Moss of Auchlea (ch107450)*

- 24.4.100 There would be no direct hydrological impacts on the Moss of Auchlea assuming that the catchment area draining to the burn would be maintained. The culvert that would be installed on the Moss of Auchlea drainage system would allow the connectivity of the moss to the catchment area upstream of the road to be maintained. No road outfall is proposed in this area. The impact on the water quality and hydrology of the moss is of negligible magnitude and Slight/Negligible significance.

*Network Culvert: Moss of Auchlea (ch107305)*

- 24.4.101 At ch107305, road drainage would be passed from one side of the road to the other via a network culvert 56m long 0.9m diameter. This culvert would only service the drainage network, therefore the geomorphological and water quality assessments have not considered potential impacts. However, the hydrological assessment has assessed the risk of flood risk as a result of potential culvert blockage. This is considered to be of low magnitude since the land surrounding the culvert comprises predominantly pasture land.

- 24.4.102 Currently, no watercourse exists in this location and therefore no baseline assessment has been completed. However, the magnitude of impact is considered to be low.

*Westholme Burn (ch108650)*

- 24.4.103 The proposed extensive outfall to Westholme Burn would result in a low magnitude of impact on the hydrology of the burn as there is the potential to cause an increase in flows. The catchment area of the outfall would include the burn's existing catchment and that of the proposed road.

- 24.4.104 An increase in fine sediment from road runoff or the proposed outfall has the potential to result in channel erosion, increasing fluvial process rates that would cause changes in the sediment regime and channel morphology. However, the straight and relatively stable nature of Westholme Burn would be expected to limit any potential impacts. Therefore, the impact magnitude is considered to be low.

- 24.4.105 The unmitigated impact of the road drainage outfall would result in a major change from existing conditions resulting in a high magnitude of impact for water quality. Calculations indicate that levels of copper and zinc may increase by over 100% from the baseline and result in levels that may fail the environmental quality standards. In addition, the accidental spillage risk is expected to increase to unacceptable levels.

- 24.4.106 Overall, impacts on the water environment of this burn would be of high magnitude and Moderate significance. The impacts are largely driven by impacts on water quality that would result from an untreated drainage outfall.

*Network Culvert: Westholme (ch108585)*

- 24.4.107 At ch108585 road drainage would be passed from one side of the road to the other via a network culvert approximately 113m long 0.9m diameter. This culvert would only service the drainage network therefore, the geomorphological and water quality assessments have not considered potential impacts. However, the hydrological assessment has assessed the risk of flood risk as a result of potential culvert blockage. This is considered to be of low magnitude since the land surrounding the culvert comprises predominantly pasture land.

- 24.4.108 Currently, no watercourse exists in this location and therefore no baseline assessment has been completed. However, the magnitude of impact is considered to be low.

*Borrowstone Burn and Ponds (ch110400)*

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- 24.4.109 This burn and associated pond has been scoped out of geomorphology and water quality assessments due to the distance of the proposed scheme from the watercourses. However, from a hydrological perspective, although the burn or ponds are not crossed by the AWPR there is a minor (less than 1%) reduction in the catchment area due to the position of the AWPR and the drainage scheme. This catchment area would drain to Westholme Burn outfall before discharging into Brodiach Burn further downstream. The assessment found an overall negligible magnitude and Negligible significance of impact on the water environment of the burn.

#### Catchment Impacts (Operational)

##### *Catchment Impacts on Crynoch Burn*

- 24.4.110 Due to the proximity of Burnhead, Blaikiewell and Kingcausie Burn to Crynoch Burn it is necessary to consider the potential impacts on the water environment downstream. In addition to this, potential catchment impacts from watercourses reported in the Fastlink study area in Chapter 39 (Water Environment) draining to the catchment are considered here (Craigentath Burn, Circle Burn, Square Burn and Wedderhill Burn).
- 24.4.111 The potential for release of sediment and pollutants into Burnhead Burn from the drainage outfall is considered to be of high magnitude. However, given the dilution available as the sediment plume moves downstream, there is the potential for this impact to reduce to medium magnitude to Crynoch Burn. Impacts on geomorphology are likely to reduce with distance, although some are considered to be local impacts focused around the proposed crossings. The proposed activities on the smaller watercourses assessed in the Fastlink study area would likely result in a negligible impact on Crynoch Burn. Cumulative catchment impacts on the water quality of Crynoch Burn as a result of the proposed drainage outfalls were assessed using the SIMCAT water quality model. The outcome of this assessment indicates that there is likely to be high magnitude of impact.
- 24.4.112 Overall, this impact to the water environment is considered to be of high magnitude and Substantial significance.
- 24.4.113 Due to its regional importance, catchment impacts on the River Dee are discussed in Part E (Cumulative Scheme Impacts) of this Environmental Statement.

#### Construction Impacts

##### *Loirston Burn and Loch (ch205585)*

- 24.4.114 During construction, the installation of four culverts, a road drainage outfall and an extensive realignment is anticipated to result in a medium magnitude of impact on the hydrology of the watercourse. This is likely to occur through changes to hydrological pathways during the construction period.
- 24.4.115 Geomorphologically, the short-term impact on the channel is considered to be of medium magnitude. The trees in the plantation alongside the channel, filter surface runoff, trapping fine sediment. If this vegetation is removed, more sediment is likely to enter the channel directly. The high sediment supply could lead to fine sediment deposition in the channel and potentially to an increase in vegetation growth, due to the low gradient of the watercourse.
- 24.4.116 From a water quality perspective, short-term impacts would be of medium magnitude due to the amount of potentially polluting works that would be required in, and in proximity to, the channel. Overall, the impact on the watercourse would be of medium magnitude, which is largely driven by the impact on water quality. This results in a Moderate significance of impact.

##### *Greengate Ditch (ch205050)*

- 24.4.117 It is proposed that this burn would be taken into pre-earthworks drainage. Therefore the impact on hydrology is considered to be of low magnitude. This process would have a low magnitude of

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impact on the geomorphology of the burn given the potential for suspended solid release. The amount of in channel works results in a high magnitude on water quality in the short-term.

- 24.4.118 Overall, the impact is driven by the potential to pollute the watercourse and would be of high magnitude and Moderate significance.

#### *Jameston Ditch (ch204500)*

- 24.4.119 During construction, the impacts on hydrology would be short-term and of low magnitude, as the proposed works are likely to only have minimal works in or in the proximity of the channel. The impact on geomorphology is expected to be of low magnitude while water quality impacts are likely to be of negligible magnitude.

- 24.4.120 Overall, impacts on the water environment in the short-term would be of low magnitude and Moderate significance.

#### *Burn of Ardoe (ch204000)*

- 24.4.121 The construction of a culvert and the potential for temporary obstruction to the hydrological pathways to Hare Moss would be of medium magnitude in the short-term. Impacts on geomorphology are likely to arise from vegetation clearance, culvert construction, realignment construction and associated suspended solid release. This is would be of low magnitude. From a water quality perspective, the extent of the potentially polluting works in the vicinity of the channel means that the impact is considered to be of a high magnitude. Pollution of this watercourse may impact the moss downstream as the burn flows into the southern edge of the moss.

- 24.4.122 Overall, the impact on the burn is considered to be of high magnitude and Substantial significance. The impact is predominantly driven by the potential short-term impact on water quality from the construction of a culvert and realignment in the channel.

#### *Bishopston Ditch (ch203900)*

- 24.4.123 The construction of a culvert and the potential for temporary obstruction to the hydrological pathways to Hare Moss would be of medium magnitude in the short-term. Impacts on geomorphology are likely to arise from vegetation clearance, culvert construction, realignment construction and associated suspended solid release. This is considered to be of low magnitude. From a water quality perspective, the extent of the potentially polluting works in the vicinity of the channel means that the impact is considered to be of a high magnitude. Pollution of this watercourse may affect the moss downstream, as the burn flows into the southern edge of the moss.

- 24.4.124 Overall, the impact on the burn is considered to be of high magnitude and Substantial significance. The impact is largely driven by the potential short-term impact on water quality from the construction of a culvert and realignment in the channel.

#### *Heathfield Burn (ch203650)*

- 24.4.125 The construction of a culvert and the potential for temporary obstruction to the hydrological pathways to Hare Moss would be of medium magnitude in the short-term. Impacts on geomorphology are likely to arise from vegetation clearance, culvert construction, realignment construction and associated suspended solid release. This is considered to be of low magnitude. However, from a water quality perspective the extent of the potentially polluting works in the vicinity of the channel means that the impact is considered to be of a high magnitude. Pollution of this watercourse may impact the moss downstream, as the burn flows into the southern edge of the moss.

- 24.4.126 Overall, the impact on the burn is considered to be of high magnitude and Substantial significance. The impact is mainly driven by the potential short-term impact on water quality from the construction of a culvert and realignment in the channel.

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##### *Hare Moss (ch204500)*

- 24.4.127 Hare Moss would be situated downstream of the AWPR. Although no direct impacts on the moss are anticipated, connectivity of the catchment could be reduced during construction. This is considered to be of medium magnitude. Impacts on the quality of the moss may arise from impacts on any of its feeder burns. The potential high magnitude impacts on Heathfield, Bishopston and Burn of Ardoe may also impact the moss.
- 24.4.128 Consequently, the overall impact on the moss would be of high magnitude and Substantial significance. This is mainly driven by the potential short-term impact on water quality from the construction of the culverts and associated realignments.

##### *Whitestone Burn (ch201000)*

- 24.4.129 The construction of a culvert and its associated realignment would impact on the hydrology of the burn to a medium magnitude. Geomorphological impacts would be of medium magnitude. They are likely to arise from the extent of required vegetation clearance and the potential for suspended solid release in conjunction with the installation of a culvert and associated in channel works.
- 24.4.130 The extent of potentially polluting in channel works results in a potentially high magnitude of impact on the water quality of the watercourse in the short-term. Overall, the impact on the watercourse is considered to be of high magnitude and Moderate significance driven by the potential impact on water quality.

##### *Burnhead Burn (ch200100)*

- 24.4.131 The construction of a culvert, its associated realignment and a potential outfall would be of medium magnitude of impact on the hydrology of the burn. However, these activities would have a greater impact on the fluvial geomorphology in the short-term and would be of high magnitude. Installing culverts would lead to major disturbance of the channel, especially in the downstream location, where the channel is fairly steep and has varied bed morphology. Sediment released by in-channel works is likely to enter Blaikiewell Burn due to the close proximity of the confluence. Additionally, the burn would have to be realigned for culverting and also to alter its course along a side road. Excavating the new channel and any temporary realignment could lead to a temporary high sediment supply during construction operations. The resulting increase in sediment delivery is likely to lead to channel sedimentation downstream, reducing morphological quality with potential adverse effects on aquatic ecology.
- 24.4.132 Given the extent of the works proposed, the impact on water quality would be of high magnitude. Overall, the impact on the water environment in the short-term is considered to be of high magnitude and Substantial significance, mainly driven by the potential impacts on water quality and geomorphology. These impacts may have an associated indirect impact on the burns downstream (Blaikiewell and Crynoch Burns) and on the associated freshwater habitats dependent on the current regimes.

##### *Blaikiewell Burn (ch100150)*

- 24.4.133 The construction of a bridge is considered to have a short-term medium magnitude of impact on surface water hydrology and flood risk. During construction, the same activities would have a high magnitude of impact on geomorphology and a medium magnitude on water quality. Increased sediment supply through earthworks, vehicle access and runoff could have a detrimental impact on channel morphology and water quality, especially if fine sediment or potential pollutants enter the channel. As mentioned previously, there may also be potential indirect impacts on the burn as a result of the works required on Burnhead Burn on the water environment and associated freshwater habitats of Crynoch Burn. Overall, these impacts would be of high magnitude and Substantial significance.

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##### *Kingcausie Burn (ch101500)*

- 24.4.134 Construction impacts on hydrology from the installation of a culvert and realignment would be of medium magnitude. In a similar manner to the assessment of impacts on Burnhead Burn, these activities are considered to have a much higher impact on the geomorphology and water quality of the watercourse, which are assessed as being of high and medium magnitude respectively.
- 24.4.135 Extensive works in and around the channel would have a medium potential impact on water quality. The burn runs through a small broad-leaved woodland. The wooded area coincides with a morphological diverse and high quality reach of the burn. Clearing trees and shrubs may lead to bank instability and increased fine sediment input particularly as ground vegetation cover is thin. If this vegetation is removed, more sediment is likely to enter the channel directly. The potential loss of woodland habitat is also a concern for wildlife in general as well as for the direct impact on the river. A substantial length of culvert and realignment would need to be installed, causing major disruption to the river bed and banks and severely impacting the morphological quality of the channel. The channel would need to be diverted while these works are completed, possibly releasing large amounts of sediment and changing the character of flow.
- 24.4.136 Overall, the impact on this burn in the short-term is considered to be of high magnitude and Substantial significance, which is driven mainly by the potential impact on geomorphology. These impacts may lead to an indirect impact on Crynoch Burn and, given its proximity to the River Dee confluence, possibly the River Dee itself.

##### *River Dee (ch102000)*

- 24.4.137 General construction impacts on hydrology would be of negligible magnitude given the size of this watercourse. The potential impact on hydrology and potential impact as a result of the construction of the bridge is considered to be of medium magnitude. This is likely to result from the amount and duration of works required on the floodplain.
- 24.4.138 An increase in sediment supply that would result from earthworks for construction adjacent to the bridge, outfall construction, vehicle access and site runoff would have a detrimental impact on channel morphology. This has the potential to affect the quality of sediment in the large riffles and resulting in fine sediment deposition around bar features. It is considered that this is likely to have a high magnitude of impact on the watercourse. Additionally, the sediment modelling assessed the potential impact on suspended solid concentrations in the River Dee during construction of the mainline approach roads. This indicated that, in the absence of mitigation, there would be a high magnitude of impact on the watercourse during the construction phase.
- 24.4.139 Overall, the impact on the water environment of the River Dee during construction is considered to be of high magnitude and Substantial significance, which has the potential to indirectly affect freshwater ecology and habitats.

