

39 Water Environment

This chapter describes and assesses the potential impacts of the proposed scheme on the existing water environment for the Fastlink 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.

Twenty-one watercourses and one wetland area, Fishermyle wetland, were identified within the study area. No designated areas were identified within the study area. However, Burnhead Burn eventually flows into Crynoch Burn, which is part of the River Dee SAC. As there is an overlap between the watercourses in the Fastlink and Southern Leg, for consistency the assessment of Crynoch Burn is reported in Chapter 24 (Water Environment, Southern Leg).

With the effective implementation of appropriate mitigation, the majority of potential impacts on water features, both watercourses and wetland areas would be reduced to Slight, Slight/Negligible or Negligible significance.

Although certain aspects of mitigation would reduce impacts, the overall significance of residual impacts would only reduce to Moderate level during the operational phase for Limpet Burn. During the construction phase, the application of mitigation measures, such as adherence to best practice, is considered to reduce the impact to low magnitude and Moderate significance. The residual significance, for both operation and construction, is a reflection of the inherent sensitivity of the watercourse.

39.1 Introduction

- 39.1.1 This chapter is concerned with the impacts of the proposed scheme on the water environment within the study area of the Fastlink section of the AWPR. Technical assessment reports supporting this chapter are provided as appendices in Volume 10, Part D.
- 39.1.2 Cumulative impacts, combining the predicted impacts on the water environment study area for the entire AWPR proposed route are described in Volume 5, Part E of the Environmental Statement (ES).
- 39.1.3 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, water quality and fluvial geomorphology. The results of the assessment on groundwater and fisheries/aquatic habitat are reported in Chapters 38 (Geology, Contaminated Land and Groundwater) and 40 (Ecology and Nature Conservation) respectively.
- 39.1.4 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.
- 39.1.5 The 2000/60/EC 'Water Framework Directive' (WFD) is transposed into Scottish law by the 'Water Environment and Water Services (Scotland) Act 2003' (WEWS Act) and 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).

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39.1.6 In addition to the WEWS Act, the Water Environment (Controlled Activities) (Scotland) Regulations 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 License (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.

39.2 Approach and Methods

39.2.1 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 water on or near the land surface, which is intrinsically linked to hydrogeology, water quality, geomorphology and ecology;
- Fluvial geomorphology: the assessment of landforms associated with river channels and the sediment transport processes that 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.

39.2.2 The following technical reports are the supporting appendices to the Water Environment chapter:

- Appendix A39.1: Surface Water Hydrology;
- Appendix A39.2: Fluvial Geomorphology Report; and
- Appendix A39.3: Water Quality Report.

39.2.3 Appendix A39.4 contains 28 Annexes, which support the technical reports, referenced as appropriate in Appendixes A39.1 to A39.3.

39.2.4 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.

39.2.5 The potential impacts on groundwater and associated potable water are considered in detail in Chapter 38 (Geology, Contaminated Land and Groundwater). Impacts on riparian amenity and riparian landscape are considered in detail within Chapter 41 (Landscape), Chapter 42 (Visual) and Chapter 46 (Pedestrians, Cyclists, Equestrians and Community Effects).

39.2.6 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 typically used as a biological indicator of high quality water (Hendry & 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 40 (Ecology and Nature Conservation).

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39.2.7 In order to undertake this assessment, the Water Environment, Geology/Groundwater and Freshwater Ecology Teams worked together to ensure that the interaction of the physical processes and the habitats they support were sufficiently represented.

Baseline Conditions

39.2.8 The study area for the assessment includes 21 watercourses and Fishermyle Wetland, which as the name suggests, is a wetland area. Although Burnhead Burn and Crynoch Burn are referred to in this chapter, the assessment of these watercourses is included in the Southern Leg reporting in Chapter 24 (Water Environment). Only watercourses 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.

39.2.9 Extensive consultation, as described in Chapter 6 (Scoping and Consultation), was 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 freshwater species, e.g. salmonids);
- Aberdeen City and Aberdeenshire Councils (floodplain identification, area with historical flood problems); and
- relevant district fisheries board (for example the Dee District Salmon Fisheries Board who are concerned with the Crynoch Burn, a major tributary of the River Dee).

39.2.10 Desk-based studies followed the guidance of 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.

39.2.11 Watercourses affected by the route were assessed for surface water hydrology, geomorphology and water quality. Hydrodynamic models were not constructed for all watercourses owing to their small size and lesser importance, however the surface water hydrology appendix addresses flood risk issues.

39.2.12 Baseline water features are graphically presented in Figures 39.1a-f.

Impact Assessment

39.2.13 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.

39.2.14 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 detailed development and assessments of these proposals will be required for the Controlled Activity Regulation (CAR) licenses, which must be agreed with SEPA prior to construction.

39.2.15 As described in Chapter 5 (Overview of Assessment Process), significance of impact was determined with respect to the sensitivity/importance of the baseline conditions and the magnitude of potential impact. This is described below.

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Sensitivity/Importance

- 39.2.16 The criteria used to assess the sensitivity of surface water features are summarised in Table 39.1. In defining these criteria, guidance such as the DMRB, Transport Analysis Guidance (TAG) and Scottish Transport Appraisal Guidance (STAG) has been consulted to ensure a holistic approach.
- 39.2.17 Each discipline (Surface Water Hydrology, Fluvial Geomorphology and Water Quality) evaluated the sensitivity or vulnerability of a water feature by a separate set of criteria. These are listed in Table 39.1. For the purposes of summarising the impacts on the surface water environment, this chapter then assigns an overall sensitivity to the water feature, which defaults to the highest sensitivity identified by the separate disciplines.

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Table 39.1 – Criteria to Assess the Sensitivity of Water Features

Sensitivity	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality (Chemical and Biological indicators)
High	<p>A watercourse/hydrological feature with hydrological importance to:</p> <ul style="list-style-type: none"> i) sensitive and protected ecosystems; ii) critical economic and social uses (e.g. water supply, navigation, recreation, amenity); iii) flooding of property (or land use of great value) that has been susceptible to flooding in the past. <p>Or a watercourse/floodplain/hydrological feature that provides critical flood alleviation benefits.</p>	<p>Sediment regime</p> <p>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>Channel morphology</p> <p>Watercourses exhibiting a range of morphological features such as pools and riffles.</p> <p>Natural fluvial processes</p> <p>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 incl. Sites of Special Scientific Interest, National Nature Reserves and Natural Areas (part of Regional BAP).</p>
Medium	<p>A watercourse/hydrological feature with some but limited hydrological importance to:</p> <ul style="list-style-type: none"> i) sensitive or protected ecosystems; ii) economic and social uses (e.g. water supply, navigation, recreation, amenity); iii) flooding of property (or land use of value) that may potentially be susceptible to flooding. <p>Or a watercourse/floodplain/hydrological feature that provides some flood alleviation benefits.</p>	<p>Sediment regime</p> <p>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>Channel morphology</p> <p>Watercourses exhibiting limited morphological features such as pools and riffles.</p> <p>Natural fluvial processes</p> <p>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>
Low	<p>A watercourse with minimal hydrological importance to:</p> <ul style="list-style-type: none"> i) sensitive or protected ecosystems; ii) economic and social uses (e.g. water supply, navigation, recreation, amenity); iii) flooding of property (or land use of value). <p>Or a watercourse/floodplain/hydrological feature that provides minimal flood alleviation benefits.</p>	<p>Sediment regime</p> <p>A watercourse which does not support any significant species sensitive to changes to suspended solids concentration or turbidity.</p> <p>Channel morphology</p> <p>Watercourses exhibiting no morphological diversity: flow is uniform gravel bars absent and bank types uniform and stable.</p> <p>Natural fluvial processes</p> <p>Watercourse which shows no evidence of active fluvial processes and which is not likely to be affected by modification to boundary conditions.</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 sensitivity ecosystem of local and less than local importance.</p>

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Interaction with Ecology

- 39.2.18 In line with the WFD and as mentioned in paragraphs 39.1.5 and 39.2.1, the individual discipline sensitivities and the overall 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.
- 39.2.19 To avoid double counting during the assessment, all direct assessments of freshwater ecology are reported in Chapter 40 (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.
- 39.2.20 Direct impacts on the flow and sediment regime, morphological diversity and water quality of watercourses can result in indirect ecological impacts. Table 39.2 illustrates how the water environment sensitivity categories described in this section relate to those categories used in the baseline assessments of aquatic ecology presented in Chapter 40 (Ecology and Nature Conservation).

Table 39.2 – Classification of Watercourse Sensitivity (Water Environment in relation to Ecology)

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

Impact Magnitude

- 39.2.21 The magnitude of potential impact was determined in accordance with the criteria shown in Table 39.3. 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 39.3. 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 predicted impact from each discipline.
- 39.2.22 Where appropriate, cumulative catchment effects are considered within this assessment. This has been completed on a qualitative basis only.

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Table 39.3 – Criteria to Assess the Magnitude of Impact

Magnitude	Surface Water Hydrology	Fluvial Geomorphology	Water Quality
High	<p>General Impact</p> <p>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).</p> <p>The extent of ‘medium to high risk’ areas as classified by the Risk Framework contained in Scottish Planning Policy 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 exceedence probability (AEP).</p>	<p>General Impact</p> <p>Major shift away from baseline conditions.</p> <p>Sediment regime</p> <p>Major impacts to the river bed over this area due to deposition or erosion. Major impacts to sensitive species or habitats as a result of changes to suspended sediment load or turbidity.</p> <p>Channel morphology</p> <p>Major impacts on channel morphology over this area leading to a reduction in morphological diversity with consequences for ecological quality.</p> <p>Natural fluvial processes</p> <p>Major interruption to fluvial processes such as channel planform evolution or erosion and deposition.</p>	<p>General Impact</p> <p>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.</p> <p>Routine Runoff</p> <p>An increase to copper or zinc concentrations of 100% or greater over the baseline situation, plus/or a failure of Environmental Quality Standards (EQS) for either pollutant.</p> <p>Accidental Spillage</p> <p>An accidental spillage risk below the probability threshold level of 1 in 100 or 1 in 50 years (refer to the Impact Assessment Methodology section).</p>
Medium	<p>General Impact</p> <p>Moderate shift away from baseline conditions and moderate changes to the flow regime.</p> <p>The extent of ‘medium to high risk’ areas (as classified by the Risk Framework contained in SPP7) will be moderately increased.</p>	<p>General Impact</p> <p>Moderate shift away from the baseline conditions.</p> <p>Sediment regime</p> <p>Moderate impacts to the river bed and sediment patterns due to either erosion or deposition. Changes to suspended sediment load or turbidity resulting in a moderate impact on sensitive habitats or species.</p> <p>Channel morphology</p> <p>Moderate impact on channel morphology.</p> <p>Natural fluvial processes</p> <p>Moderate interruption to fluvial processes such as channel planform evolution or erosion.</p>	<p>General Impact</p> <p>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.</p> <p>Routine Runoff</p> <p>An increase to copper or zinc concentrations of 60-99% over the baseline situation, plus/or a failure of EQS for either pollutant.</p> <p>Accidental Spillage</p> <p>An accidental spillage risk above the probability threshold level of 1 in 100 or 1 in 50 years (refer to the Impact Assessment Methodology section) with up to 1 in 200 years.</p>

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Magnitude	Surface Water Hydrology	Fluvial Geomorphology	Water Quality
Low	<p>General Impact</p> <p>Minor shift away from baseline conditions and minimum changes to the flow regime.</p> <p>The extent of 'medium to high risk' areas (as classified by the Risk Framework contained in SPP7) will be similar to the magnitude of the errors attached to the estimate of the extent.</p>	<p>General Impact</p> <p>Minor shift away from the baseline conditions.</p> <p>Sediment regime</p> <p>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 to sediment patterns over this area due to either erosion or deposition.</p> <p>Channel morphology</p> <p>Limited impact on channel morphology.</p> <p>Natural fluvial processes</p> <p>Minimal change in fluvial processes operating in the river any change is likely to be highly localised.</p>	<p>General Impact</p> <p>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.</p> <p>Routine Runoff</p> <p>Specifically for the purposes of the soluble pollution assessment, a low 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.</p> <p>Accidental Spillage</p> <p>For the purposes of this assessment, a low impact will be classed as an accidental spillage risk above the probability threshold level of 1 in 100 or 1 in 50 years (refer to the Impact Assessment Methodology section) and between 1 in 200 and 1 in 500 years.</p>
Negligible	<p>General Impact</p> <p>Slight shift away from baseline conditions and negligible changes to the flow regime (i.e. changes that are within the monitoring errors).</p> <p>The extent of 'medium to high risk' areas (as classified by the Risk Framework contained in SPP7) will be much smaller than the errors attached to the estimate of the extent.</p>	<p>General Impact</p> <p>Slight change to the baseline conditions.</p> <p>Sediment regime</p> <p>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.</p> <p>Channel morphology</p> <p>No significant impact on channel morphology in the local vicinity of the proposed site.</p> <p>Natural fluvial processes</p> <p>No change in fluvial processes operating in the watercourse, any change is likely to be localised.</p>	<p>General Impact</p> <p>Slight change from the baseline conditions such that no discernible effect on the watercourse's ecology results. No change in classification.</p> <p>Routine Runoff</p> <p>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.</p> <p>Accidental Spillage</p> <p>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 (refer to the Impact Assessment Methodology section) and over 1 in 500 years.</p>

Impact Significance

- 39.2.23 The significance of impacts was determined by reference to both the overall sensitivity of the water feature and the overall magnitude of impact, according to the matrix shown in Table 39.4.