##### *Milltimber Burn (ch102650)*

- 24.4.140 The construction of a culvert and its associated realignment is considered to be of medium magnitude to the hydrology of the burn. Geomorphological impacts would be of medium magnitude. They are likely to arise from the potential for suspended solid release in conjunction with the installation of a culvert and associated in channel works.
- 24.4.141 The extent of potentially polluting in channel works results in a potentially high impact on the water quality of the watercourse in the short-term. Overall, the impact on the watercourse is considered to be of high magnitude and Moderate significance driven by the potential impact on water quality.

##### *Culter House Burn (ch103600)*

- 24.4.142 As the catchment of this burn would be entirely lost through severance and it is proposed to drain and backfill this watercourse during construction, the magnitude of impact on hydrology and

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geomorphology is considered to be low. The amount of in channel works is considered to result in a high magnitude of impact on water quality in the short-term.

- 24.4.143 Overall, the impact is driven by the potential to pollute the watercourse and is considered to be of high magnitude and Moderate significance.

#### *Beans Burn (ch105150)*

- 24.4.144 It is proposed that this burn would be taken into pre-earthworks drainage. Therefore the magnitude of impact on hydrology and geomorphology is considered to be low. The amount of in channel works is considered to result in a high magnitude of impact on water quality in the short-term.

- 24.4.145 Overall, the impact is driven by the potential to pollute the watercourse and is considered to be of high magnitude and Moderate significance.

#### *Upper Beanshill Burn and Ponds (ch106500)*

- 24.4.146 It is proposed that this burn would be taken into pre-earthworks drainage. Therefore the magnitude of impact on hydrology and geomorphology is considered to be low. The amount of in channel works is considered to result in a high magnitude of impact on water quality in the short-term.

- 24.4.147 Overall, the impact is driven by the potential to pollute the watercourse and is considered to be of high magnitude and Moderate significance.

#### *Gairn Burn (ch106500)*

- 24.4.148 The installation of two culverts, proposed realignment and required road outfall construction is considered to have a medium magnitude of impact on the hydrology of the watercourse, potentially constricting flows and changing pathways in the short-term. Impacts on the geomorphology of the burn would arise from culvert installation, associated vegetation clearance and proposed realignment construction all potentially releasing fine sediment into the channel, changing morphology. These impacts would be of medium magnitude. Given the proposed extent of the works in the channel, the impact on water quality is considered to be of medium magnitude.

- 24.4.149 Overall, all three technical disciplines indicate that there is likely to be a medium unmitigated impact on the water environment of the watercourse, resulting in a Moderate significance.

#### *Moss of Auchlea Drainage System (ch107450)*

- 24.4.150 Installation of a culvert is considered to have a medium magnitude of impact on the hydrology of the watercourse. Similar activities would have a low magnitude of impact on geomorphology given the already straightened nature of the watercourse. Impacts on water quality may be of high magnitude given the extent of works required.

- 24.4.151 Overall, the impacts on the water environment would be of high magnitude and Substantial significance.

#### *Moss of Auchlea (ch107450)*

- 24.4.152 Construction activities are not expected to affect the Moss of Auchlea directly as the proposed scheme would be located to the east of the site. As the site is upstream of the moss, there is potential for indirect affects through other surface water pathways. The impact on water quality during construction for the Moss of Auchlea Drainage System is considered to be of high magnitude and Substantial significance. Hence, the overall unmitigated impact on the moss feature is of Substantial significance.

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##### *Westholme Burn (ch108650)*

- 24.4.153 Due to the limited requirement for works in the channel, the impact on hydrology, geomorphology and water quality of the burn is considered to be of low magnitude and hence of Negligible significance.

##### *Borrowstone Burn and Ponds (ch110400)*

- 24.4.154 These waterbodies have been scoped out of geomorphology and water quality assessments due to the distance of the site from the watercourse. From a hydrological perspective, construction activities are not expected to affect the watercourse directly as the proposed scheme would be located to the east of the burn. Any indirect impacts would be of negligible magnitude and Negligible significance.

##### Catchment Impacts (Construction)

##### *Catchment Impacts on Crynoch Burn*

- 24.4.155 Due to proximity of Burnhead, Blaikiewell and Kingcausie Burn to Crynoch Burn, it is necessary to consider the potential impacts downstream. These burns would be affected by the Southern Leg section of the proposed scheme.
- 24.4.156 In addition to this, potential catchment impacts on watercourses reported in the Fastlink (Chapter 39: Water Environment), but draining to the Crynoch Burn catchment are considered here (Craigtath Burn, Circle Burn, Square Burn and Wedderhill Burn).
- 24.4.157 The potential to release sediment and pollutants to local watercourse during the construction phase is of high magnitude. There is potential for these impacts to indirectly affect Crynoch Burn, resulting in a Substantial significance.
- 24.4.158 Due to its regional importance, catchment impacts on the River Dee are discussed in Part E (Cumulative Impact Assessment) of this Environmental Statement.

##### Groundwater

- 24.4.159 The Southern Leg would pass along the southern edge of Hare Moss and through its upper catchment over inflowing surface water features. Consequently, there is potential for the road to alter the water balance in the moss. The magnitude of impact on the water balance is considered to be low to medium and the impact assessed as Moderate to Substantial significance. Refer to Chapter 23 (Geology, Contaminated Land and Groundwater) for more information.

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**Table 24.8 – Summary of Potential Impacts**

Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Loirston Burn	Medium	2 culverts and 2 culvert extensions: ch205580 (34m) Side road (24m) A90 (45m) A956 (47m)	Realigned length 778m (length maintained).	1 proposed outfall draining total of 2.6ha	<p>Construction</p> <p>Culverting of existing straightened channel and construction of proposed outfall would involve earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Risk of accidental spillage of pollutants during construction.</p> <p>Hydrology, Geomorphology and Water Quality: Medium</p>	Medium	Moderate
					<p>Operation</p> <p>Long-term decrease to morphological diversity due to extensive culverting and realignment of channel. High potential for decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur increasing levels of copper and zinc over EQS values. Increased accidental spillage risk due to traffic loadings.</p> <p>Hydrology: Medium Geomorphology: Low Water Quality: High</p>	High	Moderate/Substantial
Network culvert: Loirston (Ch.205955)					<p>Construction</p> <p>n/a</p>	n/a	n/a
					<p>Operation</p> <p>Potential to cause localised constriction of flow and introduce flood risk, as a result of culvert blockage.</p> <p>Hydrology: Medium Geomorphology and Water Quality: Scoped out of assessment.</p>	Medium	n/a
Greengate Ditch	Low	Watercourse taken into pre-earthworks drainage ditches			<p>Construction</p> <p>Watercourse would be re-directed into pre-earthworks drainage design, therefore a section of the watercourse downstream of the proposed road may be lost. Release of fine sediments and pollutants may occur.</p> <p>Hydrology and Geomorphology: Low Water Quality: High</p>	High	Moderate

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Section of the watercourse downstream of road may be lost.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of assessment</p>	Negligible	Negligible
Jameston Ditch	High	No crossing proposed	No realignment proposed	1 proposed outfall draining total of 7.1ha	<p>Construction</p> <p>Slight potential for accidental spillage of fuel and concrete during construction due to the distance of works to watercourse. Potential for impact on hydrological function.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Moderate
					<p>Operation</p> <p>Change to discharge regime due to road runoff discharge to the burn may lead to siltation and the requirement for dredging, which in turn may impact the hydrological function of the Moss. The sustainability of the water balance of Hare Moss is likely to be improved by increased flows within Jameston Ditch as a direct result of the road outfall. Major potential for decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur increasing levels of copper and zinc over EQS values. Increased accidental spillage risk due to traffic loadings.</p> <p>Hydrology : Beneficial</p> <p>Geomorphology: Low</p> <p>Water Quality: High</p>	High, but beneficial to hydrological regime	Substantial
Burn of Ardoe	High	1 No. culvert ch204040 (59m)	Realignment associated with culvert construction: Length 80m (length maintained).	No road drainage discharge to burn	<p>Construction</p> <p>Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for small scale spillage of potential pollutants, however, this has the potential to impact the moss downstream.</p> <p>Hydrology: Medium</p> <p>Geomorphology: Low</p> <p>Water Quality: High</p>	High	Substantial
					<p>Operation</p> <p>Minimal change to flow and sediment regime as a result of culvert.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Moderate

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Bishopston Ditch	High	1 No. culvert ch203900 (55m)	Realignment associated with culvert construction: Length 95m (length maintained).	No road drainage discharge to burn	<p>Construction</p> <p>Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for small scale spillage of potential pollutants, however, this has the potential to impact the moss downstream.</p> <p>Hydrology: Medium  Geomorphology: Low  Water Quality: High</p>	High	Substantial
					<p>Operation</p> <p>Minimal change to flow and sediment regime as a result of culvert.</p> <p>Hydrology and Geomorphology: Low  Water Quality: Negligible</p>	Low	Moderate
Heathfield Burn	High	1 No. culvert ch203650 (46m)	Realignment associated with culvert construction: Length 89m (length maintained).	No road drainage discharge to burn	<p>Construction</p> <p>Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for small scale spillage of potential pollutants, however, this has the potential to impact the moss downstream.</p> <p>Hydrology: Medium  Geomorphology: Low  Water Quality: High</p>	High	Substantial
					<p>Operation</p> <p>Minimal change to flow and sediment regime as a result of culvert.</p> <p>Hydrology: Low  Geomorphology: Medium  Water Quality: Negligible</p>	Medium	Moderate/ Substantial
Hare Moss	High	N/A			<p>Construction</p> <p>Culverting of 3 burns which provide hydraulic connectivity to the moss, plus the construction of a treatment outfall to a fourth burn is considered to result in a high potential for pollution of the moss during the construction phase.</p> <p>Hydrology: Medium  Geomorphology: Scoped out of assessment.  Water Quality: High</p>	High	Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>The AWPR crosses to the south of the Moss and upstream of all watercourses draining to the Moss. Although the road does not have a direct impact on Hare Moss there is potential for the road to alter the water balance of the Moss through changes in the hydrological inputs to the Moss area. However, long-term inputs of road runoff to the moss through the Jameston Ditch would have a high impact on the feature.</p> <p>Hydrology: High</p> <p>Geomorphology: Scoped out of assessment.</p> <p>Water Quality: High</p>	High	Substantial
Whitestone Burn	Low	1 No. culverts: ch200990 (51m)	Realignment associated with culvert construction: Length 123m (length maintained).	No road drainage discharge to burn	<p>Construction</p> <p>Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for spillage of potential pollutants to a burn with low dilution potential.</p> <p>Hydrology and Geomorphology: Medium</p> <p>Water Quality: High</p>	High	Moderate
					<p>Operation</p> <p>Minimal change to flow and sediment regime as a result of culvert.</p> <p>Hydrology and Geomorphology: Medium</p> <p>Water Quality: Negligible</p>	Medium	Slight
Burnhead Burn	High	1 No. culvert ch200100 (65m)	1 No. major realignment – length 118m (length maintained).	1 proposed outfalls draining total of 8.95 ha	<p>Construction</p> <p>Culverting and realignment would involve major earthworks, possibly resulting in sediment release and straightening of the channel, leading to loss of morphological diversity and increasing short-term suspended solid loads possibly impacting the downstream SAC. Construction of a culvert, realignment and an outfall may increase risk of accidental spills/pollution due to amount of major construction activity near watercourse.</p> <p>Hydrology: Medium</p> <p>Geomorphology and Water Quality: High</p>	High	Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Long-term decreased geomorphological diversity due to burn realignment, with culverting. Potential change to discharge regime due to road runoff outfall and realignment. Additionally road runoff discharge to the burn may lead to siltation and the requirement for dredging. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes. Length of culvert likely to impact on water quality due to lack of light. Potential flood risk to properties as a result of potential blockage of the new culvert.</p> <p>Hydrology: Medium  Geomorphology and Water Quality: High</p>	High	Substantial
Blaikiewell Burn	High	1 No. Buried structure ch112150	No realignment is proposed	No road drainage discharge to burn	<p>Construction</p> <p>Bridging would involve extensive earthworks, possibly resulting in sediment release leading to short-term increase to suspended sediment loads and turbidity within the channel potential impacts on water quality and geomorphological diversity.</p> <p>Hydrology and Water Quality: Medium  Geomorphology: High</p>	High	Substantial
					<p>Operation</p> <p>The installation of a bridge structure has the potential to change the discharge regime of the burn (in addition to the flows contributed by upstream outfall proposed for Burnhead Burn). This may result in a change to sediment regime and erosion/deposition patterns such that there is an impact on the turbidity and hence the water quality of the channel and perhaps the downstream SAC.</p> <p>Hydrology: Low  Geomorphology: High  Water Quality: Negligible</p>	High	Substantial
Kingcausie Burn	High	1 No. culverts: ch101470 (47m)	Realignment associated with culvert construction Realigned length 404m resulting in a shortening of the channel by 37m.	No road drainage discharge to burn	<p>Construction</p> <p>Extensive culverting and realignment would involve earthworks, possibly resulting in sediment release and straightening of the channel, leading to loss of morphological diversity and short-term increase in suspended solid loads. Potential risk of accidental spillage of pollutants during construction due to the length of works in close proximity to the watercourse.</p> <p>Hydrology and Water Quality: Medium  Geomorphology: High</p>	High	Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Long-term decreased morphological diversity due to long section of culverting and proposed realignments, which straighten the channel reducing sinuosity and decrease morphological diversity in close proximity to the SAC. Change to discharge regime due to shortening realignment may lead to localised siltation or erosion. Length of culvert may impact on water quality due to lack of light. Impacts on groundwater and associated private wells considered to be of moderate significance in the area.</p> <p>Hydrology: Medium  Geomorphology: High  Water Quality: Negligible</p>	High	Substantial
River Dee	High	1 No. Bridge ch114000	No realignment proposed	1 Proposed outfall. Total of 10.7 ha	<p>Construction</p> <p>Bridging, approach road and outfall construction would involve extensive earthworks, possibly resulting in sediment release leading to short-term increase to suspended sediment loads and turbidity within the channel potential impacts on water quality and geomorphological diversity.</p> <p>Hydrology: Medium  Geomorphology and Water Quality: High  Sediment Modelling: High</p>	High	Substantial
					<p>Operation</p> <p>Potential change to discharge regime due to road runoff outfall. Road runoff discharge to the watercourse may lead to siltation and indirect impacts on freshwater habitats. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes.</p> <p>Hydrology: Low  Hydrodynamic Modelling: Negligible  Geomorphology and Water Quality: High  Water Quality Modelling: Negligible</p>	High	Substantial
Milltimber Burn	Low	1 No. culverts: ch102670 (77m)	Realignment associated with culvert construction: Length 107m (length maintained).	No road drainage discharge to burn	<p>Construction</p> <p>Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for small scale spillage of potential pollutants.</p> <p>Hydrology and Geomorphology: Medium  Water Quality: High</p>	High	Moderate

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Minimal change to flow and sediment regime as a result of culvert and associated realignment.</p> <p>Hydrology and Geomorphology: Medium</p> <p>Water Quality: Negligible</p>	Medium	Slight
Culter House Burn	Low	Catchment severed and watercourse filled in and lost			<p>Construction</p> <p>Catchment of watercourse would be severed, resulting in watercourse running dry, catchment being re-directed into pre-earthworks drainage design and watercourse being filled in. Release of fine sediments and pollutants may occur.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate
					<p>Operation</p> <p>Watercourse under road entirely filled in and lost.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of assessment.</p>	Negligible	Negligible
Beans Burn	Low	Watercourse taken into pre-earthworks drainage ditches			<p>Construction</p> <p>Watercourse would be re-directed into pre-earthworks drainage design, therefore a section of the watercourse downstream of the proposed road may be lost. Release of fine sediments or pollutants may occur.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate
					<p>Operation</p> <p>Section of the watercourse downstream of road may be lost.</p> <p>Hydrology: Medium</p> <p>Geomorphology and Water Quality: Scoped out of assessment</p>	Medium	Slight
Upper Beanshill Burn	Low	Watercourse taken into pre-earthworks drainage ditches			<p>Construction</p> <p>Watercourse would be re-directed into pre-earthworks drainage design, therefore a section of the watercourse downstream of the proposed road may be lost. Release of fine sediments or pollutants may occur.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Section of the watercourse downstream of road may be lost.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of assessment.</p>	Negligible	Negligible
Gairn Burn	Medium	2 No. culverts: side road ch163 (12m) and pond access ch270 (8m)	Realignment associated with culvert construction: Length 163m (shortening of the burn by 13m).	1 Proposed outfall. Total of 4.75 Ha.	<p>Construction</p> <p>The construction of an extensive outfall, culvert and realignment would involve major earthworks, possibly resulting in sediment release, leading to loss of morphological diversity and increasing short-term suspended solid loads. Construction may increase risk of accidental spills/pollution due to amount of major construction activity near watercourse.</p> <p>Hydrology, Geomorphology and Water Quality: Medium</p>	Medium	Moderate
					<p>Operation</p> <p>Potential change to discharge regime due to road runoff outfall, culvert and realignment. Road runoff discharge to the burn may lead to siltation and the requirement for dredging. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes. Impacts on groundwater and associated private wells considered to be of moderate significance in the area.</p> <p>Hydrology and Geomorphology: Medium</p> <p>Water Quality: High</p>	High	Moderate/ Substantial
Network culvert: Gairn (ch106175)					<p>Construction</p> <p>n/a</p>	n/a	n/a
					<p>Operation</p> <p>Potential to cause localised constriction of flow and introduce flood risk, as a result of culvert blockage.</p> <p>Hydrology: Medium</p> <p>Geomorphology and Water Quality: Scoped out of assessment</p>	Medium	n/a
Moss of Auchlea Drainage System	High	1 No. culverts: ch107440 (75m)	Realignment associated with culvert construction: Length 84m (shortening of the burn by 9m).	No road drainage discharge to burn	<p>Construction</p> <p>Culverting of existing straightened channel would involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for small scale spillage of potential pollutants, however, this has the potential to impact the moss downstream.</p> <p>Hydrology: Medium</p> <p>Geomorphology: Low</p> <p>Water Quality: High</p>	High	Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Minimal change to flow regime to the moss as a result of culvert. Potential risk to flooding as a result of potential culvert blockage.</p> <p>Hydrology: Medium</p> <p>Geomorphology and Water Quality: Negligible</p>	Medium	Moderate/Substantial
Moss of Auchlea	High	N/A			<p>Construction</p> <p>Culverting of a watercourse which provides hydraulic connectivity to the moss may result in a high potential for pollution of the moss during the construction phase.</p> <p>Hydrology: Negligible</p> <p>Geomorphology: Scoped out of assessment</p> <p>Water Quality: High</p>	High	Substantial
					<p>Operation</p> <p>There are no direct hydrological impacts on the Moss of Auchlea assuming that the catchment area draining to the burn is maintained. The culvert on the Moss of Auchlea drainage system allows connectivity of the moss to the catchment area upstream of the road.</p> <p>Hydrology and Water Quality: Negligible</p> <p>Geomorphology: Scoped out of assessment</p>	Negligible	Slight/Negligible
Network culvert: Moss of Auchlea (ch107305)					<p>Construction</p> <p>n/a</p>	n/a	n/a
					<p>Operation</p> <p>Potential to cause localised constriction of flow and introduce flood risk, as a result of culvert blockage.</p> <p>Hydrology: Low</p> <p>Geomorphology and Water Quality: Scoped out of assessment</p>	Low	n/a
Westholme Burn	Low	No crossing proposed	No realignment proposed	1 Proposed outfall. Total of 8.25 ha.	<p>Construction</p> <p>The construction of a an extensive outfall would involve major earthworks, possibly resulting in sediment release, leading to loss of morphological diversity and increasing short-term suspended solid loads possibly impacting the downstream fisheries designated river. Construction of an outfall may increase risk of accidental spills/pollution due to amount of major construction activity near watercourse.</p> <p>Hydrology, Geomorphology and Water Quality: Low</p>	Low	Negligible

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>Potential change to discharge regime due to road runoff outfall. Road runoff discharge to the burn may lead to siltation and the requirement for dredging. Decreased water quality resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes.</p> <p>Hydrology and Geomorphology: Low  Water Quality: High</p>	High	Moderate
Network culvert: Westholme (ch108585)					<p>Construction</p> <p>n/a</p>	n/a	n/a
					<p>Operation</p> <p>Potential to cause localised constriction of flow and introduce flood risk, as a result of culvert blockage.</p> <p>Hydrology: Low  Geomorphology and Water Quality: Scoped out of assessment</p>	Low	n/a
Borrowstone Burn and Ponds	Low	No crossing proposed	No realignment proposed	No outfall proposed	<p>Construction</p> <p>Scoped out of geomorphology and water quality assessments due to the distance of the site from the watercourses. Construction activities are not expected to affect the watercourse directly as the proposed scheme would be located to the east of the site. Any indirect impacts would be negligible.</p> <p>Hydrology: Negligible  Geomorphology and Water Quality: Scoped out of assessment</p>	Negligible	Negligible
					<p>Operation</p> <p>Scoped out of geomorphology and water quality assessments due to the distance of the site from the watercourses. Although the burn or ponds are not crossed by the AWPR, there is a minor (less than 1%) reduction in the catchment area due to the position of the AWPR and the drainage scheme. This catchment area would drain to Westholme Burn outfall before discharging into Brodiach Burn further downstream.</p> <p>Hydrology: Negligible  Geomorphology and Water Quality: Scoped out of assessment</p>	Negligible	Negligible

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##### Summary

- 24.4.160 Table 24.8 identifies the overall magnitude and significance of potential impacts for each of the water features. Potential impacts of Substantial significance have been identified during construction and operation for four watercourses and one moss feature:
- Kingcausie Burn;
  - Burnhead Burn;
  - Blaikiewell Burn;
  - River Dee; and
  - Hare Moss.
- 24.4.161 In addition to this, potential impacts on Jameston Ditch have been assessed as being of Substantial significance for the operational phase of the work scheme.
- 24.4.162 From a catchment perspective, the indirect impact on Crynoch Burn, resulting from the impacts on Burnhead, Kingcausie and Blaikiewell Burn, is considered to be of high magnitude. This arises from the level of impact experienced on the three burns, particularly from a geomorphological perspective, but includes the impact on water quality at Burnhead Burn. Overall, the potential impacts on water quality have been assessed as Substantial significance.
- 24.4.163 The assessment found that, during construction, potential impacts on four other watercourses and one moss feature would be of Substantial significance:
- Bishopston Ditch;
  - Heathfield Ditch;
  - the Burn of Ardoe; and
  - the Moss of Auchlea drainage system and the Moss of Auchlea.
- 24.4.164 During the operational phase, the following burns are predicted to have Moderate/Substantial impact significance:
- Loirston Burn;
  - Gairn Burn;
  - Heathfield Ditch; and
  - Moss of Auchlea drainage system.
- 24.4.165 During the operation phase, the following burns would be impacted to a Moderate significance level:
- Burn of Ardoe;
  - Bishopston Ditch;
  - Milltimber Burn; and
  - Westholme Burn.

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24.4.166 During construction, potential impacts on the following watercourse have been assessed as being of Moderate significance:

- Loirston Burn;
- Gairn Burn;
- Whitestone Burn
- Upper Beanshill Burn;
- Beans Burn;
- Culter House Burn;
- Milltimber Burn;
- Jameston Ditch; and
- Greengate Ditch.

24.4.167 The rest of the watercourses would be impacted to a Slight or lower significance during the operation and construction phases.

## **24.5 Mitigation**

### **Introduction**

24.5.1 The objectives of the mitigation measures outlined in this section are to prevent, reduce or offset the potential impacts described in Section 24.4.

24.5.2 Mitigation includes those measures to convey surface water runoff from the road to receiving watercourses without detrimental effect on water quality, water quantity, associated ecosystems and the underlying groundwater. It also includes measures to minimise impacts on geomorphological features that may arise from the installation of culverts and realignments, as well as those to be implemented to avoid impacts during the construction phase.

24.5.3 The design of mitigation for impacts on water quality and hydrology has been developed using best practice. Impacts on fluvial geomorphology as a result of realignments often require detailed design to develop effective mitigation. These requirements will continue to develop through the CAR application process and ongoing liaison with SEPA.

### Guiding Principles

24.5.4 Mitigation is proposed to assess any adverse impact where practicable, including all impacts assessed as being of greater than slight significance and are intended 'to prevent, reduce or where possible, offset any significant adverse impacts on the existing drinking and bathing water quality, ecology and nature and conservation value of the surrounding area' (EIA (Scotland) Regulations (SE, 1999).

24.5.5 The implications of the WFD have also been taken into account in the formulation of mitigation strategies; mitigation measures for all watercourses aim to achieve and preserve 'good' water quality and ecological status of any watercourse. SEPA requires construction activities near most watercourses or waterbodies and road outfalls (draining over 1km of road) to be licensed under the terms of the Controlled Activities Regulations 2005. The requirements of EC Freshwater Fisheries and the Dangerous Substances Directives have also been taken into consideration when choosing the appropriate level of road runoff treatment.

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Approach to Mitigation

- 24.5.6 Mitigation measures typically comprise solutions aimed at the source of the impact. The risk of causing deterioration in status of each watercourse can be reduced by 'designing out' any risk. This has been taken into account during the selection of a preferred route and road alignment, for example to avoid important/sensitive water features where possible.
- 24.5.7 In some circumstances, potentially adverse impacts cannot be prevented (i.e. where there is a need for road runoff to be discharged to local watercourses and drainage ditches). Where this is the case, mitigation measures are proposed to ameliorate adverse impacts. In particular major design components such as road drainage, locations of bridges and culverts and watercourse realignment details have been developed through an iterative process involving structural engineers, geomorphologists, hydrologists, ecologists and water quality specialists. As described above, in some cases further design work is being undertaken to reduce potential impacts.
- 24.5.8 Consultation with SEPA and SNH has been undertaken at key design stages to seek guidance on appropriate levels of road drainage, culverting and watercourse realignment from these statutory bodies before the publication of the ES. Relevant fisheries boards have also been contacted. Further information on the consultation process is provided in Chapter 6 (Scoping and Consultation).
- 24.5.9 The mitigation proposed to address potential impacts are summarised in Table 24.10.

Water Environment (Controlled Activity) Regulations (Scotland) 2005: Licence Applications

- 24.5.10 Prior to construction, most activities within the water environment associated with the scheme will require some form of license application under the new CAR regulations (SEPA, 2007). The application will require detailed information on the;
- the proposed activity, its design and the reasons for the chosen design;
  - details of the potential impacts to the water environment, including baseline environmental information;
  - details of the mitigation included in the design, aimed at reducing the potential impact; and
  - a detailed construction methodology.
- 24.5.11 The preparation of CAR applications is currently underway in liaison with SEPA. It will be necessary to develop mitigation to the satisfaction of SEPA before a CAR licence is approved. Ongoing design and mitigation refinement will be a part of this process.

**General Mitigation Requirements**

Road Drainage

- 24.5.12 The drainage system of the proposed scheme has been designed in accordance with The SUDS Manual CIRIA C697 (CIRIA, 2007) and Sustainable Urban Drainage Systems: hydraulic, structural and water quality advice CIRIA C609 (CIRIA, 2004) (Additionally Sustainable Urban Drainage Systems (SUDS): Design Manual for Scotland and Northern Ireland CIRIA C521 (CIRIA, 2000) has been considered).
- 24.5.13 Where it has been identified as necessary for road drainage to outfall to receiving watercourses, mitigation has been designed to minimise the volume of discharge and the risk to water quality. For each outfall, a range of SUDS solutions were considered to attenuate the road runoff to pre-development rates and reduce the polluting load carried within this runoff to acceptable levels.

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- 24.5.14 For each outfall, a 'treatment train' is proposed which comprises a series of mitigation measures such as filter drains and catchpits, detention basins, swales and treatment ponds (up to three in series which may include wet or dry ponds or a mixture). Different types of treatment were considered within each treatment train (dry/wet ponds) to maximise pollutant removal.