Table 39.4 – 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

- 39.2.24 The technical reports (Appendices A39.1 to A39.3) set out the specific methodologies that were adopted to assess the sensitivity or vulnerability of each water feature and potential impacts. This is summarised below for each discipline.

Surface Water Hydrology

- 39.2.25 The impact assessment of hydrology and flood risk included baseline estimates of seasonal flow duration curves, 95-percentile flow (Q95), mean flow, bank full and embankment full flow, median annual maximum flood (QMED), mean annual maximum flood (QBAR) 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.
- 39.2.26 Flood risk 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 3km². Additionally one-dimensional models have been constructed to investigate culvert design sufficiency. Further information regarding the methods undertaken can be found in Appendix A39.1 (Surface Water Hydrology). Baseline surface water catchments are shown on Figures 39.2a-c.

Allowance for Climate Change in Hydrological Parameters

- 39.2.27 Guidance on allowance for climate change has been taken from a scoping study regarding climate change and hydrological parameters (SEPA, 2005). 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 & McKenna, 2003).
- 39.2.28 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.
- 39.2.29 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

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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.

Fluvial Geomorphology

- 39.2.30 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.
- 39.2.31 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 watercourse behaviour. The field study built on the findings of the desk study in order to determine the geomorphological forms and processes of the watercourses within the study area.
- 39.2.32 Potential impacts of the proposed scheme were assessed by evaluating the potential changes to baseline conditions (sediment regime, channel morphology and natural fluvial processes). As DMRB does not outline a specific methodology for the evaluation of geomorphological impacts, 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 A39.2 (Fluvial Geomorphology).

Water Quality

Baseline Assessment

- 39.2.33 Baseline water quality conditions for watercourses were identified through consultation with statutory consultees, review of relevant published literature, site visits and during sampling undertaken in during surveys in 2004, 2005 and 2006.
- 39.2.34 Baseline conditions for watercourses are reported by SEPA in accordance with their River Classification Scheme (Annex 25, SEPA Classification Scheme). This categorises watercourses through the monitoring of water chemistry, biology, nutrient status, aesthetic condition and concentration of toxic substances. 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.

Impact Assessment

- 39.2.35 The water quality impact assessment was carried out in accordance with the methods set out in DMRB Volume 11, Section 3, Part 10. The assessment also took 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).
- 39.2.36 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. Two separate calculations are undertaken:
- pollution calculations (routine runoff assessment); and
 - accidental spillage risk calculations.

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- 39.2.37 The range of potential impacts that can result during construction are diverse and are described in Table 39.6, Table 39.7 and Appendix A39.3 (Water Quality).

Pollution Calculations (Operational Impacts)

- 39.2.38 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. It does not include seriously major pollution events resulting from vehicular collision (addressed in the accidental spillage risk assessment).
- 39.2.39 DMRB specifies that 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). This calculated concentration can then be compared to the statutory Environmental Quality Standards (EQS) that exist for the Freshwater Fisheries Directive (FFWD). These are expressed as 95 percentile values.
- 39.2.40 In addition to the Freshwater Fisheries Directive, 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, personal communication D Clark, 2004c and SEPA, personal communication N Abrams, 2005a). 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_{mean} average flow in the watercourse).
- 39.2.41 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 and design mitigation measures. More information on the methodology and the EQS used (as directly advised by SEPA (SEPA, personal communication, D Caffrey, 2005) and contained in Statutory Instrument (Circular No34/1985)) are detailed in Appendix A39.3.

Spillage Calculations (Operational Impacts)

- 39.2.42 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 A39.3 (Water Quality) provides detailed accidental spillage calculation results.

Limitations to Assessment

Hydrological Limitations

- 39.2.43 The only continuous monitoring of hydrological data available within the entire study area of the AWPR is for the Rivers Dee and the Don. No hydrometric data was available for 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.

Geomorphological Limitations

- 39.2.44 Mathematical modelling of sediment input, transfer or deposition, during road operation or construction, was beyond the scope of this assessment 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.

- 39.2.45 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

- 39.2.46 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 – 2005) and biological (for the period 2000-2005) data provided by SEPA (SEPA, 2005) and spot sampling measurements conducted by Jacobs in the summer of 2006. No zinc or copper monitoring data were provided by SEPA for the Burn of Muchalls. 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.

39.3 Baseline Conditions

- 39.3.1 Twenty-one watercourses and one wetland area (Fishermyme Wetland), that would either be crossed by the Fastlink section of the proposed scheme or be in close proximity to it and be potentially affected, were identified within the study area. Descriptions of each of the water features are provided in Table 39.5. The assigned sensitivities of the water features are explained below.
- 39.3.2 As some of the water features within the study area were unnamed, where required, these have been assigned names to aid clarity of the assessment (e.g. Fishermyme Wetland) and generally relate to adjacent named areas such as woodlands. Chainages are provided for the purposes of identifying the water features indicated on Figures 39.1a to 39.1f. This additional reference is necessarily approximate as certain features follow the route of the proposed scheme or cross it several times. Figures 39.2a to 39.2b indicate the surface water catchments of each relevant watercourse within the study area that would be crossed by the road. Figure 39.2c shows the catchment area for Fishermyme Wetland.
- 39.3.3 Overall, the water features in the study area are considered to be of good quality from a hydromorphological and water quality perspective. Water features were evaluated as being between low and high sensitivity and each feature has been assessed in detail in the technical appendices (Appendix A39.1 to A39.4). A summary of this information is provided in this chapter and in Table 39.5. The sensitivity of the water feature for each individual discipline (hydrology, geomorphology and water quality) is presented followed by a discussion of the overall sensitivity.
- 39.3.4 In line with the WFD and as mentioned in paragraphs 39.1.5 and 39.2.1, the individual discipline sensitivities and the overall sensitivities assigned to each water feature 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 of water features from Chapter 40 (Ecology and Nature Conservation) is included in Table 39.5. Evaluation of Water Environment sensitivities considered the ecological importance of dependent habitat and species.

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Table 39.5 – 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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
Megray Burn 0.6km ² u/s 1.5km ² total	n/a A2 Good	Megray Burn is a relatively small watercourse flowing through a well defined valley in a southerly direction before discharging into Cowie Water. At present there is an abstraction on the Megray Burn that has caused the downstream area to run dry. There is also extensive culverting in the downstream reaches of the burn. The burn is considered to be of low sensitivity as it is not believed to support important habitats nor pose a direct flood risk.	The channel has a gravel bed with occasional moss covered cobbles and shows no evidence of active erosion and deposition. The morphology of the channel differs between the section that flows through arable land and the section that flow through a conifer plantation. The lower section of watercourse along side the B979 is extensively culverted although some sections are open. The extensive modifications to the watercourse, (straightening, culverting and flow regulation) and lack of active fluvial processes, means the vulnerability of this watercourse to disturbance is low.	Surrounding land use is predominantly agricultural, although a section of the watercourse passes through a conifer plantation. Megray Burn is crossed by an unnamed minor road and the A90 and may receive road drainage. The Burn is currently not monitored by SEPA. The spot sampling results indicate 'good' water therefore it has been classed as of medium sensitivity.	Megray Burn was classified as good biological status based on the macroinvertebrate assemblages and as such has been evaluated as County importance. Survey recorded signs of otter activity on the burn.	Overall, this watercourse is considered to be of medium sensitivity, based on water quality and dependent habitats.

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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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
Limpet Burn 1.3km ² u/s 2.2km ² total	n/a n/a	<p>Limpet Burn is a relatively small watercourse flowing through a well defined valley in an easterly direction, eventually into the North Sea. The valley floor consists of flat wetland with connectivity to groundwater although surface water is likely to play a key role in maintaining the supply of water to the wetland area.</p> <p>A series of springs emerge from the northern valley of Limpet Burn. It is important to consider Limpet Burn not as a narrowed surface water system limited to the burn itself but as a much wider surface water-shallow groundwater system with deeper groundwater inflows.</p> <p>The burn provides flow in to three fishing ponds in its downstream reaches. There is no existing flood risk. The burn is of high sensitivity.</p>	<p>The section of channel where the proposed scheme would cross is natural, of high morphological diversity with a low fine sediment load and is highly vulnerable to disturbance. In addition, natural low order streams such as this are relatively uncommon in Aberdeenshire due to extensive modification by landowners. The valley in which the stream is located is an important natural heritage feature as it is an old glacial melt water channel.</p> <p>The burn is considered to be highly vulnerable to change.</p>	<p>Limpet Burn is not currently monitored by SEPA. As it flows through agricultural land and woodland and supports important fishing habitats downstream, Limpet Burn is expected to have 'good' water quality and be of high sensitivity.</p>	<p>No macroinvertebrate sample was taken from the crossing point as there was no discernable channel. Due to the burn being in pristine condition in the vicinity of the crossing point, it has been evaluated as Regional value.</p> <p>Surveys recorded signs of otter activity on the burn.</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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
Coneyhatch Burn 0.02km ² u/s 0.5km ² total	n/a n/a	Coneyhatch Burn flows through agricultural land and the southern fringe of Fishermyre Wetland, which is located at the head of Limpet Burn Catchment. Although the catchment drains in a southeasterly direction, there is no obvious channel for longer than 50m. Standing water and wetland, with associated vegetation, was observed in the area of the burn. There is no existing flood risk. Hence the burn is considered to be of low sensitivity.	The channel shows evidence of modification, primarily through straightening throughout its length. At the section where the proposed scheme would cross, the burn has been over-deepened, potentially in an attempt to improve land drainage. The channel has become choked with dense vegetation and the channel shows low morphological diversity. It does not exhibit any evidence of active erosion or deposition processes. Due to the extent of modifications the burn is of low vulnerability.	Coneyhatch Burn flows mainly through moorland and Fishermyre Wetland. Fishermyre and Coneyhatch farms are within close proximity to the watercourse. This watercourse is suspected to be ephemeral and is considered to be of low sensitivity.	Not explicitly assessed by freshwater ecology. The otter surveys reported that Coneyhatch Burn is likely to be used as an otter commuting route along with Limpet and Megray Burns.	Overall, this watercourse is considered to be of low sensitivity.
Fishermyre Wetland 0.8km ² total	n/a n/a	Surface Water Hydrology This is an area of peat and wetland that drains to Green Burn recognised as offering an important habitat to water voles and wetland woodland, as well as other sensitive species. There is no existing flood risk. Surface water drains in a south easterly direction through the wetland area before flowing into Green Burn. The majority of the wetland is upstream of the proposed road and is likely to be maintained by rainfall falling directly on to the north west of it and a supply of groundwater. Walkover surveys confirmed that Fishermyre has reached a good water equilibrium where the ground remains water logged throughout the majority of the year and there is a strong connectivity between surface water and groundwater. Surface Water Quality The groundwater quality assessment and surface water quality are considered to be of high sensitivity. Overall Water Environment The area is considered to be of high sensitivity due to the important habitats it supports. Groundwater Fishermyre Wetland is supported by groundwater (depth of groundwater in area) and was indicated on historical maps as a wet area and on BGS maps as partially covered by peat.			Not explicitly assessed by freshwater ecology. Otters are likely to be present in this area. Provides linkage between three known, established water vole colonies and is assessed as national importance.	Overall, this watercourse is considered to be of high sensitivity due to the important habitats that it supports.