#### *Filter Drains and Catchpits*

- 24.5.15 Filter drains usually consist of a perforated pipe laid in a trench backfilled with gravel and usually placed along the road verge. Filter drains can be used to convey highway drainage to the discharge point and also filter out pollutants such as suspended solids, hydrocarbons and heavy metals. DMRB indicates copper removal efficiency of 20% and zinc removal efficiency of 75%. Where the proposed scheme would be situated in a cutting, there is a greater risk of groundwater contamination and the filter drain must therefore be designed with an impermeable liner to minimise risk of pollution to groundwater in areas of high sensitivity.
- 24.5.16 Piped carrier drains may be required at certain locations to transfer surface water beneath the main carriageway, and from the filter drains to designated outfall points. This type of treatment conveys surface water but generally is not designed to attenuate.
- 24.5.17 Catchpits consist of a small chamber with a sediment collection sump. These are designed to trap sediments and other debris and retain a proportion of the suspended solids present in the runoff and settle out hydrocarbons and metals. Catchpits are located at regular spacings (at intervals of no less than 90m) along filter drains and at the junctions of carrier drains.
- 24.5.18 The carriageway drainage is designed to carry the 50% AEP (1:2 year event) and is checked for surcharging at the 10% AEP (1:10 year event). Above the 10% AEP (10 year event) the water is expected to spill into the pre-earthworks drainage ditches which run alongside the road, at the toe of embankments and at the top of cuttings. These ditches (including all network culverts) are designed to convey the 1.33% AEP (1:75 year return period event). Above the 1.33% AEP flood flow routes would be identified by engineers to ensure flooding is directed either down the carriageway or down the overflowing ditches to the attenuation features (described below) before outfall into the receiving watercourses. Further design works will include the design of online attenuation features on pre-earthworks drainage ditches.

#### *Detention Basins/Treatment Ponds*

- 24.5.19 These are 'end-of-line' treatment systems, providing biological treatment and removal of dissolved contaminants and nutrients. They are constructed to collect road runoff prior to discharge to the receiving environment; detention basins are principally used to attenuate flows, whilst treatment ponds are required to treat the more polluted first flush component of road runoff. All constructed ponds would be located outwith the 0.5% AEP floodplain (1:200 year flow).
- 24.5.20 The proposed detention basins would mitigate flows up to the 0.5% AEP (1:200 year return period event) by storing water and providing a controlled discharge into receiving waters. The basins would be designed to attenuate the 1% AEP (1:100 year event) back to pre development runoff rates ( $Q_{MED}$  Greenfield runoff rate). Then, to account for climate change (as detailed in section 24.2.2-24.2.31), the freeboard allowance on the basins are checked to ensure that the 0.5%AEP (1:200 year) can be held within the basin.
- 24.5.21 Treatment ponds are reported to remove 65% of zinc and copper from road drainage (CIRIA, 2004). The required storage volume to treat road drainage (the treatment volume) is calculated based on the guidance contained in the SUDS Design Manual (CIRIA, 2000) and guidance on best design practice for pollutant removal given in 'Treatment of Highway Runoff Using Constructed Wetlands' (Environment Agency, 1998) and 'CIRIA C609' (CIRIA, 2004). This would include consideration of wet and dry ponds in sequence to maximise pollutant removal by differing methods. Design treatment times would be between 24-48 hours depending on the number of ponds and level of treatment required. Pollution removal rates decrease in efficiency as detention time in ponds increases and studies have shown that a detention time beyond 24 hours does not

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result in a significant improvement in quality (CIRIA, 2004). In general, all treatment systems are designed to attenuate flows for over 24 hours (between 39 and 192 hours (design dependent)).

- 24.5.22 The required storage volume to treat road drainage (the treatment volume) has been calculated based on the guidance contained in the CIRIA SUDS Design Manual (CIRIA, 2000) and the design guidance given in Treatment of Highway Run-off Using Constructed Wetlands (Environment Agency, 1998). CIRIA guidance states that ponds should be designed with storage volume,  $V_t$  (the volume generated by a mean annual flood) or, in exceptional circumstances,  $4V_t$  (four times the volume generated by a mean annual flood). In agreement, SEPA recommends that ponds draining particularly sensitive catchments should be designed for storage volume  $4V_t$ . Best design practice for pollutant removal, as detailed in CIRIA C609 (2004) and CIRIA C697 (2007), would be adhered to.

#### *Swales*

- 24.5.23 Swales are vegetated surface features that drain water evenly off impermeable areas. The swale channel is broad and shallow and covered by grass or other suitable vegetation to slow down flows and trap pollutants (CIRIA, 2004). Swales can also be designed for a combination of conveyance, infiltration, detention and treatment of runoff (CIRIA, 2004). They are typically located next to highways but can also be constructed in landscaped areas within car parks and elsewhere.

- 24.5.24 Swales are generally effective at removing pollutants through filtration and sedimentation for frequent small storm events (CIRIA, 2004). For larger, less frequent storms of between a 50% and 10% AEP (1 in 2 and 1 in 10 year return period), they can act as a storage and conveyance mechanism. For larger storms with an AEP of less than 10% (return periods greater than 1 in 10 years), providing storage in swales may become impractical as catchment size increases and they are often used in conjunction with other techniques. They are reported to remove 70%-90% of total zinc and 50%-70% dissolved copper from the road drainage (DMRB, 1998). For the purpose of this assessment, the removal efficiencies are assumed to be 70% for total zinc and 50% for dissolved copper.

- 24.5.25 Swales are often integrated into the surrounding land use, for example public open space or road verges. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat. Care will be taken in the choice of vegetation as tussocks create local eddies, increasing the potential for erosion on slopes. Shrubs and trees can be planted but in this case the vegetated area will need to be wider and have a gentler slope (CIRIA, 2004).

#### *Outfall Structures*

- 24.5.26 Mitigation will ensure that the outfall is correctly positioned to limit the potential for scour around the culvert. The location and design of the outfall will ensure that there would be no significant alteration to flow patterns which may lead to turbulence and/or excessive deflection of flow towards the bed or banks of the channel. The outfall will not project out into the channel and would not be located where flow converges with river banks causing higher shear stresses or where active bank erosion is occurring. Details of best practice are identified in CIRIA 697 (CIRIA, 2007). Indicative outfall locations are shown on Figures 24.7a-d; however finalised locations will be determined at the detailed design stage.

#### *Maintenance of Road Drainage Network*

- 24.5.27 To avoid failure or sub-optimal operation of the road drainage network, maintenance of its components is necessary as follows:
- maintenance of filter drains include inspection and weed control, sediment removal and vegetation build up, replace clogged filter material typically once in 10 years or more;
  - maintenance of filtration devices include inspections, grass cutting and site rubbish removal, annual reinstatement of eroded areas or damaged vegetation and removal of sediment;

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- regular maintenance of detention basins and treatment ponds to ensure efficient operation and the settlement of solids and removal of pollutants (such as hydrocarbons). The maintenance includes inspections and site rubbish removal, bank side and pond vegetation clearance at least every 3 years, remove sediment from forebay (the first depression within the basin, usually concrete for easy maintenance) when 50% full and from the pool when volume reduced by 25% (25 years or greater);
- regular maintenance of receiving watercourses and culverts to reduce the risk of blockages and thus increased flood risk;
- if herbicides are used, those recommended by SEPA for use near watercourses are to be applied in line with manufacturer's instructions to reduce pollution of watercourses; and
- provision of scour protection at the drainage discharge outfall to protect the banks and bed of the receiving ditch and to limit erosion.

24.5.28 Water quality/sedimentation/ecological monitoring downstream of key outfalls would be undertaken to provide an indication for problems should they arise. In particular, this would be undertaken at the proposed outfall for the River Dee to monitor any potential long-term impacts on the watercourse.

#### *Network Culverts*

24.5.29 Similar to conventional watercourse culvert crossings, a regular maintenance regime would be set in place to prevent any blockages in or around the network culverts that could reduce the capacity of the structure. This would include the removal of debris and dead vegetation from the drainage channel and the banks upstream of the structure. Where there is considered to be a significant potential risk of culvert blockage due to surrounding land use, a suitably designed culvert trash screen may be considered to reduce the risk of blockage designed in line with the guidance offered in CIRIA Report No. C168 and the Design and operation of trash screens, Interim Guidance Notes, (NRA, 1993). Alternatively, if a serious risk of blockage remains sizing the culvert to pass 0.5% AEP could be considered.

#### Water Crossings (Bridges and Buried Structures)

24.5.30 As described in Section 24.4, bridges are proposed for the scheme to cross over the River Dee and Blaikiewell Burn. Bridging these high sensitivity, and in the case of the River Dee, salmonid watercourses will minimise adverse impacts on water quality, the hydrological regime, geomorphological diversity. The major river crossing design for the River Dee has been developed by a team comprising engineers, hydraulic modellers, environmental scientists and aesthetic advisors. Descriptions of the River Dee bridge are provided in Chapter 4 (The Proposed Scheme), with aspects specific to water quality, quantity and geomorphology outlined below.

24.5.31 The use of bridges for crossing structures will minimise impacts on the hydrological regime during construction and operation. Although all crossing structures have been designed with the capacity to convey at least the 0.5%AEP (1 in 200 year design period) event, bridges may accommodate flows of higher return period events due to their structural form. Bridges have been designed to span the watercourse to minimise impacts on watercourse hydrology during normal flow conditions, however channel conveyance may still be impacted

24.5.32 Buried structures act in a similar way to bridges in that they are set back from the watercourse and allow the retention of natural substrate through the structure. Often these structures can be built over the watercourse without requiring the realignment of the watercourse. Buried structures tend to be lower in height than bridges, which can result poor light penetration in longer structures. Poor light may mean that riparian vegetation through the structure would be unlikely to survive, resulting in poor bank stability and bare banks alongside the watercourse.

24.5.33 The proposed bridge design for the River Dee is a three-span viaduct (refer to Appendix A24.2) and the design does not require any piers to be located in the water column, which will avoid the need for in-channel works at these crossing points. During construction, this will significantly

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reduce the potential for accidental spillage and sediment release within the water channel and avoids the requirement for river diversion or pumping water away during construction. The design of the bridge will minimise impacts on the morphological diversity of the river and retain the natural sinuosity of the channel as it will span the watercourse.

- 24.5.34 The bridge crossing structures have also been designed to minimise damage to the surrounding riparian zone, with abutments set back from the water's edge. For this reason, viaduct options are generally preferred over the construction of large embankments on floodplains. In addition to reducing any risk of increase to flood risk, this also allows sufficient light through most bridge structures to maintain riparian vegetation, thereby reducing erosion and minimising adverse impacts on water quality.

#### Watercourse Crossings (Culverts)

- 24.5.35 Watercourse crossings such as culverts have been designed to specified return period flows. SEPA requires design to a 0.5% AEP (return period of at least 1 in 200 years). SPP7 states that this return period already includes an allowance for climate change (refer to paragraph 24.2.31). Culvert design will follow SEPA policy and the guidelines set out in 'Culvert Design Manual: Report 168' (CIRIA, 1997). In addition, the culvert design accommodates fish passage following guidance from 'River Crossings and Migratory Fish: Design Guidance: A Consultation Paper for the Scottish Executive' (SEERAD, 2000). The design of the proposed crossings will ensure that there is minimal disruption to the existing flow regime of the affected watercourse. Mammal ledges will also be installed to provide wildlife access, as described in Chapter 25 (Ecology and Nature Conservation).
- 24.5.36 The decision to install depressed invert culverts at all crossings (with the exception of Blaikiewell Burn and the River Dee) has been made taking into account engineering, economic and environmental constraints. It should be noted that this culvert design will reduce impacts to some watercourses, but not all. For example, morphologically diverse watercourses such as Kingcausie Burn will remain affected as the culvert will reduce the sinuosity and morphological diversity of the watercourse in the long-term.
- 24.5.37 As previously noted, depressed invert culverts allow the base of the culvert to be set at below bed level to allow natural substrate to be used within the culvert to provide bed continuity through the structure. To ensure no increased impacts on a watercourse, the bed substrate must be formed prior to the routing of flow through the culvert. Bed sediments will not be transferred from the existing channel as this may release fine sediments and pollutants stored beneath the bed armour (coarse sediments forming the top layer of the bed sediments). The new bed will be formed of locally sourced material of the same size as the dominant particle size in the pre-existing gravel channel (excluding silt accumulations), where possible. No fine sediment will be placed in the new channels.
- 24.5.38 The long-term stability of the bed sediments in depressed invert culverts will depend on stream power within the culvert. Where the gradient of the culvert is high, scouring may occur within the culverts causing loss of bed sediments to downstream depositional areas. Problems associated with stream power are most likely to occur where culverting has involved the straightening of previously sinuous watercourses. In order to minimise the risk of scour, it may be necessary to install baffles in some culverts to dissipate flow energy and to stabilise the bed sediments. As noted previously, all culverts have been designed to allow flows through during a 0.5% AEP (1:200 year) flood and ensure that gradients do not differ markedly from existing conditions to avoid excessive siltation or erosion.
- 24.5.39 Culverts will be designed to minimise the potential for blockages to occur (e.g. due to trapped debris). This includes the provision of large capacity, smooth transitions into the culverts. A one dimensional model of all the proposed culverts crossing natural watercourses has been constructed and results indicate culverts are suitably designed and pass the 0.5% AEP (1:200-years) flow with spare capacity. A regular maintenance regime will also be necessary to prevent blockages around culverts and buried structures that could reduce the capacity of the structure.