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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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
Green Burn 0.8km ² u/s 2.9km ² total	n/a C Poor	Green Burn initially flows in a southerly direction before turning to flow in a northeasterly direction into the Burn of Muchalls. Wet woodland within Fishermyre Wetland that is thought to be dependent on surface water hydrology is located within the upper catchment. The burn is culverted under existing roads. The burn is considered to be of medium sensitivity due to the habitats dependent on the hydrology.	The section of Green Burn that would be crossed by the proposed scheme has a natural form with a morphologically diverse bed. Unmodified low order streams such as this are uncommon in the area around Aberdeen, due to the extensive nature of watercourse modification to aid land drainage, therefore, this section of channel is of significance. The channel is of medium vulnerability to future modifications, which are likely to be detrimental to the morphology of the stream.	Results from spot sampling carried out by Jacobs in 2006 indicated that the water quality in the upstream section of Green Burn was of category C (poor). It is suspected that this is due to road drainage discharge from the U167K road. However, as the burn flows through an area of important peatland habitats and supports population of water voles, it has been classed as being of medium sensitivity.	Green Burn was classified as having poor biological status as a result of the macroinvertebrate assemblage and as such has been evaluated as County importance. This watercourse offers good habitat and is of importance to the survival of the Fishermyre Wetland water vole population. It is therefore considered to be of national importance.	Due to the presence of dependent habitats sensitive to changes in the water environment, overall this watercourse is considered to be of medium sensitivity.
Green Ditch 0.02km ² u/s 0.1km ² total	n/a n/a	Green Ditch is a tributary of Green Burn flowing in a southerly direction, draining agricultural land to the east of the proposed route. The proposed crossing point is located within the upper catchment. The burn is considered to be of low sensitivity as it is not believed to support important habitats nor pose a direct flood risk.	The channel exhibits low morphological diversity and does not exhibit any evidence of active erosion or deposition processes. The artificial nature of the watercourse and lack of active fluvial processes means the vulnerability of this watercourse to disturbance is low.	Green Ditch is likely to receive road drainage from the adjacent farm track and agricultural runoff from the land it drains. It is suspected to be ephemeral and is therefore considered of low sensitivity.	Not explicitly assessed by freshwater ecology. Offers good habitat and is of importance to the survival of the Fishermyre Wetland water vole population therefore considered to be of national importance.	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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
Allochie Burn 0.01km ² u/s 0.4km ² total	n/a A2 Good	Allochie Burn is a straightened tributary of Back Burn. The burn is considered to be of low sensitivity as it is not believed to support important habitats nor pose a direct flood risk.	The low gradient of the watercourse and past modification means the channel does not exhibit any evidence of active erosion or deposition processes. The artificial nature of the watercourse and lack of active fluvial processes means the vulnerability of this watercourse to disturbance is low.	It is considered to be ephemeral in its upper reaches. However, spot samples indicated good macroinvertebrate assemblages and consequently it is considered to be of medium sensitivity.	Allochie Burn was classified as showing good biological status as a result of the macroinvertebrate assemblage identified. The good biological classification results in an evaluation of County value.	Despite being a severely modified, straightened filed drain, good biological water results in an overall sensitivity of medium.
Burn of Muchalls 6.7km ² u/s 14.2km ² total	A2 Good A2 Good	The Burn of Muchalls is a relatively large watercourse flowing in an easterly direction. The lower and upper reaches have well defined valley sides. The middle reaches are flat wetland and include the highly sensitive Red Moss of Netherley SAC. Numerous artificial ponds upstream may be controlled by surface water within the catchment area. At the road crossing point, the Indicative River and Coastal Flood Maps (Scotland) predict that the Burn of Muchalls will flood at the 0.5% AEP (200 year return period event). At this location and for approximately 200m upstream and downstream of the proposed crossing, flooding is predicted to be predominantly confined to the	The bed of the channel possesses good morphological diversity with generally natural banks and the watercourse supports a diverse ecology. The absence of fine sediment in the water column and on the bed, means that the watercourse is vulnerable to activities which may increase fine sediment inputs. As such, the watercourse is highly vulnerable to activities that may affect the morphology of the stream.	The burn flows mainly through isolated agricultural land. Along its length the watercourse is crossed by the U88K road and the A90, therefore it may receive road drainage at these locations. The watercourse is culverted beneath the A90 and approximately 200m downstream, it is crossed by the North East Mainline railway. The Burn of Muchalls is currently monitored by SEPA and its water quality has been classified by SEPA as A2 (good). It is a natural burn that supports brown trout. Therefore, it is classed as being of high sensitivity.	Upstream, the burn is obviously modified with evidence of realignment whilst retaining a degree of semi-naturalness. Downstream, the burn is significantly modified. The macroinvertebrate sample point was at the crossing point and the burn was classified as being of good biological status. Within this area small salmonids were identified during the surveys. The burn has been evaluated as Regional importance. Otter survey records this burn as a key area of otter activity.	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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
		<p>right bank. The Burn of Muchalls is predicted to flood land within 100m of the channel. There appears to be no properties in the flood risk area with the floodplain consisting of arable and pasture farmland.</p> <p>Aberdeenshire Council have advised that the predicted flood risk is likely to be overestimated by the SEPA indicative flood risk maps in this particular location.</p> <p>Due to its size the burn is considered to be of medium sensitivity.</p>				
<p>Burn of Blackbutts</p> <p>0.2km² u/s</p> <p>1.1km² total</p>	<p>n/a</p> <p>n/a</p>	<p>This watercourse is the main tributary of the Burn of Muchalls flowing in a southeasterly direction and draining an area of predominantly agricultural land. Observations suggest that the watercourse may be ephemeral in its upper catchment, but it appears to have more continued flow further downstream.</p> <p>The burn is considered to be of low sensitivity as it is not believed to support important habitats nor pose a direct flood risk.</p>	<p>The heavily modified nature of the watercourse and the ephemeral nature of the flow in the location of the proposed scheme crossing means that this watercourse is of low vulnerability to future modification.</p>	<p>It is likely that the Burn of Blackbutts receives agricultural runoff and road drainage. Although this watercourse is not monitored by SEPA, it is a tributary of the Burn of Muchalls. The Burn of Muchalls water quality is classed as A2 by SEPA. The Burn of Blackbutts would only be affected by the proposed scheme in its upper reaches and is evaluated as low sensitivity.</p>	<p>The channel was not sampled for macroinvertebrates as there was little water identified. As such the burn has been assessed as being of Local value based on the RHS assessment.</p> <p>Otter survey records this burn as a key area of otter activity.</p>	<p>Overall, this watercourse is considered to be of low sensitivity.</p>
<p>Cookney Ditch</p> <p>0.2km² u/s</p>	<p>n/a</p> <p>n/a</p>	<p>Cookney Ditch appears to be part of an agricultural field drainage system with no obvious channel.</p>	<p>The source of Cookney Ditch is at the foot of the northern slopes of the hill on which the village of Cookney is situated.</p>	<p>Cookney Ditch flows through moderately sloping land of rough pasture,</p>	<p>No macroinvertebrate samples were collected due to low flows at time of</p>	<p>Overall, this watercourse is considered to</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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
0.5km ² total		The channel is choked with vegetation, but drains in an easterly direction before discharging in to the Pheppie Burn. The head of the catchment drains a small area of wetland and gorse The burn is considered to be of low sensitivity as it is not believed to support important habitats nor pose a direct flood risk.	The stream is located within a straight and over-deepened ditch-like channel, which is entirely artificial in origin. The degree of modification of the channel means that the watercourse is considered to be of low vulnerability.	following field boundaries. The ditch is crossed by C24K road at Harecraig and is likely to receive road drainage and agricultural runoff. It is therefore considered to be of low sensitivity	sampling. As such this watercourse has been assessed as being of Local value based on the RHS assessment.	be of low sensitivity.
Stoneyhill Ditch 0.2km ² u/s 0.8km ² total	n/a n/a	Stoneyhill Ditch is a tributary of the Burn of Elsick flowing in a northeasterly direction. The section that the proposed scheme would cross over is located in the upper catchment. Hence, the burn is of low sensitivity.	This watercourse is considered to be artificial in nature and ephemeral where the proposed scheme would cross. This watercourse is of low vulnerability to future modification.	Stoneyhill Ditch is likely to receive agricultural and road runoff from the surrounding land and roads. Hence the burn is considered to be of low sensitivity.	Not explicitly assessed by freshwater ecology.	Overall, this watercourse is considered to be of low sensitivity.
Balnagubs Burn 0.2km ² u/s 0.6km ² total	n/a n/a	A tributary of the Burn of Elsick flowing in a northeasterly direction, draining agricultural land. The section that the proposed scheme would cross is in the upper catchment. The burn is considered to be of low sensitivity as it is not believed to support important habitats nor pose a direct flood risk.	The channel is densely vegetated which encourages ponding of flow and deposition on the bed. The bank tops are lined by rock debris which is probably composed of material dredged from the channel. The channel shows no evidence of active geomorphological processes such as erosion and deposition and has low morphological diversity. The heavily modified nature of the watercourse, in the location of the proposed road crossing, means that this watercourse has a low vulnerability to	This watercourse is not monitored by SEPA and no spot sampling carried out. However, the burn flows through isolated pasture land and is expected to possess good water quality with possible nutrient enrichment from grazing animals or bank erosion from poaching. Balnagubs Burn is considered of low sensitivity.	No macroinvertebrate samples were collected due to low flows at time of sampling. As such this watercourse has been assessed as being of Local value based on the RHS assessment. Otter survey records this burn as a key area of otter activity.	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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
			future modification.			
Tributary of Elsick Burn 1.0km ² u/s 1.7km ² total	n/a A2 Good	This watercourse flows in an easterly direction into the Burn of Elsick. It is likely that the burn has been modified as part of field drainage. There is a possibility that the catchment may play a role in the water balance of a pond downstream of the confluence with the Burn of Elsick. It is thought that this is unconnected to the burn. Hence the burn is of low sensitivity.	The watercourse has a low to moderate gradient. It is aligned along the margins of fields and appears to have been straightened and deepened. The channel shows no evidence of active geomorphological processes such as erosion and deposition and has low morphological diversity. The burn is low vulnerability.	The watercourse flows through predominantly rough pasture land before joining Banagubs Burn and then the Burn of Elsick. The watercourse is crossed by farm tracks and a minor road. Spot sampling results show good water quality (class A2). Tributary of Elsick Burn has been classed as medium sensitivity	The burn was classified as good biological status based on the macroinvertebrate assemblage and has been evaluated as of Local value. Otter survey records this burn as a key area of otter activity.	The overall sensitivity of this burn is considered to be medium, which is driven by the water quality evaluation.
Whiteside Burn 0.4km ² u/s 2.1km ² total	n/a A2 Good	Whiteside Burn flows in an easterly direction into the Burn of Elsick. The upstream end of the burn has been piped and it is likely that the full length of the burn has been modified as part of a field drainage system. The burn is of low sensitivity.	The channel has a gravel-bed, but due to past modification it has low morphological diversity. There is no evidence of active geomorphological process operating along the watercourse. The heavily modified nature of the watercourse and low morphological diversity means the watercourse has low vulnerability to future modification.	Whiteside Burn drains through agricultural land. It is crossed by a farm road then further downstream by a Class C road at the point of its confluence with the Burn of Elsick. The water quality of the burn is not monitored by SEPA. However, spot sampling results indicated good (class A2) water quality. Whiteside Burn is considered to be of a medium sensitivity.	The burn was in good biological status based on the macroinvertebrate assemblage and as such the burn was evaluated as Local value.	The overall sensitivity of this burn is considered to be medium, which is driven by the water quality evaluation.
Crossley Burn 0.2km ² u/s	n/a B Fair	Crossley Burn is a small tributary of the Burn of Elsick flowing in a southeasterly direction. The section that would be crossed by the proposed scheme is located in	The channel is straight and over-deep for its size, which indicates past modification. Given the low gradient of the channel, it is unclear whether a distinct channel would have formed here under natural	Crossley Burn drains agricultural land and is currently not crossed by any roads or railway tracks and is not in close proximity of	Macroinvertebrate samples were taken from two points downstream of the crossing point that offer differing 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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
0.7km ² total		the upper catchment where the channel is heavily vegetated. Stagnant water has been observed within the channel The burn is of low sensitivity.	conditions. It is likely that this channel is an artificial drainage ditch excavated to reduce waterlogging of the surrounding land. Due to its artificial nature, the burn is of low vulnerability.	any properties along its length. It is not monitored by SEPA for its water quality. Spot sampling carried out by Jacobs in 2006 indicated that the water quality to be of category B (fair). Therefore, it is classed as being of low sensitivity.	The burn was identified to be of fair biological status. The burn has been evaluated as being of County value.	
Cairns Burn 0.1km ² u/s 0.1km ² total	n/a n/a	Cairns Burn is a small tributary of Crossley Burn flowing in a southeasterly direction. The burn is considered to be of low sensitivity.	The channel has a low gradient and it is not clear whether a distinct channel would have been present under natural conditions. It is likely that this channel owes its origin to excavation as a drainage channel, rather than being a natural watercourse. Due to its artificial nature, the burn is of low vulnerability.	Cairns Burn is not classified under the SEPA Water Quality Classification Scheme. It flows through agricultural land and is likely to receive agricultural runoff. Due to its heavily modified nature, it is considered to be of low sensitivity.	Not assessed by freshwater ecology.	Overall, this watercourse is considered to be of low sensitivity.
Circle Burn 0.1km ² u/s 0.1km ² total	n/a n/a	Circle Burn is a relatively small, ephemeral tributary of Stranog Burn. Due to its size and ephemeral nature, the burn is considered to be of low sensitivity.	Flow in this watercourse is ephemeral and the channel shows low morphological diversity and no evidence of active fluvial processes. Consequently, it is a low vulnerability channel.	Circle Burn flows through agricultural land and it may receive agricultural runoff. This burn is classed as low sensitivity due to its ephemeral nature.	Not assessed by freshwater ecology.	Overall, this watercourse is considered to be of low sensitivity.
Square Burn 0.1km ² u/s 0.1km ² total	n/a n/a	Square Burn is a relatively small, ephemeral tributary of the Greens of Crynoch Burn. Due to its size and ephemeral nature, the burn is considered to be of low sensitivity.	Flow in this watercourse is ephemeral and the channel shows low morphological diversity and no evidence of active fluvial processes. Consequently, it is a low vulnerability channel.	Square Burn follows agricultural field boundaries. This burn is classed as low sensitivity.	Not 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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
Wedderhill Burn 0.1km ² u/s 0.2km ² total	n/a n/a	A tributary of Crynoch Burn flowing in a northwesterly direction. Crynoch Burn is a designated SSSI and SAC. Wedderhill Burn catchment only accounts for approximately 1% of the total Crynoch Burn catchment and only provides a small input to the total hydrological system. Therefore, it is considered unlikely to affect the characteristics and habitats of Crynoch Burn. The burn is considered to be of low sensitivity.	The watercourse drains the northern slopes of Wedderhill and is thought to be an ephemeral tributary of Crynoch Burn, although during field visits no clear connection could be found. As the watercourse has been modified by straightening and recent dredging and does not appear to be well connected to Crynoch Burn, it has a low vulnerability to future modification.	The water quality of Wedderhill Burn is not currently monitored by SEPA. It flows predominantly through rural land and it may receive agricultural runoff. It is considered to be of a low sensitivity.	Not assessed by freshwater ecology.	Overall, this watercourse is considered to be of low sensitivity.
Craigentath Burn 0.4km ² u/s 0.8km ² total	n/a n/a	A tributary of Crynoch Burn flowing in a northwesterly direction. The channel section where the proposed scheme would cross is not distinct and appears more like a wetland. No obvious flow was observed and the burn was defined by an area of standing water within the wetland. Crynoch Burn is a designated SSSI and SAC. Craigentath Burn catchment only accounts for approximately 2% of the total Crynoch Burn catchment and only provides a small input to the total hydrological system. Therefore, it is unlikely to affect the characteristics and habitats of Crynoch Burn. The burn is considered to be of	This watercourse also drains the northern slopes of Wedderhill and is thought to be a tributary of Crynoch Burn. During field visits, no clear connection was found. In its upper reaches, the channel is generally straight and follows field boundaries. From a sediment transport perspective, this burn is not considered to be connected to Crynoch Burn. Consequently, the burn is considered to be of low vulnerability to change.	Craigentath Burn flows predominantly through rural land and it may receive agricultural runoff. The watercourse is crossed by Lochton-Auchlunies-Nigg Road (C5K) and may also receive road runoff. It has been classed as being of low sensitivity.	Not 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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
		low sensitivity.				
Burnhead Burn 4.2km ² u/s 4.3km ² total	n/a A2 Good	Burnhead Burn is the main tributary of Blaikiewell Burn and flows in a northwesterly direction. The burn is able to support Trout and thus considered an important habitat, sensitive to the supply of surface water. Burnhead Burn is shown 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). 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 Burnhead Burn. There are no properties within 250m of the proposed crossing. The sensitivity of the burn is considered to be medium.	Part of the upstream area of the catchment is likely to have been modified and realigned as part of a field drainage system. The upper low gradient section of Burnhead Burn 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 medium to high vulnerability to future change.	This watercourse drains an area of agricultural land and woodland. Burnhead Burn is not monitored by SEPA. Recent spot sampling results (Jacobs, 2006) indicated good water quality (class A2). Burnhead Burn is considered to have a high sensitivity as it is the main tributary of Blaikiewell Burn.	Burnhead Burn was assessed for habitat modification at two locations and was identified to be both significantly and severely modified. The burn was sampled for macroinvertebrates near to 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, which is driven by the water quality and geomorphology evaluations.
Crynoch Burn n/a 31.7km ² (to confluence with Dee)	A2 Good A1 Excellent	Crynoch Burn is located in the vicinity of the study area and is part of the River Dee SAC. The majority of its 31.7 km ² catchment falls within the study area of the proposed route. Qualifying species of the SAC are freshwater pearl mussels, otter and atlantic salmon. The proposed scheme	Crynoch Burn's headwater streams have relatively steep gradients, while the gradients of the central valleys decline progressively downstream. 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	Crynoch Burn forms after the confluence of Cairnie Burn and Burn of Monquich, flowing northeast through Durris Forest and entering the Dee near Culter camping site. SEPA monitoring data for Crynoch Burn show good	Crynoch Burn was sampled for macroinvertebrates at two locations within the route corridor. The site furthest upstream was not assessed for therefore evaluations are based on the biological status of	Overall, this watercourse is considered to be of high sensitivity. This burn has been evaluated as being of International