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##### Watercourse Realignments

- 24.5.40 Watercourse realignments are generally required to direct watercourses away from the road or to install a culvert under the road at a particular location or alignment. However, the objective of realignment may also be to reduce impacts elsewhere in the catchment by minimising crossing lengths and can represent substantial opportunities for improving the morphological diversity of modified watercourses. During the design of the watercourse crossings, several workshops were conducted with engineers, ecologists and geomorphologists at key design stages to ensure that watercourse realignments were limited to essential works and minimised adverse impacts.
- 24.5.41 A list of proposed realignments is provided in Section 24.4, with more detailed information provided in Appendix A24.3 (Fluvial Geomorphology). Further detailed site specific investigations will be undertaken for each watercourse realignment, as required, but designs will be based on the following principles:
- realignments through culverts were only used where necessary to reduce crossing (culvert) lengths by allowing the watercourse to cross underneath the mainline AWPR at 90 degrees;
  - designed to ensure that the realigned lengths were similar to original lengths as far as possible;
  - realignments in low gradient areas were designed to minimise sedimentation, e.g. by allowing the realigned section to be either straighter or shorter than the original;
  - realignments in high gradient areas were designed to minimise erosion, e.g. by allowing the realigned section to either meander more or be longer than the original, this will include the use of pool and riffle sequences; and
  - where possible, will maximise morphological diversity through the inclusion of meander bends, secondary channels, riparian zones, backwaters and ox bow lakes where appropriate.
- 24.5.42 Any realignment of a watercourse will be designed such that it causes minimal disturbance to flow patterns within the watercourse and adverse changes on water quality. Where possible, the realignment is required to mirror the original alignment and during the detailed design stage, a geomorphologist will be consulted for input to the design. Additional geomorphological assessments will be provided to SEPA, where required, as part of the CAR Application for each realignment.

##### *Pre-earthworks Drainage Ditches*

- 24.5.43 Taking a watercourse into pre-earthworks drainage ditches is the equivalent of realigning a watercourse and allowing it to drain in a different channel. Mitigation for these during the operation phase is aimed at ensuring that flood risk is not increased. The drainage system has been designed in accordance DMRB HA 106/04, to account for and be able to convey, the extra flow that these small, mainly ephemeral, watercourses contribute, up to the 1.33% AEP (1 in 75-year) flood event.

##### *Sedimentation/Erosion Monitoring of Realigned and Culverted Watercourses*

- 24.5.44 Although river diversions and culverts are to be designed to minimise the risk of sedimentation and erosion, a monitoring program will be undertaken to flag any potential problems during the construction phase. This approach is aimed at reducing the risk of dramatic changes to the geomorphological character of watercourses, which may lead to adverse impacts on water quality. Details of the monitoring approach are given in Appendix A24.3 (Fluvial Geomorphology), but must include regular inspections after construction to monitor watercourse for any areas of new erosion or deposition.

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Construction

*Adherence to Best Practice*

- 24.5.45 Avoidance and reduction of construction impacts on watercourses will be achieved by:
- minimising the duration and spatial extent of works in the vicinity of watercourses and ensure adequate sediment control measures are in place around the works;
  - the presence of an Ecological Clerk of Works (ECoW) on site during construction to ensure the implementation of appropriate environmental safeguards;
  - progressive rehabilitation of exposed areas throughout the construction period as soon as possible after the work has been completed to minimise sediment release into the channel;
  - installation of temporary treatment ponds, where required, to ensure the protection of water quality throughout construction. Details regarding any temporary construction treatment ponds will be agreed with SEPA prior to commencement of construction;
  - guidance detailed in CIRIA reports C648 and C697 relating to temporary SUDS;
  - the use of erosion controls such as sediment fencing to minimise sediment release into watercourses;
  - inspection and maintenance of all erosion controls weekly and after heavy rainfall events;
  - any abstractions from the watercourse will be identified and quantified. Formal consent from SEPA will be sought for any abstractions from watercourses;
  - silt fences or gravel bags will be erected around all stockpiles, stockpiles of materials will be located away from watercourses;
  - the width of area to be disturbed is to be kept to a minimum;
  - location of site compounds away from watercourses and floodplains; and
  - regulation of the storage of any materials on the floodplain or near tributaries to reduce risk of pollutants/fine sediment entering watercourses.
- 24.5.46 Measures to avoid, minimise or control pollution of surface water and groundwater will incorporate SEPA requirements for pollution control, including Pollution Prevention Guidelines (PPGs) detailed below:
- PPG01 General Guide to the Prevention of Water Pollution;
  - PPG04 Disposal of Sewage Where no Foul Sewer is Available;
  - PPG05 Works In Near or Liable to Affect Watercourses;
  - PPG06 Working at Construction and Demolition Sites;
  - PPG07 Refuelling Facilities;
  - PPG08 Storage and Disposal of Used Oils;
  - PPG09 Prevention of Pollution by Pesticides;
  - PPG10 Highways Depots;
  - PPG13 High Pressure Water and Steam Cleaners;
  - PPG18 Control of Spillages and Fire Fighting Runoff; and
  - PPG21 Pollution Incident Response Planning.

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24.5.47 Mitigation requirements for works in the vicinity of water features (incorporating PPG recommendations) are provided in Table 24.10.

**Table 24.10 – Mitigation Measures During Construction**

Source of Impact	Mitigation
Suspended Solids	<p>Runoff and erosion control measures will include perimeter cut-off ditches; ditches at the base of embankments (where the adjacent ground slopes towards the embankment); settlement lagoons; the installation of silt fences on cut slopes in the proximity of watercourses, around drainage inlets and any drainage path; placement of hay bales; mulching; erosion control blankets; sediment fencing and hydro-seeding. Should chemical flocculants be proposed for settlement, SEPA will be consulted to obtain the necessary approvals.</p> <p>Stockpiles will not be located near watercourses, stockpiles must be covered when not in use and silt fencing must be provided around the perimeter of all stockpiles. Vehicles or vehicle wheels must not be washed near watercourses.</p> <p>Temporary bridges should be used to cross watercourses rather than temporary culverts and fording watercourses must be avoided.</p> <p>A method statement will be provided detailing proposed measures to mitigate release of suspended solids during the CAR licensing process.</p>
Oils, Fuels and Chemicals	<p>Bunded areas with impervious walls and floor lining for the storage of fuel, oil and chemicals must be provided. These bunded areas will have a value of at least 110% that of the storage tanks.</p> <p>In the event of large oil spills that cannot be dealt with at the local level, a detailed contingency plan will be provided to ensure effective mitigation.</p>
Concrete, Cement and Admixtures	<p>Storing potential pollutants or undertaking potentially polluting activities (e.g. concrete batching and mixing) will be completed away from watercourses, ditches and surface water drains.</p>
Watercourse/Drain Crossings and Diversions	<p>Construction of culverts will be undertaken in the dry to minimise potential contamination of the watercourse. Temporary diversions should be in place before culvert construction is undertaken. Temporary culverts (like permanent ones) will be designed to the 0.5% AEP to ensure adequate passage of water during high flow conditions and will be designed to ensure fish and mammal passage is facilitated.</p> <p>Where land drains are interrupted they will be incorporated into the pre-earthworks drainage ditches.</p> <p>Minimal disturbance to the banks and beds of watercourses and minimal disturbance to existing land drainage systems must be ensured. Where required, the existing land drainage would be culverted or diverted, as appropriate.</p>
Outfall Construction	<p>Ensure that construction of outfall is not conducted during periods of high flow as the disturbed exposed river banks will be vulnerable to erosion.</p> <p>Sediment control measure will be used to prevent sediment being washed into the watercourse. Limit the extent of disturbance on the banks of the watercourse.</p>
Sewerage	<p>If service diversions need to be carried out, the diversion will be undertaken prior to construction and will be undertaken using good engineering practices to ensure spillage risk is minimised. It is likely that statutory bodies may undertake the diversion works under their own access rights.</p> <p>Arrangements for safe storage and disposal of sewage effluent from workers on site will be agreed with SEPA and Building Control in advance of construction in accordance with PPG 4</p>
Contaminated Land and Sediment	<p>The ground investigation, which will be carried out, will identify areas of contamination and similar methods to those outlined to reduce suspended solids entering watercourses will be used to ensure disturbed sediment does not enter the watercourses. More information can be found in Appendix A24.3: Fluvial Geomorphology.</p>

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##### *Watercourse Realignment*

- 24.5.48 Prior to the installation of culverts, watercourses will be diverted to a temporary channel. This will minimise the impact to the watercourse as a result of accidental spillage from pollutants.
- 24.5.49 Further detailed site specific assessments in advance of the CAR application process, prior to construction. The approach will be based on the following principles:
- In order to limit the potential for bank erosion, new banks of the realignments will be appropriately graded to include geomorphological and ecological considerations.
  - Covering newly formed banks along the new alignment with geotextile matting (where deemed necessary) will also reduce the potential for erosion by physically holding the newly exposed bank sediments together. This will limit the potential for fluvial erosion and runoff induced erosion on the exposed banks during rainfall. The geotextile matting will be seeded to promote vegetation colonisation to ensure rapid stabilisation of this new section of watercourse.
  - It is essential that no flow is routed through the realignment during construction. The channel works will be complete, including the new culverts prior to the rerouting of water and no further in-channel works will be conducted. The new channel will be constructed by moving progressively upstream to minimise the risk of flow switching into the new channel during high flow events, prior to completion.
  - Bed sediments must not be transferred from the existing channel as this will necessitate a temporary realignment during sediment transfer. Bed sediments will not be taken from the existing channel as transferring river bed sediment may release fine sediments and pollutants stored beneath the bed armour (coarse sediments forming the top layer of the bed sediments). Bed sediments will be appropriately sized (and shaped) gravels derived from a local source. The use of gravel sized sediments will provide voids within the channel which will act as a sediment sink to fine material allowing a reduction in sediment transfer downstream where any localised readjustment (erosion) occurs following the re-routing of flow.
  - It is likely that when flow is routed through the new channel alignment, there will be a period of adjustment during where some sediment release can be expected. The new channel will be monitored regularly and where signs of instability are observed, such as erosion or incision, appropriate remediation measures will be undertaken.
  - Sediment control measures will be placed at the downstream end of the temporary realignment to intercept sediment delivered to the temporary realignment as a result of construction activities.
  - Site activity in the vicinity of temporary realignment will be carefully managed to avoid the risk of accidental spillage into the watercourse. All pumps must have drip trays to avoid accidents and be set away from the watercourse. Where required, site road crossings will consist of a piped section sufficiently long to provide a road together with strips of ground either side to provide a barrier between the road and open channel sections.
  - It is recommended that works be carried out during lower flow conditions.

##### *Programme of Works*

- 24.5.50 The impact of the proposed scheme can be greatly reduced or avoided through timing of works. For all watercourses, works must be avoided during periods of low flow to reduce the risk of a pollution event such as a sediment release and occurrence of dissolved oxygen sags. Additionally works will be avoided during periods of high flow and increased flood risk for health and safety reasons.

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24.5.51 The appropriate timing of mitigation measures is also critical to ensure their successful implementation. Treatment ponds proposed to be included as part of scheme design (Figure 24.5a-h) will be scheduled for construction early in the programme, to allow settlement and treatment of any pollutants contained in site runoff and to control the rate of flow before water is discharged into the receiving watercourses. Additional temporary settlement ponds may also be required during construction, particularly in the vicinity of sensitive watercourses such as the River Dee.

#### *Monitoring*

24.5.52 The Contractor will be required to monitor water quality prior to, and during, construction assessing chemical (temperature, pH, conductivity, suspended solids, heavy metals, etc.) and biological parameters (macroinvertebrate communities and macrophytes) at some or all watercourses. Monitoring locations, parameters, frequency of sampling and discharge limits will be agreed with SEPA in advance of construction.

#### Groundwater Mitigation

24.5.53 Road drainage features in areas of high well density will be lined to prevent possible groundwater contamination at the following locations:

- ch110902 to 111000 near Derbeth;
- ch108000 to 16100 near Moss of Auchlea and Blacktop;
- high well density area along the River Dee located to the west of the proposed scheme;
- ch10200 to 10100 near Kingcausie;
- ch201300 to 202400 near Hill of Blairs;
- ch202800 to 203500 near Bishopton; and
- ch204800 to 205200 near Hare Moss.

24.5.54 In addition, the areas around Duff's Hill (ch20500), Burnhead (ch200550), Eastland Cottage (ch101200), Milltimber (ch103200 and ch103300), Nether Beanshill (ch104000) and the eastern branch of the proposed junction at ch101000 will be lined.

24.5.55 Changes in groundwater flow conditions and potential migration of contaminants towards cuttings may potentially affect supplies around Hare Moss (ch205250 to 206550), Crynoch (ch101400 to 101600) and Derbeth cuttings (ch1103300 to 111300). Monitoring of groundwater flow and quality will be required to determine the zone of influence of each cutting. If potential contaminated land is within the zone of influence, a site investigation will then determine the exact nature of contamination. If required, a risk assessment will be carried out and further measures will be proposed.

#### **Site Specific Mitigation**

24.5.56 The mitigation measures described previously will be applied to all watercourses that would be affected by the proposed scheme. This section describes the additional site specific mitigation that must be applied to particularly sensitive watercourses identified in the assessment, such as salmonid burns and rivers or small sub-catchments that would be affected by the proposed works.

#### River Dee

24.5.57 During the construction of the River Dee crossing and associated mainline approach roads, the following specific mitigation measures, in addition to the general best practice construction mitigation stated above, will be required:

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- sediment fencing will be constructed as a perimeter to the construction footprint to reduce the sediment release;
- temporary treatment ponds will be constructed to reduce the run-off pollution from the approach road construction. Often the permanent ponds are constructed first to allow these to be utilised during the construction period providing they are subsequently cleaned out;
- use measures such as plastic sleeve and double falsework/shuttering when working over the watercourse to ensure minimal concrete spillage;
- enclosed spraying when waterproofing preventing chemicals from entering the watercourse;
- works with a high potential of sediment release should be carried out between May and September where practicable (refer to Chapter 25: Ecology and Nature Conservation);
- aquatic Ecological Clerk of Works will be present on site during construction, to supervise the implementation of appropriate environmental safeguards. Consultation with the Dee District Salmon Fisheries Board will be required;
- no bridging works to be conducted between 14 October and 31 May to avoid impacts to migratory and spawning salmon (refer to Chapter 10); and
- baseline information on substrate particle size should be collected before and after the construction works, and upstream and downstream of the proposed crossing site. If an impact from construction is detected, gravel cleaning should be undertaken to restore benthic microhabitats to pre-construction conditions (refer to the Appendix 25.9 Freshwater Ecology);
- a detailed construction method statement will be agreed with SEPA prior to commencement of works; and
- long-term water quality/ecological monitoring before, during and after construction (to be agreed with SEPA prior to work commencement).