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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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
		<p>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 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 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 area is included within the Dee Flood Model (Appendix A24.2).</p>	<p>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 thought 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 weir designed to supply water to a pond associated with a former mill. The watercourse is crossed by two existing bridges.</p> <p>The watercourse exhibits excellent morphological diversity and the watercourse has high vulnerability to disturbance.</p>	<p>(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>the watercourse. The burn was found to be in excellent status and was evaluated as regional value. Further downstream, the burn falls within the River Dee SAC boundary. Both river habitat and macroinvertebrate surveys found the burn to be significantly and obviously modified throughout the survey reach. It was found to be in excellent biological status. Despite the degree of modification, the burn has been evaluated as International value due to its excellent biological status and the fact that it falls within the boundary of the River Dee SAC.</p>	<p>importance based on the habitats it supports and being within the boundary of a SAC.</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 40: Ecology and Nature Conservation, for more information)	Overall Sensitivity/ Vulnerability
		The sensitivity of the burn is considered to be high.				

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Summary of Watercourse Sensitivity

Megray Burn (ch600)

39.3.5 Megray Burn drains predominantly agricultural land and is straightened along field boundaries in the downstream section before it is culverted underneath the A90. Ultimately, it drains to Cowie Water and an online abstraction exists currently within Megray Wood. The burn is considered to be low sensitivity from a hydrological and geomorphological perspective due to its modified nature. Despite the anthropogenic pressure the burn currently receives, the spot sampling undertaken in 2006 indicated that water quality was good and it has been assessed as being of medium sensitivity.

39.3.6 As a precautionary approach has been adopted for this assessment, on the basis on water quality the overall sensitivity of this burn is considered to be medium.

Limpet Burn (ch1500)

Coneyhatch Burn (ch2600)

39.3.7 Coneyhatch Burn is a small, upstream tributary of Limpet Burn. All three disciplines indicate that the burn is of low sensitivity in the area of interest. Consequently, the overall sensitivity is considered to be low.

39.3.8 Limpet Burn runs through a natural gorge. The valley floor consists of flat wetland with connectivity to groundwater, although surface water is likely to play a key role in maintaining the supply of water to the wetland area. The channel in the location of the proposed road crossing is natural and of high morphological diversity, with a low fine sediment load. Natural low order streams such as this are relatively uncommon in Aberdeenshire due to extensive modification by landowners. The burn provides an important flow in to three fishing ponds in the downstream reaches, which will be sensitive to any alteration in the water balance, sediment regime or water quality of the catchment. Consequently the burn is considered to be of overall high sensitivity.

Green Burn (ch3100)

Green Ditch (ch3150)

Fishermyre Wetland (ch3100)

39.3.9 Surface water drains in a southeasterly direction through the wetland before flowing into Green Burn. The area supports several important habitats that are dependant on its hydrological regime. In addition, a colony of water voles is known to occur in Fishermyre Wetland and Green Burn. Consequently, the wetland is considered to have an overall sensitivity of high.

39.3.10 Green Burn, in the location of the proposed road, has a natural form with a morphologically diverse bed. As unmodified low order streams such as this are uncommon in the area around Aberdeen, due to the extensive nature of watercourse modification that has been undertaken to aid land drainage, this section of channel is of significance. All disciplines indicated that the burn is of medium sensitivity, consequently based on these assessments and the important habitats that the burn supports it is considered to have an overall sensitivity of medium.

39.3.11 Green Ditch is a small, highly modified and straightened ditch. All three disciplines indicate that this is of low sensitivity, therefore following the precautionary approach, the overall sensitivity is low.

Allochie Burn (ch4000)

39.3.12 Allochie Burn is a small, modified field ditch that is a tributary of Back Burn, which eventually drains to the Burn of Muchalls. Hydrology and geomorphology classified the burn as low sensitivity. However, based on good macroinvertebrate assemblages, the burn was classified as being of medium sensitivity from a water quality perspective. These biological results indicated that the burn is of good ecological health and as such the overall sensitivity defaults to medium.

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Burn of Muchalls (ch4700)

- 39.3.13 The Burn of Muchalls is a relatively large watercourse in the study area. The bed of the channel has a good morphological diversity and the banks are generally natural and thus the watercourse supports a diverse ecology. The macroinvertebrate sampling at the proposed crossing point indicated that the burn is of good biological status. Within this area, small salmonids were identified during the surveys. The assessments indicated that the burn is unlikely to support salmon, although it may possibly support trout. The water quality and geomorphology assessments indicate that the burn is of high sensitivity. Therefore, despite the hydrological assessment, which assigns a medium sensitivity, the burn is considered to be of high sensitivity overall.
- 39.3.14 At the road crossing point, the Indicative River and Coastal Flood Maps (Scotland) suggest that the Burn of Muchalls will flood at the 0.5% AEP (200 year return period event). It should be noted that Aberdeenshire Council have advised that indicative flood risk maps may over estimate flood risk in this particular location (pers. comm., Aberdeenshire Council, 2007).

Burn of Blackbutts (ch5600)

- 39.3.15 The Burn of Blackbutts is the main tributary of the Burn of Muchalls, flowing in a southeasterly direction and draining an area of predominantly agricultural land. Observations suggest that at the point of crossing, near the most upstream end of the catchment, the watercourse may be ephemeral but appears to have more continued flow further downstream. All three disciplines consider the burn to be of low sensitivity, which consequently defines its sensitivity for the water environment.

Cookney Ditch (ch6500)

Stoneyhill Ditch (ch6900)

- 39.3.16 Cookney Ditch and Stoneyhill Ditch are modified, straightened field ditches that are considered by hydrology, geomorphology and water quality assessments to be of low sensitivity. Consequently, their overall sensitivity defaults to low.