24.5.58 Sediment modelling of the construction of the proposed mainline approach roads in the River Dee Valley indicates that temporary SUDS should consist of at least two treatment ponds on the southern side of the Dee and three treatment ponds on the north side. It is further recommended that the works in the vicinity of the Dee are phased, whereby work on the northern side is not undertaken concurrently with work on the southern side, with the exception of bridge construction. Further information is provided in Appendix A24.6.

24.5.59 During operation, two treatment ponds will be required to treat road runoff before discharging it via an outfall to the River Dee. Properly maintained, this will prevent the river from receiving road runoff with metals or suspended solids above permitted levels. Hare Moss

24.5.60 Lined filter drains are required to prevent infiltration into groundwater and minimise the risk of pollution of the moss. Before treated road runoff is discharged into Jameston Ditch, road drainage will pass through three lined treatment ponds to remove pollutants and reduce the risk of pollution as a result of accidental spillage events.

24.5.61 Maintaining the connectivity of the moss to adjacent watercourses, upstream and downstream of the site, is essential. The existing catchment size draining to the moss must be maintained in order to minimise changes to surface water hydrology.

24.5.62 The road embankment (ch203300-204600) running along Hare Moss would be constructed using permeable materials in order to allow shallow groundwater to flow towards Hare Moss and ensure that the road does not act as a barrier. Mitigation measures at Hare Moss would include the reinforcement of the peat bund running along the Jameston ditch, in particular where breaches were noted. Reinforcing the peat bund should include:

1. ensuring that the peat bund is not interrupted; and
2. compacting the bund to reduce its permeability.

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24.5.63 Further mitigation details are reported in Chapter 23 (Geology, Contaminated Land and Groundwater).

#### Moss of Auchlea

24.5.64 Existing flow paths will be maintained by culverting the drainage lines associated with the Moss of Auchlea drainage system, where required. The existing catchment size draining to the moss will be maintained in order to minimise changes to surface water hydrology. Lined filter drains will be installed to prevent infiltration into groundwater and minimise the risk of pollution to the moss.

#### Kingcausie Burn

24.5.65 In addition to reducing the risk of sediment runoff entering Kingcausie Burn during construction through the implementation of best practice, the following site specific mitigation measures will be required:

- works with a high potential of sediment release should be carried out between May and September, where practicable (refer to Chapter 25: Ecology and Nature Conservation);
- a detailed construction method statement will be agreed with SEPA prior to commencement of works; and
- water quality and ecological monitoring will be conducted before, during and after construction (to be agreed with SEPA prior to work commencement).

24.5.66 Due to the proximity of this watercourse to Crynoch Burn, which lies within the River Dee SAC, the realignment will be designed to prevent erosion within the channel as this could lead to sediment transfer downstream. The realignment will have a sinuous planform designed to replicate a natural stream and enable the inclusion of morphological units, such as riffles and pools associated with this form of channel to be included. The channel will be designed to convey flows of a magnitude up to the 0.5% probability event (1 in 200 year flood), while maintaining a normal flow channel that is sized to contain the QMED (50%AEP or 1 in 2 year flood). Further information is provided in Appendix A24.3.

#### Burnhead Burn and Blaikiewell Burn

24.5.67 In addition to the implementation of the mitigation described previously, the following specific mitigation will be applied:

- use of measures such as plastic sleeve and double falsework/shuttering when working over Blaikiewell Burn to mitigate against potential concrete spillage;
- minimise work undertaken on the riparian zone;
- enclosed spraying when waterproofing preventing chemicals from entering the watercourse;
- works with a high potential of sediment release should be carried out between May and September where practicable (refer to Chapter 25: Ecology and Nature Conservation);
- long-term water quality/ecological monitoring before, during and after construction (to be agreed with SEPA prior to work commencement); and
- a detailed method statement will be agreed with SEPA prior to commencement of works.

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**Table 24.11 – Summary of Mitigation Measures**

<b>Water Feature</b>	<b>Potential Impact</b>	<b>Mitigation Measures</b>
Loirston Burn	Road Drainage	Treatment train consists of filter drains, 1 detention basin and 1 treatment pond.
	Crossing	4 x depressed invert box culverts (2 new culverts and 2 extensions to existing) designed to carry a 0.5%AEP (1:200 year flow) with mammal ledge. Bed continuity will be maintained through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Adherence to general principles set out in text will be applied (refer to Appendix A24.3: Fluvial Geomorphology). Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Sensitive realignment design to re-introduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to minimise erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release. Use of new similarly sized material to cover the bottom of any construction culverts. The landfill in the vicinity must not be disturbed. Preliminary investigation for contaminants required. Development of detailed method statement for agreement with SEPA.
Network culvert: Loirston	Road Drainage	Network culvert: Carry out regular maintenance and clearance of debris. Consideration of requirement for trash screen at detailed design stage.
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52.
Greengate Ditch	Road Drainage	N/A
	Crossing	N/A
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches. Development of detailed method statement for agreement with SEPA.
Jameston Ditch	Road Drainage	Treatment train consists of filter drains, 1 detention basin, 3 treatment ponds. Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	N/A
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Sediment control measures will be used to control site runoff around earthworks perimeter. Refer to site specific mitigation measures for Hare Moss. No deepening of the ditch will be carried out. Development of detailed method statement for agreement with SEPA.

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<b>Water Feature</b>	<b>Potential Impact</b>	<b>Mitigation Measures</b>
Burn of Ardoe	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Adherence to general principles set out in text will be applied (refer to Appendix A24.3: Fluvial Geomorphology). Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts. Refer to Hare Moss text for site specific mitigation. Development of detailed method statement for agreement with SEPA.
Bishopston Ditch	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Adherence to general principles set out in text will be applied (refer to Appendix A24.3: Fluvial Geomorphology). Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts Refer to Hare Moss text for site specific mitigation. Development of detailed method statement for agreement with SEPA.
Heathfield Burn	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Adherence to general principles set out in text will be applied (refer to Appendix A24.3: Fluvial Geomorphology). Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.

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Water Feature	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts Refer to Hare Moss text for site specific mitigation. Development of detailed method statement for agreement with SEPA.
Hare Moss	Road Drainage	Road drainage treatment train will protect water quality of Hare Moss. Filter drains in the area will be lined to prevent infiltration to groundwater. Refer to Chapter 23 for groundwater protection mitigation measures.
	Crossing	Connectivity of inflow and outflow pathways to the moss area will be maintained. Existing catchment area size draining to the moss will be maintained.
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52.. Duration of construction and areas of disturbance will be minimised. Surface runoff pathways will be maintained at all times. Development of detailed method statement for agreement with SEPA.
Whitestone Burn	Road Drainage	N/A
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts Development of detailed method statement for agreement with SEPA.
Burnhead Burn	Road Drainage	Treatment train consists of filter drains, detention basin, 2 treatment ponds. Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Adherence to general principles set out in text must be applied (refer to Appendix A24.3: Fluvial Geomorphology). Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.

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Water Feature	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts. Development of detailed method statement for agreement with SEPA.
Blaikiewell Burn	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Design of buried structure to span the channel will maintain good water quality and morphological diversity during operation and reduce potential damage to riparian habitats.
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. No in-channel works will be required during construction, which will reduce the risk of accidental spillage, water diversion and sediment release. Development of detailed method statement for agreement with SEPA.
Kingcausie Burn	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Adherence to general principles set out in text must be applied and detailed information provided in Appendix A24.3. Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts. Development of detailed method statement for agreement with SEPA.
River Dee	Road Drainage	Treatment train consists of filter drains, 1 detention basin and 2 treatment ponds. Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Design of bridge to span the river channel will maintain good water quality and morphological diversity during operation and reduce the damage to riparian habitats.
	Realignment	N/A

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Water Feature	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. No in-channel works will be required during construction of the bridge, which will reduce the risk of accidental spillage, water diversion and sediment release. Detailed method statement covering the proposed works, including outfall construction, will be agreed with SEPA.
Milltimber Burn	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culvert.
	Realignment	Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts. Development of detailed method statement for agreement with SEPA.
Culter House Burn	Road Drainage	N/A
	Crossing	N/A
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches. Development of detailed method statement for agreement with SEPA.
Beans Burn	Road Drainage	N/A
	Crossing	N/A
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches. Development of detailed method statement for agreement with SEPA.
Upper Beanshill Burn	Road Drainage	N/A
	Crossing	N/A
	Realignment	N/A

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Water Feature	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches. Development of detailed method statement for agreement with SEPA.
Gairn Burn	Road Drainage	Treatment train consists of filter drains, 1 detention basin and 4 treatment ponds. Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris. Use of new similarly sized material to cover the bottom of the culverts
	Realignment	Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts. Development of detailed method statement for agreement with SEPA.
Network culvert: Gairn	Road Drainage	Network culvert: Carry out regular maintenance and clearance of debris. Consideration of requirement for trash screen at detailed design stage.
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52.
Moss of Auchlea Drainage System	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Depressed invert box culverts have been designed to carry a 1:200 year flow (with mammal ledge) and maintain bed continuity through the structure. Carry out regular maintenance and clearance of debris.
	Realignment	Geomorphological features will be reproduced, where possible, hydraulic gradient and length will be maintained. Realignment design will reintroduce meanders, alternating pools and riffle sequences and morphological diversity, where possible, to offset straightening of channel and other culverting proposed on the watercourse. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Batching and mixing will be conducted off site using quick setting cement mixes and bunded areas with impervious walls. Diversion or pumping away during construction of culvert/realignments. Geotextile lining of temporary realignment to reduce erosion and sedimentation. Cut-off ditches, sediment fencing and treatment ponds will be used to minimise sediment release. Use of new similarly sized material to cover the bottom of any construction culverts Development of detailed method statement for agreement with SEPA.
Moss of Auchlea	Road Drainage	Filter drains in the area will be lined to prevent infiltration to groundwater.
	Crossing	Connectivity of inflow and outflow pathways to the moss area will be maintained. Existing catchment area size draining to the moss will be maintained.

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Water Feature	Potential Impact	Mitigation Measures
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Duration of construction and areas of disturbance will be minimised. Surface runoff pathways will be maintained at all times. Development of detailed method statement for agreement with SEPA.
Network culvert: Moss of Auchlea	Road Drainage	Network culvert: Carry out regular maintenance and clearance of debris. Consideration of requirement for trash screen at detailed design stage.
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52.
Westholme Burn	Road Drainage	Treatment train consists of filter Drains, 1 detention basin, 3 treatment ponds and 1 swale.
	Crossing	N/A
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release around earthworks perimeter. Development of detailed method statement for agreement with SEPA.
Network culvert: Westholme	Road Drainage	Network culvert: Carry out regular maintenance and clearance of debris. Consideration of requirement for trash screen at detailed design stage.
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52.
Borrowstone Burn and Ponds	Road Drainage	N/A
	Crossing	Groundwater connectivity will be maintained (Chapter 23: Geology, Contaminated Land and Groundwater).
	Realignment	N/A
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraphs 24.5.45 – 24.5.52.

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## 24.6 Residual Impacts

24.6.1 Following successful implementation of all mitigation outlined above, the potential for impacts on the water environment will be reduced. Residual impacts are detailed below, with supporting information provided in the technical appendices and summarised in Table 24.12.

### Impact Assessment

24.6.2 The methodology adopted for assigning this residual impact adopts a precautionary approach. Consequently, the overall residual impact magnitude was assigned based on the highest potential residual magnitude by each of the technical disciplines following the adoption of the mitigation measures detailed in section 24.5. This overall residual magnitude will then be combined with the overall sensitivity of the watercourse to provide an overall residual impact significance for each watercourse. Indirect residual impacts on the associated habitats are presented in Chapter 25 (Ecology and Nature Conservation).

#### Operational Residual Impacts

##### *Loirston Burn and Loch (ch205585)*

24.6.3 With mitigation, the potential impacts on Loirston Burn and the loch downstream would be reduced to negligible magnitude for hydrology and geomorphology, however the impact magnitude would only reduce to low for water quality. Overall, the residual impact would be of Slight significance.

##### *Network Culvert: Loirston (ch205955)*

24.6.4 With the implementation of the mitigation described, the residual impact to the hydrology would be reduce to negligible magnitude.

##### *Greengate Ditch (ch205050)*

24.6.5 The impacts remains unchanged on this watercourse and is considered to be of negligible magnitude and Negligible significance.

##### *Jameston Ditch (ch204500)*

24.6.6 Impacts on the water quality and hydrology of this watercourse as a result of the proposed drainage outfall would be reduced to a negligible magnitude. Hydrological impacts may be beneficial to the moss given the extra water that will be added to its catchment. Consequently, impacts upon the ditch are considered to be of Slight/Negligible significance.

##### *Burn of Ardoe (ch204000)*

24.6.7 Installation of a culvert, in combination with a sensitively designed realignment, would result in a negligible impact magnitude on the hydrology, geomorphology and water quality of the watercourse. This impact on this straightened watercourse would be of Slight/Negligible significance.

##### *Bishopston Ditch (ch203900)*

24.6.8 Appropriate realignment design and the use of a depressed invert culvert would reduce impacts on the hydrology, geomorphology and water quality of this burn to a negligible magnitude. Therefore, the installation of a culvert and associated realignment of this heavily modified watercourse is assessed as Slight/Negligible residual impact significance.

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##### *Heathfield Burn (ch203650)*

- 24.6.9 The impacts resulting from the installation of a depressed invert culvert, in combination with an appropriately designed realignment, would be of negligible impact magnitude on the hydrology, geomorphology and water quality of the watercourse. The residual impacts on this straightened watercourse have been assessed as Slight/Negligible significance.

##### *Hare Moss (ch204500)*

- 24.6.10 Overall, impacts on the moss would be reduced by ensuring the maintenance of hydraulic connectivity through the culverting of Heathfield Ditch, Bishopston Ditch and the Burn of Ardoe. The treatment of road runoff, provision of additional flow via the proposed drainage outfall into Jameston Ditch and repair of the existing bund would also protect the water quality and hydrology of the moss. The maintenance of groundwater connectivity through the use of permeable media to construct the section of road alignment past Hare Moss would also reduce potential impacts. Consequently, impacts are considered to reduce to Slight/Negligible significance, with a beneficial impact to hydrology.