Balnagubs Burn (ch7550)

Tributary of the Burn of Elsick (ch7950)

Whiteside Burn (ch8850)

Crossley Burn (ch9200)

Cairns Burn (ch9150)

- 39.3.17 These five watercourses eventually all drain to the Burn of Elsick. In general, they are considered to be modified field drains and the hydrological and geomorphological assessments have classified the burns as low sensitivity. However from a water quality perspective, Whiteside Burn and the Tributary of the Burn of Elsick recorded good water quality during the spot sampling completed by Jacobs in the summer of 2006. Consequently, these burns are considered to be of overall medium sensitivity driven by the water quality assessment. The remaining three watercourses are considered to be of low sensitivity.

Circle Burn (ch9950)

Square Burn (ch10150)

Wedderhill Burn (ch10400)

Craigentath Burn (ch10600)

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- 39.3.18 These series of small watercourses drain to Crynoch Burn within the designated SAC boundary. From a geomorphological perspective, Craigentath and Wedderhill burns have been straightened and generally follow field boundaries. It is believed that these watercourses eventually drain to Crynoch Burn, however, no obvious hydrological connection was observed during field investigations. Consequently, it is believed that the connection may occur through underground pipes or groundwater mechanisms. Craigentath and Wedderhill Burns are not thought to contribute to the sediment regime of Crynoch Burn. Circle and Square Burns are considered to be ephemeral in nature. In general, all four of these watercourses are considered to be of low sensitivity.

Burnhead Burn (ch200100)

- 39.3.19 Burnhead Burn overlaps between the Fastlink and Southern Leg sections of the proposed scheme. For completeness, the baseline conditions are reported in both sections, however any impacts on the burn are included in the Southern Leg section assessment in Chapter 24 (Water Environment). Burnhead Burn is the major contributing tributary to Blaikiewell Burn, which flows directly to Crynoch Burn (which is part of the River Dee SAC).
- 39.3.20 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). For the majority of its length, it is a straightened watercourse that follows field boundaries. Due to its hydrological importance to Blaikiewell Burn, which is upstream of Crynoch Burn (part of the River Dee SAC), it is considered to have an overall high sensitivity for the water environment. This assessment is principally driven by the geomorphology and water quality assessments.

Crynoch Burn

- 39.3.21 Crynoch Burn overlaps between the Fastlink and Southern Leg sections of the proposed scheme. For completeness, the baseline conditions are reported in both sections, however any impacts on the burn are included in the Southern Leg section assessment in Chapter 24 (Water Environment). Crynoch Burn is included in the River Dee SAC and is one of its major tributaries.

Groundwater Baseline

- 39.3.22 The details of the groundwater baseline assessment are provided in Chapter 38 (Geology, Contaminated Land and Groundwater). Chapter 38 provides information regarding wells and springs used for domestic and/or agricultural water supply and of relevance to the Water Environment assessment. Chapter 38 also provides additional information regarding groundwater connectivity for Limpet Burn and Fishermyle Wetland.

39.4 Potential Impacts

- 39.4.1 Impacts on surface water features, as a result of road construction, are described for each of the three specialist disciplines described in Section 39.2.
- 39.4.2 This section first provides a description of the types of impacts that may occur as a result of the proposed scheme, which then forms the basis for the specific impacts subsequently described for each water feature identified in the baseline conditions.
- 39.4.3 It is emphasised that the impacts presented in this section are predicted 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 39.5 and the residual impacts of the scheme, following mitigation, are presented in Section 39.6.

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General Impacts

39.4.4 Impacts may result from the following:

- Road Drainage: reduced infiltration 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 impacts on geomorphology and subsequently water quality;
- Watercourse realignments: often a result of the watercourse crossing design, these can change the catchment of the watercourse leading to increased local flood risk and changes to sedimentation patterns along the watercourse;
- Network culverts: localised change or increase to flood risk;
- Watercourse re-direction in pre-earthworks drainage, or catchment severance: water transfer from one catchment to another;
- 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.

39.4.5 These impacts are discussed further below.

Road Drainage Impacts

Surface Water Hydrology

39.4.6 The proposed scheme would introduce new impermeable areas to the watercourse catchment. It is estimated that the surface area of the proposed road pavement would be approximately 0.18km². 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 may 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. This could increase flows to some watercourses while reducing flows in others.

39.4.7 These potential hydrological impacts are likely to alter flood risk and the discharge, fundamentally altering the baseline flow regime of the watercourse. Indirect impacts on aquatic ecology may also accrue, for example a significant change to the discharge regime to the Limpet Burn could result in indirect impacts on trout farming in the stocked ponds at Logie Farm downstream. Any potential ecological impacts on habitats of this type are assessed in Chapter 40 (Ecology and Nature Conservation).

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

Fluvial Geomorphology

39.4.9 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;

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- 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.

39.4.10 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 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.

39.4.11 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.

39.4.12 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 39.5.

Water Quality

39.4.13 Impacts on water quality are principally caused by pollutants carried 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 are 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 salts and alternative de-icing agents.

39.4.14 Metals in road runoff contaminants include copper, zinc, lead and nickel. As noted in section 39.2 (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 both 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).

39.4.15 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.

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- 39.4.16 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.
- 39.4.17 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 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 bed of the watercourse, also leading to the death of aquatic species.
- 39.4.18 De-icing salts, 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.
- 39.4.19 Appendix A39.3 (Water Quality) provides detailed pollution and accidental spillage calculation results.

Watercourse Crossing Impacts

Surface Water Hydrology

- 39.4.20 The proposed scheme coincides with (or is adjacent to) surface water features at a number of locations, mainly crossing watercourses, but also environmental features critically dependent on the surface hydrology (for example wetland). Impacts of watercourse crossings on the surface hydrology could occur through alteration of the physical flow and water level regimes:
- potential for increased localised flood risk upstream of where the proposed scheme would cross; or
 - if hydrological pathways that currently allow the functioning of the local environment are severed or constrained this may lead to an increase to flood risk.

Fluvial Geomorphology

- 39.4.21 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 culverts designed to convey a range of flows up to the 1:200 year flow level. The culverts will generally be installed level with the existing watercourse bed, effectively providing artificial bed and banks.
- 39.4.22 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 reducing capacity over time, without proper maintenance. 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.
- 39.4.23 The morphological diversity of a watercourse within the culvert is generally greatly reduced, in comparison with the existing watercourse, 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.

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- 39.4.24 Where it is proposed to cross a watercourse through the use of a bridge or similar structure, geomorphological impacts are generally reduced, in comparison with 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.
- 39.4.25 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. The soffit (underside of the ceiling) of buried structures tend to be lower than bridges, as they often have to carry carriageway drainage pipes over the watercourse. Depending on the height and length of the structure, light penetration can often be poor, resulting in bare banks and poor bank stability, which affects the geomorphology of the watercourse. Additionally, in some cases the watercourse may require realignment through the structure, effectively creating a new watercourse channel. Soils may be more susceptible to erosion where light deficiency limits the potential for roots to bind the bankside material.

Water Quality

- 39.4.26 Construction of the Fastlink section of the proposed scheme involves approximately 13 crossings of the previously identified watercourses (in addition to the proposed extension of an existing culvert on Megray Burn). As noted above, culverting could potentially change the riverbed morphological diversity and sediment regime of the watercourses. This may have an associated impact on water quality by releasing previously locked contaminants into the water column. As bridge structures are likely to result in less geomorphological impact, they are also likely to have a reduced impact on water quality.
- 39.4.27 Culverts and buried structures 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

- 39.4.28 Realignments will change the discharge regime of the watercourse. However, if designed correctly for hydraulic purposes, these realignments should not impact on the surface water hydrology unless the realignment significantly changes the catchment of the affected watercourse. Any impacts to flood regime, as a result of erosion or deposition, are discussed in the fluvial geomorphology section below. Severance of a catchment by the proposed scheme may result in changes to the current hydrological response in the catchment, leading to potential increases in the flood risk of affected watercourses.
- 39.4.29 At certain locations along the proposed scheme, the upper sections of some minor watercourses and drainage ditches have been designed to discharge directly to the pre-earthworks 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 the smaller watercourses/drainage ditches, all of which are considered to be of low sensitivity and ecological value and potential impacts are not considered to be significant.

Fluvial Geomorphology

- 39.4.30 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

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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.

- 39.4.31 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.

Water Quality

- 39.4.32 As with the installation of culverts, the main impact of realignment 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.

Redirection of Watercourses into Pre-Earthwork Drainage or Catchment Severance

- 39.4.33 During construction, very small or ephemeral watercourses may be re-directed into pre-earthworks drainage ditches. Alternatively, flow from severed catchments may be picked up by these ditches and the water transferred into larger watercourses.

- 39.4.34 Pre-earthwork ditches are a series of drains that would run along the edge of the road alignment, either at the toe of embankments or at the top of cuttings, where the adjacent ground slopes towards the proposed road, collecting clean water runoff from the surrounding land. The ditches then discharge to local larger watercourses.

Surface Water Hydrology

- 39.4.35 Where watercourses, or the flow from severed catchments, would be redirected into pre-earthwork drainage, the two main impacts that may occur are:

- 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

- 39.4.36 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 have been considered in detail.

Construction Impacts

Surface Water Hydrology

- 39.4.37 Construction impacts can include effects such as soil compaction due to works traffic, sedimentation and disturbance/unintentional changes to channel dimensions which may impact on the hydraulic flow characteristics of a watercourse as well as on the geomorphology, ecology and water quality.

- 39.4.38 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;
- temporary detention basins at drainage outfalls; and

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- temporary arrangements to control runoff.

Fluvial Geomorphology

- 39.4.39 Potential impacts during the construction phase are similar to those of the operational phase except they are short-term and potentially more intense. There are a higher number of sources of potential impacts relating to suspended solids, including runoff from plant and vehicle washing, excavations and blasting and excavation of road drains. Vegetation near the watercourse may also be cleared for construction works and, depending on proximity to the watercourse, could influence bank stability.
- 39.4.40 The magnitude of impact is dependent on the scale of excavations and the need for blasting at each location. Blasting may be required by the contractor in areas where excavations are in rock. 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 greater extent of 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.
- 39.4.41 Table 39.6 summarises potential geomorphological impacts during construction. As discussed previously, geomorphological impacts will also affect water quality.

Table 39.6 – Potential Construction Impacts on Fluvial Geomorphology

Source of Impact	Potential Effects
<p>Suspended Solids</p> <p>Can result from excavations, blasting, runoff from stockpiles, plant and wheel washing, runoff from site roads, runoff during earthworks construction 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>Potential increase in turbidity and siltation with a reduction in diversity is likely due to increased fine sediment supply. The ecology of gravel bed watercourse would 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 A39.2 and A39.3 (Fluvial Geomorphology and Water Quality respectively).</p>
<p>Vegetation Clearance</p> <p>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 A39.2 (Fluvial Geomorphology).</p>
<p>Watercourse/Drain Crossings and Diversions, Realignment of Watercourses and outfall construction</p> <p>Construction of structures over or in watercourses, the installation of 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 waterlogging of soils. Potential for increased localised flooding upstream of where the proposed scheme would cross. Diversions could cause long-term impacts on the watercourse. More details can be found in Appendix A39.2 (Fluvial Geomorphology).</p>

Water Quality

- 39.4.42 In addition to sedimentation impacts on water quality identified in Table 39.6, construction activities may also impact on water quality through accidental spillages or disturbance of contaminated land. Table 39.7 below illustrates 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 the water quality of a watercourse. However, impacts may have a longer term indirect effect on aquatic ecology (see Chapter 40: Ecology and Nature Conservation).

Table 39.7 – Potential Water Quality Impacts During Construction

Activities	Potential Impacts
Oils, Fuels and Chemicals 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.
Concrete, Cement and Admixtures 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 or watercourse or groundwater. Potential for adverse effects on aquatic organisms if pH elevated to/ maintained above 8.5.
Sewerage Accidental/uncontrolled release of sewage from sewers through damage to pipelines during service diversion.	Pollution to watercourses/groundwater: refer to Chapter 38 (Geology, Contaminated Land and Groundwater).
Contaminated Land and Sediment 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 38: Geology, Contaminated Land and Groundwater).

Specific Impacts

39.4.43 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

39.4.44 No outfalls are proposed for Limpet Burn, Coneyhatch Burn, Green Ditch, Allochie Burn, Burn of Blackbutts, Cookney or Stoneyhill ditches, Balnagubs Burn, Whiteside, Crossley, Cairns, Circle, Square, Wedderhill or Craigentath Burns. However, road drainage would outfall to:

- Megray Burn;
- Green Burn;
- Burn of Muchalls;
- Tributary of the Burn of Elswick; and
- Burnhead Burn.

39.4.45 Burnhead Burn would receive road drainage from both the Southern Leg and Fastlink sections of the proposed scheme. The assessment of potential impacts for Burnhead Burn is reported with the Southern Leg information in Chapter 24 (Water Environment).

Watercourse Crossings

39.4.46 Bridges, in the form of buried bridge structures, are proposed at the crossing over Limpet Burn and the Burn of Muchalls, due to the size of these watercourses and their environmental sensitivity and, in the case of Limpet Burn, its associated gorge feature. Both structures are designed to span the watercourse with no in channel supports. A riparian zone of approximately 5.5m will be maintained through the structure for Limpet Burn and approximately 8m for the Burn of Muchalls. All crossings are shown on Figures 39.3a-39.3f.

39.4.47 At all other locations, a culvert is proposed to convey the watercourse under the proposed scheme. A total of eleven culverts would be required:

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- one culvert at Megray Burn (plus an extension to an existing culvert), Stoneyhill Ditch, Balnagubs Burn, Tributary of the Burn of Elsick, Whiteside Burn, Crossley Burn, Craigentath Burn; and
- two culverts on Green Burn and Cookney Ditch.

Watercourse Realignments

39.4.48 The following watercourse realignments would be required:

- Megray Burn (one extensive realignment of 951m, resulting in 49m extension to the watercourse);
- Limpet Burn (one realignment of 123m, resulting in a shortening of 1m);
- Green Burn (one realignment of 342m, resulting in a 8m shortening of the channel);
- Green Ditch (one realignment of 36m, resulting in a shortening of 59m);
- Cookney Ditch (one realignment of 244m, overall length maintained);
- Stoneyhill Ditch (one realignment of 203m, overall length maintained);
- Balnagubs Burn (one realignment of 117m, overall length maintained);
- Tributary of the Burn of Elsick (one realignment of 150m, overall length maintained);
- Whiteside Burn (one realignment of 121m, overall length maintained);
- Crossley Burn (one realignment of 161m, overall length maintained) plus realignment of Cairns Burn (one realignment of 192m, overall shortening of 40m);
- Craigentath Burn (one realignment of 216m, overall length maintained); and
- Burnhead Burn (one realignment of 118m, overall length maintained).

39.4.49 Limpet Burn would be extensively realigned as a result of the required crossing and the proposed structure while Megray Burn would be extensively realigned as a result of the proposed alignment through that section of the scheme. The remaining watercourses would require realignment to allow the installation of a depressed invert culvert.

Network Culverts

39.4.50 One network culvert would be required for the Fastlink section of the scheme near Fishermyre Wetland at ch2540.

Pre-Earthworks Drainage and Catchment Severance

39.4.51 As noted in the general discussion of potential impacts, certain minor watercourses and drainage ditches would not be culverted as a result of the scheme. These watercourses would instead be re-directed into pre-earthworks ditches and the road drainage system. This is proposed for a limited number of small ephemeral ditches and for the following named burns and ditches:

- Coneyhatch Burn;
- Allochie Burn;
- Burn of Blackbutts;
- Circle Burn; and
- Square Burn.

39.4.52 The catchment of Wedderhill Burn would be severed by the proposed scheme. The catchment on the upstream side of the road would be collected by pre-earthwork drainage ditches and transferred into the Burnhead Burn catchment through the road drainage system. On the

downstream side of the road, part of Wedderhill Burn would be lost as the source of water from its upper catchment would be re-directed.

Impact Assessment

- 39.4.53 An overall sensitivity of the watercourse was assigned in the baseline section of this chapter. This section reports the separate 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 Section 39.2 and adopts a precautionary approach. Consequently, the overall impact magnitude is assigned based on the highest impact predicted by each of the technical disciplines. This overall impact is then combined with the overall sensitivity of the watercourse to provide an impact significance for each watercourse. Indirect impacts on ecology are presented in Chapter 40 (Ecology and Nature Conservation). Where potential impacts on groundwater are considered to be of Moderate significance or above, it is summarised in this assessment under the groundwater section. Further information is detailed in Chapter 38 (Geology, Contaminated Land and Groundwater).
- 39.4.54 The potential impacts for the operation and construction phases are summarised in Table 39.8 and detailed in the relevant technical appendices of this chapter.

Operational Impacts

Megray Burn (ch600)

- 39.4.55 Potential hydrological impacts to the burn may result from the installation of a culvert, the associated realignment and receiving road drainage. Culverts would be designed to accommodate the required flood flows, therefore it is considered to have the potential for negligible impact on the watercourse. The proposed realignment may result in a low impact on the discharge regime and the operation of the drainage outfall may potentially cause an increase in flows. The catchment area of the outfall includes the burn's existing catchment, the road and would take additional runoff from Limpet Burn catchment due to the position of the AWPR and the drainage scheme. This is anticipated to result in a medium magnitude of impact on the hydrological regime of the watercourse.
- 39.4.56 The potential for increased discharge, associated changes to the hydrological regime and design of the proposed outfall structure are predicted to result in a medium impact magnitude on the geomorphology and sediment regime of the burn. The potential impact of the realignment is anticipated to result in a medium impact magnitude on geomorphological processes. As the burn is already heavily modified at its downstream end, the proposed culvert results in a low impact magnitude on the watercourse.
- 39.4.57 Megray Burn would receive discharge via an outfall draining approximately 4ha of the AWPR, which has the potential for a major shift from baseline conditions and long-term adverse impact on the water quality of the burn. The discharge of runoff to the burn may result in the potential failure of EQS, which would be classed as a high impact magnitude on water quality. An increase in accidental spillage risk in combination with the high potential for an increase in suspended solids reaching the watercourse leads to an assessment of medium impact magnitude.
- 39.4.58 Overall, the magnitude of impact is considered to be high with the significance of impact being assessed as Moderate/Substantial. This is driven by the potential impacts on water quality.

Limpet Burn (ch1500)

- 39.4.59 The proposed realignment would likely result in a slight increase in channel gradient. Any decrease in bank height may increase localised flood risk. When considered in combination with the proposed bridge crossing, potential impacts on hydrology are considered to be of low magnitude.

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- 39.4.60 The realignment and potential changes to the discharge regime may lead to the release of suspended solids into the watercourse and a change to sedimentation patterns, which may be transported downstream to the fishing ponds (considered a sensitive receptor). The magnitude of impacts on the geomorphology of this watercourse is considered to be high.
- 39.4.61 The potential risk to water quality is likely to be minor as this burn would not be a receiving watercourse for road drainage. Consequently, the magnitude of impact from the proposed road would be negligible.
- 39.4.62 Overall, the magnitude of impact is considered to be high with the significance of impact being assessed as Substantial. This is driven by the potential changes to the geomorphology of the watercourse.

Network Culvert: Fishermyre (ch2540)

- 39.4.63 At ch2540, road drainage would be passed from one side of the road to the other via a network culvert 78m long and 0.9m in diameter. This culvert would only service the road drainage network and therefore it has not been considered as part of the geomorphological and water quality assessments. However, the network culvert has implications for the hydrological assessment as its presence at that location introduces a potential flood risk should the culvert become blocked. The impacts of this are considered to be of low magnitude as any properties located in the vicinity are at a significantly higher elevation and would not be at risk of being flooded by the culvert.

Coneyhatch Burn (ch2600)

- 39.4.64 The flow from this burn would be incorporated into pre-earthworks drainage and a section of the burn would no longer exist during operation of the proposed scheme. Therefore, the assessment of potential impacts on the water quality and geomorphology of the watercourse has been scoped out. The potential for hydrological impacts is considered to be negligible. Part of the total catchment of Limpet Burn would be lost causing a slight reduction in flows to that catchment. The diverted catchment area flows would drain to the proposed Megray Burn road outfall.
- 39.4.65 Overall, the magnitude of impact is considered as negligible, with the significance of impact on the water environment at Coneyhatch Burn being assessed as Negligible.

Green Burn (ch3100)

- 39.4.66 The catchment area of the outfall would include the burn's existing catchment, the road and additional flow from a severed area of the Limpet Burn catchment, due to the position of the AWPR and the drainage system. This amounts to an increase in the catchment draining to the point of the road outfall. This is considered to result in an impact of medium magnitude on the watercourse.
- 39.4.67 The change to discharge regime as a result of the road drainage outfall is considered to have the high magnitude of impact to the sediment regime and potential for localised scour. Similarly, the construction of two culverts and their associated realignments may result in impacts on sediment transfer downstream.
- 39.4.68 The proposed outfall of approximately 2ha of road drainage would result in the potential for a major shift from baseline conditions and a long term adverse impact on the water quality of the burn. The outfall of road runoff would potentially result in the failure of EQS, which is classed as a high magnitude of impact on the water quality. An increase in accidental spillage risk may occur which would result in a low magnitude of impact, in combination with the medium potential for an increase in suspended solid outfall to the watercourse.
- 39.4.69 Overall, the magnitude of impact is considered to be high, with the significance of impact on Green Burn being assessed as Moderate/Substantial. This is driven by potential impacts on water quality and geomorphology.

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Green Ditch (ch3150)

- 39.4.70 This watercourse would be subject to a significant realignment, resulting in a shortening of approximately 59m. The potential for hydrological and water quality impacts is considered to be negligible, while the potential impact upon geomorphology is considered to be of low magnitude. The significant shortening of this burn may result in changes to the sinuosity and morphology of the burn along this section.
- 39.4.71 Overall, the magnitude of impact is considered to be low, with the significance of impact on Green Ditch being assessed as Negligible. This is due to the low sensitivity of the watercourse and the low magnitude of potential impacts on its geomorphology.

Fishermyre Wetland (ch3100)

- 39.4.72 The road alignment would act as a form of barrier to surface water runoff through the eastern section of the wetland. Approximately 6% of the wetland area would be cut-off from the rest of the wetland. This is considered to pose a high magnitude and a Substantial significance of impact at this location. Water quality in the vicinity of Fishermyre Wetland has been evaluated as being of high sensitivity. In the event of accidental spillages from the road, the magnitude of impact would be high.
- 39.4.73 Overall, the potential impacts on Fishermyre Wetland have been assessed Substantial impact significance, without the implementation of appropriate mitigation.

Allochie Burn (ch4000)

- 39.4.74 The flow from this burn would be incorporated into pre-earthworks drainage and consequently the burn would no longer exist during operation of the proposed scheme. Therefore, the assessment of potential impacts on the water quality and geomorphology of the watercourse has been scoped out. The potential for hydrological impact is considered to be negligible as this catchment would continue to drain to the Burn of Muchalls via the road drainage outfall.
- 39.4.75 Overall, the magnitude of impact is considered to be negligible, with the significance of impacts on the water environment at Allochie Burn being assessed as Negligible.

Burn of Muchalls (ch4700)

- 39.4.76 There is likely to be an increase in the catchment size at the point of the road crossing due to the position of the road, the outfall of the road drainage and the location in which it would outfall. There would be approximately 6.5ha of hard standing draining to this outfall, which is considered to present a low magnitude of impact to the hydrology of the watercourse.
- 39.4.77 The potential for impact on the geomorphology of the Burn of Muchalls is considered to be of high magnitude. This is a result of the proposed drainage outfall, which may increase discharge, suspended solid release and localised scour around the structure resulting in a change to the sediment regime.
- 39.4.78 The proposals for this burn represent a potential risk of deterioration of baseline water quality conditions as a result of receiving road runoff. However, routine runoff, risk of accidental spillage and the release of suspended solids are considered to present a low magnitude of impact on the watercourse as the watercourse provides a reasonable level of dilution.
- 39.4.79 Overall, the magnitude of impact is considered to be high, with the significance of impact on the water environment of the Burn of Muchalls being assessed as Substantial due to the potential impacts to geomorphology.