##### *Whitestone Burn (ch201000)*

- 24.6.11 With mitigation, impacts on Whitestone Burn would be reduced to negligible magnitude for all three disciplines. Overall, the residual impact would be of Negligible significance.

##### *Burnhead Burn (ch200100)*

- 24.6.12 Mitigation measures proposed for Burnhead Burn would reduce impacts on hydrology, geomorphology and water quality to negligible magnitude. Overall, the residual impact is of Slight/Negligible significance.

##### *Blaikiewell Burn (ch100150)*

- 24.6.13 The use of a buried structure across the surrounding valley would result in limited disruption to geomorphological processes and the character of the bed and banks of the burn. The structure would be installed along a relatively straight section, which despite previous modification, exhibits varied morphology and some connectivity to the adjacent floodplain. With mitigation, the impacts on hydrology, geomorphology and water quality would be reduced to negligible magnitude. Overall, the residual impact is of Slight/Negligible significance.

##### *Kingcausie Burn (ch101500)*

- 24.6.14 The mitigation measures proposed for Kingcausie Burn would reduce impacts on hydrology and water quality to negligible magnitude. Residual impacts on geomorphology as a result of the culvert and extensive realignment relatively close to the River Dee SAC (approximately 100m downstream) are considered to reduce to negligible magnitude. The potential for scour and suspended solid release from the proposed realignment would be reduced through sensitive realignment design, resulting in a residual negligible impact magnitude and Slight/Negligible significance.

##### *River Dee (ch102000)*

- 24.6.15 Impacts on the water quality of this major watercourse during the operation phase are expected to be reduced to a negligible magnitude as road runoff would be treated prior to discharging through the proposed outfall. Road runoff that would be discharged into tributaries of the River Dee would also be treated. Results of the water quality modelling, which investigated the cumulative impact of multiple outfalls to the Dee subcatchment on water quality, indicated that the residual impact is of negligible magnitude.

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- 24.6.16 Impacts on the geomorphology of the River Dee are expected to be of negligible magnitude as a result of the proposed bridge crossing design as the structure would be set back from the river edge. However, some residual risk to the morphology of the River Dee may remain as a result of potential impacts on its tributaries.
- 24.6.17 In terms of hydrology and flood risk, the proposed structure is considered to result in a negligible magnitude of impact given that it is predicted not to change water levels upstream of the proposed scheme.
- 24.6.18 Overall, this results in a residual impact assessment of Slight/Negligible significance on a highly sensitive watercourse.
- Milltimber Burn (ch102650)*
- 24.6.19 With the effective implementation of mitigation, the installation of a culvert, in combination with a realignment, would represent negligible impact magnitude on the hydrology, geomorphology and water quality of the watercourse. This straightened watercourse will experience a Negligible significance of impact.
- Culter House Burn (ch103600)*
- 24.6.20 The impact remains unchanged on this watercourse and is considered to be of negligible magnitude and Negligible significance.
- Beans Burn (ch105150)*
- 24.6.21 The impact remains unchanged on this watercourse and is considered to be of negligible magnitude and Negligible significance.
- Upper Beanshill Burn and Ponds (ch106500)*
- 24.6.22 The impact remains unchanged on this watercourse and is considered to be of negligible magnitude and Negligible significance.
- Gairn Burn (ch106500)*
- 24.6.23 With appropriate culvert and realignment design, the treatment of road drainage prior to outfall and the lining of filter drains in the area, the impact on hydrology, flood risk, geomorphology and water quality is expected to reduce to negligible magnitude.
- 24.6.24 The residual impact on the watercourse is considered to be of negligible magnitude and Negligible significance.
- Network Culvert: Gairn (ch106175)*
- 24.6.25 With the implementation of mitigation, the residual impact to hydrology would be of negligible magnitude.
- Moss of Auchlea Drainage System (ch107450)*
- 24.6.26 The installation of a depressed invert culvert, in combination with an appropriately designed realignment would represent negligible impact magnitude on the hydrology, geomorphology and water quality of the watercourse. This straightened watercourse will experience a Slight/Negligible significance of impact.

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##### *Moss of Auchlea (ch107450)*

- 24.6.27 Overall, the impacts on the moss would be reduced by ensuring the maintenance of hydraulic connectivity through the culverting of the Moss of Auchlea Drainage System. Filter drains carrying road drainage will be lined in the area to ensure infiltration of pollutants into groundwater is minimised. Overall, the impacts on the moss are expected to be of negligible magnitude and Slight/Negligible significance.

##### *Network Culvert: Moss of Auchlea (ch107305)*

- 24.6.28 With the implementation of mitigation, the residual impact to hydrology would be of negligible magnitude.

##### *Westholme Burn (ch108650)*

- 24.6.29 With mitigation, impacts on Westholme Burn would be reduced to negligible magnitude for hydrology and geomorphology. A low magnitude of impact is expected to remain as a result of the proposed drainage outfall. However, concentration levels of pollutants in treated road drainage would be reduced to below required levels and accidental spillage rates are expected to be within acceptable probabilities. Overall, the residual impact assessment is Negligible significance.

##### *Network Culvert: Westholme (ch108585)*

- 24.6.30 With the implementation of mitigation, the residual impact to hydrology would be of negligible magnitude.

##### *Borrowstone Burn and Ponds (ch110400)*

- 24.6.31 The impact remains unchanged on this watercourse and is considered to be of negligible magnitude and Negligible significance.

#### Catchment Impacts (Operation)

##### *Catchment Impacts on Crynoch Burn*

- 24.6.32 As several of the burns, namely Kingcausie, Burnhead and Blaikiewell Burn drain into Crynoch Burn, there is a need to consider the potential for residual impacts on Crynoch Burn itself.
- 24.6.33 The results of water quality modelling indicate that the proposed level of mitigation is sufficient to reduce cumulative impacts on the water quality of Crynoch Burn to negligible magnitude. Given the proximity of the works on Kingcausie, Burnhead and Blaikiewell Burns to their confluences with Crynoch Burn, the residual impact magnitude is considered to be negligible. Operational impacts on those burns considered in the Fastlink section of the scheme would be reduced to negligible magnitude. Therefore, the potential residual long-term impacts on the SAC have been assessed as Slight/Negligible significance.
- 24.6.34 Due to its regional importance, catchment impacts on the River Dee are discussed in Part E (Cumulative Impact Assessment) of this Environmental Statement.

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Construction Impacts

*Loirston Burn and Loch (ch205585)*

- 24.6.35 Adherence to the general mitigation measures is considered to reduce the impact on the hydrology of the watercourse a negligible magnitude. Providing a temporary flow diversion and ensuring that channel works are completed before flow is routed along the watercourse will minimise the risk of temporary increases in sediment supply occurring. Any sediment releases that occur as a result of accidental spillage or failure of mitigation measures are likely to be of short duration and will have a negligible magnitude of impact on this watercourse. However, impacts on water quality would be reduced to a low magnitude providing mitigation measures are adhered to.
- 24.6.36 Overall, potential impacts have been assessed as low magnitude and Slight significance.

*Greengate Ditch (ch205050)*

- 24.6.37 Through best practice mitigation measures, the magnitude of residual impacts on the watercourse would be reduced to a negligible level for hydrology, geomorphology and water quality. Overall, the impacts would be of Negligible significance.

*Jameston Ditch (ch204500)*

- 24.6.38 Impacts on the Jameston Ditch are reduced to negligible magnitude for all three disciplines provided the mitigation measures stated above are adhered to. Hence, the overall residual impact is of Slight/Negligible significance.

*Burn of Ardoe (ch204000)*

- 24.6.39 With the adherence to best practice mitigation set out above the impact on the watercourse is considered to reduce to negligible magnitude for each discipline, resulting in a Slight/Negligible significance of impact.

*Bishopston Ditch (ch203900)*

- 24.6.40 With the adherence to best practice mitigation set out above the impact on the watercourse is considered to reduce to negligible magnitude for each discipline, resulting in a Slight/Negligible significance of impact.

*Heathfield Burn (ch203650)*

- 24.6.41 With the adherence to best practice mitigation set out above the impact on the watercourse is considered to reduce to negligible magnitude for each discipline, resulting in a Slight/Negligible significance of impact.

*Hare Moss (ch204500)*

- 24.6.42 Obstruction of surface water flow pathways to Hare Moss during construction, are likely to be effectively mitigated by minimising the duration and extent of works and adherence to best practice mitigation set out above. It is considered that the impacts on the hydrology of the moss are reduced to negligible magnitude.
- 24.6.43 Short-term impacts on the moss may also result from impacts on the watercourses feeding it. The impacts on these burns are likely to be reduced to Slight/Negligible significance. Hence, the overall residual impacts on Hare Moss have been assessed as Slight/Negligible significance.

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##### *Whitestone Burn (ch201000)*

- 24.6.44 With the adherence to best practice mitigation set out above the impact on the watercourse is considered to reduce to negligible magnitude for each discipline, resulting in a Negligible significance of impact.

##### *Burnhead Burn (ch200100)*

- 24.6.45 Best practice mitigation and the preparation of detailed method statements prior to commencement of works would reduce the potential for impacts on the hydrology, geomorphology and water quality of the watercourse to negligible magnitude. The overall residual impact has been assessed as Slight/Negligible significance.

##### *Blaikiewell Burn (ch100150)*

- 24.6.46 Best practice mitigation would reduce impacts on the hydrology and water quality of the watercourse to negligible magnitude.
- 24.6.47 The construction of the crossing structure would result in impacts to land adjacent to the watercourse but, with the implementation of best construction practice, is anticipated to have minimal impact on the actual watercourse itself. Impacts would result from difficult access, steep terrain, plant and vehicle movements, vegetation clearance and earthworks. With the effective implementation of mitigation the magnitude of impact is reduced to negligible magnitude.
- 24.6.48 The overall impact on the watercourse is considered to be of negligible magnitude and Slight/Negligible significance.

##### *Kingcausie Burn (ch101500)*

- 24.6.49 The implementation of best practice mitigation during construction would reduce impacts on the hydrology and water quality of the watercourse to a low and negligible magnitude, respectively. However, the installation of a culvert and associated realignment along a long stretch of channel would disturb the watercourse and riparian corridor, involving earthworks, vegetation clearance as well as plant and vehicle movements. These activities would have a particularly significant impact on the lower section of the watercourse, which is morphologically diverse and has local significant changes in gradient.
- 24.6.50 In addition to the impacts on this diverse section of channel, increases in channel erosion or deposition downstream are also likely due to channel slope changes. These activities may potentially accelerate sediment release into Crynoch Burn as its confluence is in close proximity to the crossing point. The proposed works will be carried out in accordance to a detailed method statement that will be agreed with SEPA, prior to the commencement of construction. In addition to the application of the other mitigation measures described, this would reduce residual impacts to low magnitude.
- 24.6.51 Consequently, residual Impacts would be of low magnitude and Moderate significance, driven by impacts on the hydrology and geomorphology during the construction phase.

##### *River Dee (ch102000)*

- 24.6.52 The construction of the bridge will not require any in-channel works. The design and micrositing of the proposed outfall structure will be agreed with SEPA and its operation will be licensed under CAR. With the effective implementation of mitigation and adherence to best practice during construction, the overall impacts on the river would reduce to negligible magnitude and Slight/Negligible significance. This reflects the sensitivity of the river in the study area.

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##### *Milltimber Burn (ch102650)*

- 24.6.53 With the effective implementation of mitigation and adherence to best practice during construction, impacts on the watercourse would be reduced to negligible magnitude for each discipline. This result in residual impacts assessed as Negligible significance.

##### *Culter House Burn (ch103600)*

- 24.6.54 With the effective implementation of mitigation and adherence to best practice during construction, residual impacts on the watercourse would be reduced to negligible impact for hydrology, geomorphology and water quality. Overall, the residual impacts have been assessed as Negligible significance.

##### *Beans Burn (ch105150)*

- 24.6.55 Through the application of best practice mitigation measures, residual impacts on the watercourse would reduce to negligible for hydrology, geomorphology and water quality. Overall, the residual impacts have been assessed as Negligible significance.

##### *Upper Beanshill Burn and Ponds (ch106500)*

- 24.6.56 With the effective implementation of mitigation and adherence to best practice during construction, residual impacts on the watercourse would be reduced to negligible for all three disciplines. Overall, the residual impacts have been assessed as Negligible significance.

##### *Gairn Burn (ch106500)*

- 24.6.57 With the effective implementation of mitigation and adherence to best practice during construction, the impact on the watercourse would be reduce to negligible magnitude for hydrology and water quality.

- 24.6.58 Road construction, the installation of a culvert and associated realignment would result in disturbance along the watercourse corridor. These activities would require vegetation clearance and earthworks affecting the geomorphology of the watercourse, which is relatively natural in form and has a diverse morphology. Ensuring that no flow is routed along the new watercourse during construction will limit the quantity of fine sediments released during construction reducing the residual impact to a negligible magnitude. Therefore, overall the residual impact is of negligible magnitude and Negligible significance for Gairn Burn.

##### *Moss of Auchlea Drainage System (ch107450)*

- 24.6.59 With the effective implementation of mitigation and adherence to best practice during construction, the impacts at this location would be reduced to negligible magnitude for each discipline, resulting in residual impacts of Slight/Negligible significance.

##### *Moss of Auchlea (ch107450)*

- 24.6.60 Maintaining the connectivity of surface water flow pathways to the Moss of Auchlea during construction and minimising the duration and extent of works would provide important mitigation for the impacts that have been identified during construction. With the application of mitigation and adherence to best practice, the impacts on the hydrology of the moss are reduced to negligible magnitude.

- 24.6.61 Short-term impacts on the moss would also occur as a result of impacts on the watercourses in its catchment. The impacts on these burns would be reduced to negligible magnitude, resulting in a residual impact of Slight/Negligible significance.

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##### *Westholme Burn (ch108650)*

- 24.6.62 Impacts on the Westholme Burn would be reduced to negligible magnitude for all three disciplines with the application of mitigation and adherence to best practice. Hence, the overall magnitude of impact is of Negligible significance.