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Burn of Blackbutts (ch5600)

39.4.80 The flow from this burn would be incorporated into pre-earthworks drainage and consequently the burn would no longer exist during operation of the proposed scheme. Therefore, the assessment of potential impacts on the water quality and geomorphology of the watercourse have been scoped out. The changes to drainage would result in flow being added to the Burn of Muchalls further upstream from the proposed AWPR outfall instead of at the confluence. This may potentially result in a decrease to the hydrological response time of the Burn of Muchalls. The impact magnitude is anticipated to be Low.

39.4.81 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment at Burn of Blackbutts being assessed as Negligible.

Cookney Ditch (ch6500)

39.4.82 The installation of two culverts on this watercourse would also require realignment of the sections of the watercourse. Potential hydrological impacts on this watercourse, including flood risk are considered to be of low magnitude. Similarly, potential impacts upon sediment transfer, geomorphology and associated water quality are considered to be of low magnitude.

39.4.83 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment at Cookney Ditch being assessed as Negligible.

Stoneyhill Ditch (ch6900)

39.4.84 One culvert and an associated realignment would be required for this watercourse. Potential hydrological impacts on this watercourse, including increased localised flood risk, are considered to be of low magnitude. Similarly, potential impacts on sediment transfer and geomorphology are considered to be of low magnitude. Associated impacts on water quality as a result of lack of light or turbidity increases are considered to be of negligible magnitude.

39.4.85 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment at Stoneyhill Ditch being assessed as Negligible.

Balnagubs Burn (ch7550)

39.4.86 The proposed culvert and associated realignment is anticipated to result in low magnitude of impact on the hydrology of the watercourse. Due to its modified and straightened nature, the impact of culverting and realigning the burn is likely to be of low magnitude on the geomorphology of the burn. As no outfall is proposed to discharge to this watercourse, potential magnitude of impacts on water quality from road runoff, accidental spillage and suspended solids are considered to be negligible.

39.4.87 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment of Balnagubs Burn being assessed as Negligible.

Tributary of the Burn of Elsick (ch7950)

39.4.88 The potential for increased flows as a result of the proposed drainage outfall is considered to represent a medium impact magnitude on the watercourse. There is likely to be an increase in the catchment size at the point of the outfall due to the position of the road, the road drainage itself and the direction of the road drainage.

39.4.89 The increase of flows, the construction of a culvert, associated realignment and proposed outfall structure is anticipated to result in a medium magnitude of impact on the geomorphology of the watercourse in the long term. The potential for impact is considered to be medium as the burn is already heavily modified and any changes are unlikely to be of overall significance.

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39.4.90 A major shift from baseline water quality conditions as a result of the proposed discharge of road drainage is likely to result in the failure of EQS for copper and zinc downstream of the outfall. In combination with the increased risk of accidental spillage and suspended solids, a high magnitude of impact is predicted for this burn.

39.4.91 Overall, the magnitude of impact is considered to be high, with the significance of impact on the water environment of this watercourse being assessed as Moderate/Substantial. This is primarily driven by the proposed drainage outfall and its potential impacts on hydrology and water quality.

Whiteside Burn (ch8850)

39.4.92 The proposed culvert and associated realignment is anticipated to have a low impact on the hydrology of the watercourse. Due to its modified and straightened nature, the impact of culverting and realigning the burn is likely to be of low magnitude on the geomorphology of the burn. As it is not proposed to discharge to this watercourse, potential impacts on water quality from road runoff, accidental spillage and suspended solids is also considered to be of negligible magnitude.

39.4.93 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment of Whiteside Burn being assessed as Slight.

Crossley Burn (ch9150) and Cairns Burn (ch9200)

39.4.94 It is proposed to realign Cairns Burn and then culvert Crossley Burn underneath the AWPR mainline. These activities are considered to present a low magnitude of impact on the hydrology of these watercourses. As the burns are already modified, the introduction of a culvert is considered to be a low magnitude impact to the geomorphology of the watercourses. A realignment of this type of straightened watercourse may provide an opportunity to improve its morphology. However, without mitigation, the works are considered to pose a low impact on the established morphological regime of the current watercourse. No road drainage is proposed to outfall into these watercourses and an impact of negligible magnitude is anticipated on water quality.

39.4.95 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment of the watercourses being assessed as Negligible.

Circle Burn (ch9950) and Square Burn (ch10150)

39.4.96 It is proposed that the flow from these burns would be taken into pre-earthworks drainage; consequently the burns would no longer exist during operation of the scheme. Therefore, the assessment of potential impacts on the water quality and geomorphology of these watercourses has been scoped out. The magnitude of hydrological impact is considered to be negligible as this catchment would continue to drain to Crynoch Burn, but would do so via Burnhead Burn instead of discharging directly from Stranog Burn or Greens of Crynoch.

39.4.97 Overall, the magnitude of impact is considered to be negligible, with the significance of impact on the water environment of the watercourses being assessed as Negligible.

Wedderhill Burn (ch10400)

39.4.98 The catchment of this burn would be severed upstream of the road and incorporated into pre-earthworks drainage. Consequently, a section of the burn downstream would no longer exist during operation of the scheme. Therefore, the assessment of potential impacts on the water quality and geomorphology of the watercourse has been scoped out. The magnitude of hydrological impact is considered to be medium. Alterations as a result of the drainage system would result in this area of the catchment to discharge to Burnhead Burn instead of directly to Crynoch Burn.

39.4.99 Overall, the magnitude of impact is considered to be medium, with the significance of impact on the water environment of Wedderhill Burn being assessed as Slight.

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Craigentath Burn (ch10600)

- 39.4.100 The proposed culvert and associated realignment is considered to have low magnitude of impact on the hydrology of the watercourse. Due to its modified and straightened nature, the potential impact of culverting and realigning the burn is likely to be of low magnitude on geomorphology. As Craigentath Burn is a tributary of Crynoch Burn, an increase in the concentrations of suspended solids may have adverse consequences for on Crynoch Burn, which is part of a SAC. However as stated previously, the watercourse may be connected to the Crynoch Burn by means of groundwater flow or by underground field drainage (pipes) as the geomorphological field survey concluded that there was no direct surface connection to Crynoch Burn likely to allow sediment transfer. Any potential impacts on sediment in Craigentath Burn are not considered to pose a risk to Crynoch Burn.
- 39.4.101 As no road discharge is proposed to outfall to this watercourse, the magnitude of impact on water quality from road runoff, accidental spillage and suspended solids is considered to be negligible.
- 39.4.102 Overall, the magnitude of impact is considered to be low, with the significance of impact on the water environment of the Craigentath Burn being assessed as Negligible.

Burnhead Burn (ch200100)

- 39.4.103 The proposed scheme would require a culvert with associated realignment and discharge of road drainage into Burnhead Burn. As mentioned previously, the assessment of this watercourse is included in the Southern Leg reporting in Chapter 24 (Water Environment).

Catchment Impacts (Operational)

- 39.4.104 In addition to assessing the potential impacts of the construction of the proposed scheme on individual water features, consideration must be given to the potential for combined effects on a catchment scale. The catchments of the Burn of Muchalls, the Burn of Elsick and Crynoch Burn have tributaries that would be affected by the scheme.

Burn of Muchalls

- 39.4.105 The confluence of the Burn of Blackbutts with the Burn of Muchalls is situated at the Bridge of Muchalls, which is approximately 2km downstream of where the scheme would cross these watercourses. Additionally, Green Burn joins the Burn of Muchalls approximately 800m downstream of the proposed crossing. Potential catchment impacts on the Burn of Muchalls may result from the combination of direct impacts on these watercourses. As these impacts are considered to be of high, high and low magnitude respectively, when combined they lead to a prediction of high magnitude as the subcatchment is relatively small. This is driven largely by the potential impacts on the Burn of Muchalls and leads to an assessment of the significance of impact as being Substantial over the long term.

Burn of Elsick

- 39.4.106 Balnagubs Burn, Tributary of the Burn of Elsick, Whiteside Burn, Crossley Burn and Cairns Burn are located in the upper catchment of the Burn of Elsick. Individually, the majority of these burns have been assessed as being potentially affected on a low to negligible magnitude, with the exception of the Tributary of Elsick. The potential contribution of dilution available from the sub-catchments results in the overall impact to the water environment being of medium magnitude. Therefore, the significance of impact to the Burn of Elsick is assessed as being Moderate over the long term.

Crynoch Burn

- 39.4.107 Potential catchment impacts on Crynoch Burn may result from direct impacts on Circle Burn, Square Burn, Craigentath Burn and Wedderhill Burn. These are relatively minor watercourses and contribute only a small area to the overall catchment of Crynoch Burn. As mentioned previously,

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Craigentath and Wedderhill Burns may be connected to Crynoch Burn by means of groundwater flow or by underground field drainage (pipes). The geomorphological field survey concluded that there was no direct surface connection to Crynoch Burn that would contribute to sediment transfer. Potential impacts on sediment concentrations to these burns are unlikely to affect Crynoch Burn.

- 39.4.108 In general, the impacts on each burn individually are considered to be of low to negligible magnitude and given their small contribution to the Crynoch Burn catchment they are considered to be of overall negligible magnitude of impact. These combined impacts are reported in Chapter 24 (Water Environment, Southern Leg), along with the assessment of potential impacts on Burnhead Burn.

Construction Impacts

Megray Burn (ch600)

- 39.4.109 The construction of a major realignment, culvert and drainage outfall is considered to present a medium impact magnitude on the hydrology of the watercourse. These activities are likely to result in a high magnitude of impact on geomorphology, as the extent of vegetation clearance required is likely to pose a high risk of suspended solid release.
- 39.4.110 There is a major potential for accidental spillage and consequently pollution of the watercourse during construction as a result of the extent of proposed activities. The magnitude of impact is considered to be high.
- 39.4.111 Overall, the magnitude of construction impacts is considered to be high over the short-term, with the significance of construction impacts on Megray Burn being assessed as Moderate/Substantial. This is driven largely by the potential impact to water quality and geomorphology.

Limpet Burn (ch1500)

- 39.4.112 The construction of a buried structure and associated realignment of the channel is likely to result in a medium magnitude of impact to the surface water hydrology of the watercourse. These activities represent a high potential risk for suspended solid release into the channel, due to the extensive requirement for vegetation clearance. Therefore, the magnitude of impact to geomorphology is considered to be high.
- 39.4.113 The extent of proposed activities on Limpet Burn are likely to result in a medium impact magnitude on water quality, particularly given the limited dilution potential and stocked fishing ponds downstream.
- 39.4.114 Overall, the magnitude of construction impacts are considered to be high, with the significance of construction impacts to the water environment of the burn and its dependent habitats downstream being assessed as Substantial.

Coneyhatch Burn (ch2600)

- 39.4.115 As this burn would be taken into pre-earthworks drainage, the potential impact to hydrology is considered to be of low magnitude. This would have a low magnitude of impact on the geomorphology of the burn given the potential for suspended solid release. The amount of in-channel works is likely to result in a high magnitude of impact on the water quality in the short term.
- 39.4.116 Overall the magnitude of construction impacts is considered to be high, with the significance of construction impacts being assessed as Moderate. This is driven by the potential for the proposed activities to pollute the watercourse.

Green Burn (ch3100)

- 39.4.117 Hydrology impacts during construction are anticipated to be of medium magnitude, while those on geomorphology are classed to be of high magnitude. The extent of works near the channel and

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requirement for vegetation clearance increases the magnitude of impact as there is a high risk of suspended solids reaching the channel, smothering habitats and adversely affecting morphological diversity

39.4.118 The proposed outfall, realignment and the construction of two culverts would involve extensive works in and around the channel of Green Burn. The magnitude of impact on water quality is likely to be medium.

39.4.119 Overall, the magnitude of construction impacts is considered to be high over the short-term, with the significance of construction impacts on Green Burn being assessed as Moderate/Substantial. This is driven largely by the potential changes to geomorphology.

Green Ditch (ch3150)

39.4.120 The potential impacts of realigning this watercourse on its hydrology would be of medium magnitude. The works would have a low magnitude of impact on the geomorphology of the burn given the potential for suspended solid release. Similarly, the amount of in-channel works is likely to result in a high magnitude of impact on the water quality in the short term.