##### *Borrowstone Burn and Ponds (ch110400)*

- 24.6.63 The impact remains unchanged on this watercourse and is considered to be of negligible magnitude and Negligible significance.

##### Catchment Impacts (Construction)

##### *Catchment Impacts on Crynoch Burn*

- 24.6.64 Some residual impacts would remain on Kingcausie, Burnhead and Blaikiewell Burns during construction. Given the proximity of the works on these watercourses to their confluences with Crynoch Burn, the residual impact magnitude is considered to be negligible. Residual impacts on the smaller watercourses considered in the study area are of low-negligible magnitude individually and, when considered together, are of negligible magnitude. This results in the assessment of short-term impacts on the SAC of Slight/Negligible significance.
- 24.6.65 Due to its regional importance, catchment impacts on the River Dee are discussed in Part E (Cumulative Scheme Impacts) of this Environmental Statement.

##### Groundwater

- 24.6.66 Chapter 23 (Geology, Contaminated Land and Groundwater) describes the residual impacts to groundwater predicted following the application of mitigation. With mitigation, all significant groundwater areas have been identified as having a residual impact significance of Negligible.

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**Table 24.12 – Residual Impact Assessment**

Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
Loirston Burn	Medium	<p>Construction:  Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.  Hydrology and Geomorphology: Negligible  Water Quality: Low</p>	Low	Slight
		<p>Operation:  Depressed invert culverts allow natural substrate through the culvert on an already modified burn. Long-term decrease to morphological diversity as a result of culverting and realignment offset where possible by pool and riffle sequences. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year). Road drainage attenuated to pre-development rates. Road drainage system ensures that road runoff entering burn complies with Environmental Quality Standards (EQS) and is within acceptable risk limits for accidental spillage.  Hydrology and Geomorphology: Negligible  Water Quality: Low</p>	Low	Slight
Network culvert: Loirston	n/a	<p>Construction:  Adherence to best practice.  Hydrology, Geomorphology and Water Quality: Scoped out of assessment given it is part of the drainage network</p>	n/a	n/a
		<p>Operation:  Drainage culverts designed to the 1.33% AEP (1:75 yr design flood) as detailed in the DMRB HA 106/04. Regular maintenance and clearance of debris reduces impact to negligible magnitude.  Hydrology: Negligible  Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	n/a
Greengate Ditch	Low	<p>Construction:  Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised.  Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation:  Impact remains unchanged.  Hydrology: Negligible  Geomorphology and Water Quality: Scoped out of the assessment.</p>	Negligible	Negligible

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
Jameston Ditch	High	Construction: Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/ Negligible
		Operation: Change to discharge and flood regime minimised through careful design of outfall. Road drainage attenuated to pre-development rates. Road drainage system ensures that road runoff entering burn complies with Environmental Quality Standards (EQS) and is within acceptable risk limits for accidental spillage. Hydrology: Negligible Geomorphology: Scoped out of assessment Water Quality: Negligible	Negligible	Slight/ Negligible
Burn of Ardoe	High	Construction: Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/ Negligible
		Operation: Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse and sinuosity lost permanently but burn already extensively straightened. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year). Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/ Negligible
Bishopston Ditch	High	Construction: Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/ Negligible
		Operation: Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse and sinuosity lost permanently but burn already extensively straightened. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year). Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/ Negligible
Heathfield Burn	High	Construction: Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/ Negligible

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
		<p>Operation:            Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse and sinuosity lost permanently but burn already extensively straightened. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year).            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
Hare Moss	High	<p>Construction:            Risk of pollutant release minimised through best practice. Ongoing monitoring during the construction phase will identify any impacts at an early stage. Hydrological and groundwater pathways maintained during construction phase.            Hydrology and Water Quality: Negligible            Geomorphology: Scoped out of assessment</p>	Negligible	Slight/ Negligible
		<p>Operation:            Repair of bund and sufficient treatment and lining of drainage runoff provides mitigation to potential impacts. In tandem with extra water introduced to catchment results in a negligible residual impact to the moss.            Hydrology and Water Quality: Negligible            Geomorphology: Scoped out of assessment</p>	Negligible	Slight/ Negligible
Whitestone Burn	Low	<p>Construction:            Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation:            Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse and sinuosity lost permanently but burn already extensively straightened. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year).            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
Burnhead Burn	High	<p>Construction:            Risk of sediment and pollutant release minimised through best practice. Detailed construction methodology to be agreed with SEPA prior to commencement of works. Construction phase monitoring will identify accidental pollution at an early stage.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
		<p>Operation:</p> <p>This watercourse is already modified, straightened and locally culverted further upstream. However, the installation of a depressed invert culvert in the proposed location, together with a major realignment, will lead to detrimental impacts on the morphological structure of the watercourse. This can be limited, by the continuity of sensitively sized bed material provided by a natural bed in the culvert. Change to discharge and flood regime minimised through careful design of realignment, outfall and culverts. Road drainage attenuated to pre-development rates. Road drainage system ensures that road runoff entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Capacity for 0.5%AEP flow (1:200 year).</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
Blaikiewell Burn	High	<p>Construction:</p> <p>Mitigation reduces any impact from potential pollutant release during the construction of mainline approach roads to an acceptable level. The construction of a major bridging structure will have some impact on the surrounding valley, but little on the actual watercourse. Due to the difficult access, steep valley sides and wet ground, the movement of plant during construction is likely to involve vegetation clearance and ground stabilisation, potentially introducing sediment into the watercourse. Detailed construction methodology to be agreed with SEPA prior to commencement of works.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
		<p>Operation:</p> <p>The use of a bridge across the surrounding valley means that disruption to morphological processes and the character of the bed and banks of the burn will be limited. The bridge will be installed along a relatively straight section which despite previous modification exhibits varied morphology and some connectivity to the adjacent floodplain.</p> <p>Changes to discharge and flood regime will be minimised through design of the bridge. Bridge designed to have minimal impact on current 0.5%AEP (1:200 year) flows and levels.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
Kingcausie Burn	High	<p>Construction:</p> <p>Road construction will require culverting and realignment along a long stretch of channel. This will lead to disturbance along the watercourse and riparian corridor, involving vegetation clearance, tree felling and vehicle movements. This activity will have an impact on the hydrology and morphology of the lower section of the watercourse, which is morphologically diverse and has local, significant changes in gradient.</p> <p>Risk of pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Detailed construction methodology to be agreed with SEPA prior to commencement of works to ensure the minimisation of suspended sediment release. Ecological Clerk of works to be present on site to ensure mitigation measures are adhered to.</p> <p>Hydrology: Low  Geomorphology: Low  Water Quality: Negligible</p>	Low	Moderate

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
		<p>Operation:            Change to discharge and flood regime minimised through careful design of culvert and realignment.            The existing channel in the location of the proposed culvert has a natural character with good morphological diversity which will be affected as a result of the culvert installation. Careful design of realignment by geomorphologist with the inclusion of pool and riffle sequences, two-stage channel and re-establishment of watercourse sinuosity.            Length of culvert likely to affect water quality due to lack of light.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
River Dee	High	<p>Construction:            Risk of sediment and pollutant release will be minimised through best practice and treatment of runoff before outfall. Two treatment ponds on the south side of the Dee and three on the north are likely to be required. The construction of the bridge will not involve any in-channel works in this location, which will ensure that the road has no direct impact on the River Dee. The construction of the drainage outfall may require small scale works on the banks of the watercourse. The method statement that will be agreed with SEPA will include mitigation specific to the construction of the outfall to minimise the potential for impacts on the River Dee. Construction phase monitoring will identify accidental pollution at an early stage.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
		<p>Operation:            Bridging of watercourse ensures minimal impact on flow and sediment regime. Change to discharge and flood regime minimised through careful design of bridges. Hydrodynamic modelling indicates that there is unlikely to be any change to water levels at the 0.5%AEP. Road drainage attenuated to pre-development rates. Road drainage system ensures that road runoff entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Capacity for 0.5%AEP flow. (1:200 year). Cumulative impacts upon water quality of the River Dee is considered to be negligible provided the level of treatment set out for all outfalls is adhered to.            Hydrology, Geomorphology and Water Quality: Negligible            Hydrodynamic Modelling: Negligible</p>	Negligible	Slight/ Negligible
Milltimber Burn	Low	<p>Construction:            Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation:            Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse and sinuosity lost permanently but burn already extensively straightened. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year).            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
Culter House Burn	Low	<p>Construction:            Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
		<p>Operation: Impact remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	Negligible
Beans Burn	Low	<p>Construction: Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised. Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation: Impact remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	Negligible
Upper Beanshill Burn	Low	<p>Construction: Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised. Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation: Impact remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	Negligible
Gairn Burn	Medium	<p>Construction: Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation: Depressed invert culverts allow natural substrate through the culvert on an already modified burn. Long-term decrease to morphological diversity as a result of culverting and realignment offset where possible by pool and riffle sequences. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year). Road drainage attenuated to pre-development rates. Road drainage system ensures that road runoff entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
Network culvert: Gairn	n/a	<p>Construction: Adherence to best practice. Hydrology, Geomorphology and Water Quality: Scoped out of assessment given it is part of the drainage network</p>	n/a	n/a

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
		<p>Operation:            Drainage culverts designed to the 1.33% AEP (1:75 yr design flood) as detailed in the DMRB HA 106/04. Regular maintenance and clearance of debris reduces impact to negligible magnitude.            Hydrology: Negligible            Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	n/a
Moss of Auchlea Drainage System	High	<p>Construction:            Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
		<p>Operation:            Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse but burn already extensively straightened. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP flow (1:200 year).            Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Slight/ Negligible
Moss of Auchlea	High	<p>Construction:            Risk of pollutant release minimised through best practice. Ongoing monitoring during the construction phase will identify any impacts at an early stage. Hydrological and groundwater pathways maintained during construction phase.            Hydrology and Water Quality: Negligible            Geomorphology: Scoped out of the assessment</p>	Negligible	Slight/ Negligible
		<p>Operation:            Overall, hydrological pathways are maintained and road drainage is lined through the area, hence minimising potential pollution of the moss through infiltration.            Hydrology and Water Quality: Negligible            Geomorphology: Scoped out of the assessment</p>	Negligible	Slight/ Negligible
Network culvert: Moss of Auchlea	n/a	<p>Construction:            Adherence to best practice.            Hydrology, Geomorphology and Water Quality: Scoped out of assessment given it is part of the drainage network</p>	n/a	n/a
		<p>Operation:            Drainage culverts designed to the 1.33% AEP (1:75 yr design flood) as detailed in the DMRB HA 106/04. Regular maintenance and clearance of debris reduces impact to negligible magnitude.            Hydrology: Negligible            Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	n/a

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Water Feature	Overall Sensitivity	Residual Impact Description (with mitigation)	Residual Impact	
			Overall Magnitude	Significance
Westholme Burn	Low	Construction: Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Negligible
		Operation: Change to discharge and flood regime minimised through careful design of outfall. Road drainage attenuated to pre-development rates. Road drainage system ensures that road runoff entering burn complies with Environmental Quality Standards (EQS) and is within acceptable risk limits for accidental spillage. Hydrology and Geomorphology: Negligible Water Quality: Low	Low	Negligible
Network culvert: Westholme	n/a	Construction: Adherence to best practice. Hydrology, Geomorphology and Water Quality: Scoped out of assessment given it is part of the drainage network	n/a	n/a
		Operation: Drainage culverts designed to the 1.33% AEP (1:75 yr design flood) as detailed in the DMRB HA 106/04. Regular maintenance and clearance of debris reduces impact to negligible magnitude. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment	Negligible	n/a
Borrowstone Burn and ponds	Low	Construction: Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment	Negligible	Negligible
		Operation: Impact remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment	Negligible	Negligible

### **Summary of Residual Impacts**

- 24.6.67 Potential impacts, pre-mitigation, on Kingcausie Burn were assessed as Substantial. With the application of mitigation and the sensitive design of the proposed realignment, potential impacts would be reduced. Mitigation will be further developed through ongoing liaison with SEPA and will be included in detailed construction method statements. Therefore, the overall significance of residual impacts has been assessed as Slight/Negligible for operation and Moderate for construction. Impacts would remain at Moderate significance during construction due to the residual impacts on hydrological pathways and geomorphological processes.
- 24.6.68 Kingcausie Burn is currently in relatively good condition at the proposed crossing point and in close proximity to the River Dee SAC. The scheme proposals would require an extensive realignment and culverting of the watercourse. There would also be impacts on the current hydrological regime, with direct impacts on fluvial geomorphology and consequently, indirect impacts on water quality and freshwater ecology. These impacts may potentially have an indirect impact on the SAC downstream. However, with the effective implementation of mitigation and the application of best practice, the impacts would be reduced during both operation and construction phase.
- 24.6.69 Residual impacts on Burnhead Burn, Blaikiewell Burn and Crynoch Burn would be reduced through the implementation of mitigation described in this chapter and its technical appendices. Residual impacts on Blaikiewell Burn would be reduced to Slight/Negligible significance during operation and construction as a result of the design of the buried structure that would span the watercourse.
- 24.6.70 Impacts on the River Dee itself are reduced to Slight/Negligible significance for construction and operation. Hydrodynamic modelling studies indicate that the proposed bridge structure is unlikely to have any impact on water levels upstream for the 0.5%AEP (1 in 200 year event) flow.
- 24.6.71 The residual impacts on the remaining watercourses and wetland areas in the assessment are assessed as Negligible, Slight/Negligible or Slight significance with the application of mitigation.
- 24.6.72 It should be noted that the assessment has adopted a precautionary approach throughout and overall sensitivities, potential impacts and residual impacts have been reported by defaulting to the highest assessment determined by either of the disciplines (hydrology, fluvial geomorphology, water quality, hydrodynamic modelling, water quality modelling and sediment modelling, where appropriate).

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SEPA PPG05 Works in Near or Liable to Affect Watercourses

SEPA PPG06 Working at Construction and Demolition

SEPA PPG07 Refuelling Facilities

SEPA PPG08 Storage and Disposal of Used Oils

SEPA PPG09 Prevention of Pollution by Pesticides

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