39.4.121 Overall, the magnitude of construction impacts is considered to be high, with the significance of construction impacts being assessed as Moderate. This is driven by the potential for the proposed activities to pollute the watercourse.

Fishermyre Wetland (ch3100).

39.4.122 Construction of the route through Fishermyre Wetland is likely to result in impacts on the hydrological and water quality regimes in the short term. The magnitude of construction impact is considered to be medium to hydrology, resulting in a Moderate/Substantial significance of impact.

39.4.123 Groundwater and surface water quality in the vicinity of Fishermyre Wetland is of high sensitivity and the magnitude of impact is, in the eventuality of accidental spillages events, considered to be high. This results in a prediction of Substantial impact significance, without the application of appropriate mitigation.

Allochie Burn (ch4000)

39.4.124 As this burn would be taken into pre-earthworks drainage, the potential impact on hydrology is considered to be of low magnitude. This would have a low magnitude of impact on the geomorphology of the burn given the potential for suspended solid release. Similarly, the amount of in-channel works is likely to result in a high magnitude of impact on the water quality in the short term.

39.4.125 Overall, the magnitude of construction impacts is considered to be high, with the significance of construction impacts on Allochie Burn being assessed as Moderate/Substantial. This is driven largely by the potential for pollution of the watercourse during construction.

Burn of Muchalls (ch4700)

39.4.126 Impacts from the construction of a buried structure have been assessed as being of medium magnitude for surface water hydrology and low magnitude for water quality. However, the proposed works represent a high potential risk of suspended solid release into the channel via runoff from the construction site to the extensive requirement for vegetation clearance. Therefore, the magnitude of impact to geomorphology is considered to be high.

39.4.127 Overall, the impact to the water environment in the short-term is considered to be of high magnitude, which results in the significance of impact being Substantial.

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Burn of Blackbutts (ch5600)

- 39.4.128 As this burn would be taken into pre-earthworks drainage, the potential impact to hydrology is considered to be of low magnitude. This would have a low magnitude of impact on the geomorphology of the burn given the potential for suspended solid release. However, the amount of in-channel works is likely to result in a high magnitude of impact on the water quality in the short term.
- 39.4.129 Overall the magnitude of construction impacts is considered to be high, with the significance of construction impacts being assessed as Moderate. This is driven by the potential for the proposed activities to pollute the watercourse.

Cookney Ditch (ch6500)

- 39.4.130 The construction of two culverts and the associated realignment would have a medium magnitude impact on the hydrology of the watercourse. The activities are predicted to have a low magnitude of impact on the geomorphology of the watercourse given its heavily modified nature. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.131 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on Cookney Ditch being assessed as Slight. This is driven largely by the potential impacts on hydrology and water quality during construction

Stoneyhill Ditch (ch6900)

- 39.4.132 The construction of a culvert and associated realignment would have a medium magnitude impact on hydrology. Similarly, these activities are predicted to have a low magnitude of impact on geomorphology of the watercourse given its heavily modified nature. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.133 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on Stoneyhill Ditch being assessed as Slight. This is driven largely by the potential impacts on hydrology and water quality during construction

Balnagubs Burn (ch7550)

- 39.4.134 The construction of a culvert and associated realignment would have a medium magnitude impact on hydrology. Similarly, these activities are predicted to have a low magnitude of impact on the geomorphology of the watercourse given its heavily modified nature. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.135 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on Balnagubs Burn being assessed as Slight. This is driven largely by the potential impacts on hydrology and water quality during construction.

Tributary of the Burn of Elsick (ch7950)

- 39.4.136 The construction of a culvert, associated realignment and drainage outfall is likely to have a medium magnitude impact on hydrology in the short term. Similarly, these activities are predicted to have a low magnitude of impact on the geomorphology of the watercourse given its heavily modified nature. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.137 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on this watercourse being assessed as Moderate. This is driven largely by the potential impacts on hydrology and water quality during construction.

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Whiteside Burn (ch8850)

- 39.4.138 The construction of a culvert and associated realignment is likely to have a medium magnitude of impact to the hydrology of the watercourse in the short term. Similarly, these activities are predicted to have a low magnitude of impact on the geomorphology of the watercourse given its heavily modified nature. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.139 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on Whiteside Burn being assessed as Moderate. This is driven largely by the potential impacts on hydrology and water quality during construction.

Crossley Burn (ch9150) and Cairns Burn (ch9200)

- 39.4.140 The construction of a culvert, with associated realignment, on Crossley Burn and the realignment of Cairns Burn is likely to be of medium magnitude on hydrology in the short term. These activities are predicted to have a low magnitude of impact on the geomorphology of the watercourses given their heavily modified nature. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.141 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on these watercourses being assessed as Slight. This is driven largely by the potential impacts on hydrology and water quality during construction.

Circle Burn (ch9950)

- 39.4.142 This burn would be taken into pre-earthworks drainage, which is considered to be a low magnitude impact on hydrology. The proposed works would be of low magnitude impact on the geomorphology of the burn given the potential for suspended solid release. However, the amount of in-channel works is likely to result in a high magnitude of impact on water quality in the short term.
- 39.4.143 Overall the magnitude of construction impacts is considered to be high, with the significance of construction impacts being assessed as Moderate. This is driven by the potential for the proposed activities to pollute the watercourse.

Square Burn (ch10150)

- 39.4.144 As this burn would be taken into pre-earthworks drainage, the potential impact to hydrology is considered to be of low magnitude. This would have a low magnitude of impact on the geomorphology of the burn given the potential for suspended solid release. However, the amount of in-channel works is likely to result in a high magnitude of impact on the water quality in the short term.
- 39.4.145 Overall, the magnitude of construction impacts is considered to be high, with the significance of construction impacts being assessed as Moderate. This is driven by the potential for the proposed activities to pollute the watercourse.

Wedderhill Burn (ch10400)

- 39.4.146 The severance of the catchment by the road would have a low magnitude impact on hydrology and negligible magnitude on geomorphology. However, the in-channel works is likely to result in a high magnitude of impact on the water quality in the short term.
- 39.4.147 Overall, the magnitude of construction impacts is considered to be high with the significance of construction impacts being assessed as Moderate. This is driven by the potential for the proposed activities to pollute the watercourse.

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Craigentath Burn (ch10600)

- 39.4.148 The construction of a culvert and associated realignment is likely to have a medium magnitude of impact on the hydrology of the watercourse in the short term. Similarly, these activities are predicted to have a low magnitude of impact to the geomorphology of the watercourse given its heavily modified nature and lack of sediment transfer connection with Crynoch Burn. The extent of works in, and in the vicinity of, the channel poses a medium magnitude of impact on water quality.
- 39.4.149 Overall, the magnitude of construction impacts is considered to be medium, with the significance of construction impacts on Craigentath Burn being assessed as Slight. This is driven largely by the potential impacts on hydrology and water quality during construction.

Burnhead Burn (ch200100)

- 39.4.150 This burn would be realigned and culverted under the proposed scheme and would also receive road drainage via an outfall. However, as mentioned previously, the assessment of this watercourse is considered in the Southern Leg reporting in Chapter 24 (Water Environment).

Catchment Impacts (Construction)

- 39.4.151 In addition to assessing the potential impacts of the construction of the proposed scheme on individual water features, consideration must be given to the potential for combined effects on a catchment scale. The catchments of the Burn of Muchalls, the Burn of Elsick and Crynoch Burn have tributaries that would be affected by the scheme. Potential construction impacts on the individual tributaries may, when considered in combination, lead to an overall increase in impacts on the water environment of a catchment as a whole.

Burn of Muchalls

- 39.4.152 The confluence of the Burn of Blackbutts with the Burn of Muchalls is situated at the Bridge of Muchalls, which is approximately 2km downstream of where the scheme would cross these watercourses. Additionally, Green Burn joins the Burn of Muchalls approximately 800m downstream of the proposed crossing. The potential impacts from a combination of water quality (effect of dilution) and flow (potential change to hydrological response of the Burn of Muchalls) are considered to be of medium impact. This results in an assessment of significance of impact being Moderate/Substantial over the short term.

Burn of Elsick

- 39.4.153 As mentioned previously, Balnagubs Burn, Tributary of the Burn of Elsick, Whiteside Burn, Crossley Burn and Cairns Burn are located within the upper catchment of the Burn of Elsick. Individually, these burns would likely experience a medium magnitude of impact over the short term. Despite the potential dilution available from the sub catchments to the overall catchment of the Burn of Elsick, potential for combined impact on the water environment during construction is considered to be of medium magnitude, leading to the assessment of significance of impact as Moderate.

Crynoch Burn

- 39.4.154 Potential impacts on Crynoch Burn may arise from the combined effect of direct impacts on Circle Burn, Square Burn, Craigentath Burn and Wedderhill Burn. These minor watercourses contribute only a small area to overall catchment of Crynoch Burn. Additionally, as it is thought that some of these burns are connected to Crynoch Burn through pipes or underground connections, they are not thought to contribute to the sediment regime in the larger catchment.
- 39.4.155 The assessment of potential impacts for Crynoch Burn is reported in the Chapter 24 (Water Environment), along with the potential impacts on Burnhead Burn.

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Groundwater

- 39.4.156 The sensitivity of groundwater to construction activities is discussed in relation to the presence of private groundwater supplies and/or an ecological receptor that is supported by groundwater and their proximity to the proposed scheme. Only impacts of moderate significance or greater are reported here. Refer to Chapter 38 (Geology, Contaminated Land and Groundwater) for more information.

Limpet Burn (Operation)

- 39.4.157 From a groundwater perspective, the springs observed along Limpet Burn (evaluated as being of medium sensitivity) are thought to contribute significantly to its flow. It is likely that the springs originate from groundwater flowing from Kempstone Hill towards the southwest. Although Limpet Burn's springs are not located near any proposed road cuttings, the Megray Wood cutting is likely to intercept groundwater, which may disturb the local groundwater pattern and affect spring flow.
- 39.4.158 The magnitude of impact on groundwater is considered to be medium with the significance of impact on groundwater being assessed as Moderate.

Fishermyre Wetland

- 39.4.159 Fishermyre is a site of ecological importance that is dependant on groundwater and has been assessed as highly sensitive. There is potential for the road to act as a barrier to surface water flow across part of the site. The magnitude of impact on the water balance is considered to be low to medium and the overall impact assessed as Moderate to Substantial significance.
- 39.4.160 Groundwater quality in the vicinity of Fishermyre Wetland has been evaluated as being of high sensitivity. In the event of accidental spillages, the magnitude of impact would be high. Overall, this results in a significance of impact being assessed as Substantial, without appropriate mitigation.

Impact on Groundwater Quality during Road Construction

- 39.4.161 In the event of accidental road spillage, contamination may either migrate through the unsaturated zone or discharge directly into groundwater via cuttings. Contamination of groundwater could result in the deterioration of local groundwater quality. The magnitude of impacts on groundwater quality is determined as moderate in the presence of an embankment along the road or where there would be no topographical changes as a result of the proposed scheme. The magnitude of impact is determined as high in areas where cuttings would be present along a section of the road.
- 39.4.162 As a result, without the implementation of appropriate mitigation, Moderate to Substantial significance of impact levels have been predicted at several localised areas. These areas include East Lodge, Hillocks, Burn of Muchalls, C12k Overbridge, Cookney, Burnside of Newhall cutting, Rothnick, Stranog and Greens of Crynoch.
- 39.4.163 The impact of cuttings is detailed in Chapter 38. Impacts of Moderate/Substantial significance have been identified at C12K overbridge, Cookney and Stranog Hill.

Groundwater Flow and Potential Contaminated Land

- 39.4.164 The disturbance of groundwater flow caused by road cuttings may overlay with areas of potentially contaminated land. This may result in contamination reaching groundwater receptors such as private water supplies, but also represent risk to human receptors (workers operating during the construction phase).
- 39.4.165 A private water supply well located in the immediate vicinity of the Cookney cutting (ch6000 to ch6400) is assessed as having Moderate/Substantial impact significance due to the potential of contaminant migration via groundwater.

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Table 39.8 – Summary of Potential Impacts

Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Megray Burn	Medium	1 Culvert ch0 (92m) Extension of 1 existing culvert ch0	Realigned length 951m (overall lengthening of 49m)	1 proposed outfall (draining approx. 4ha)	<p>Construction</p> <p>Culverting, outfall construction and extensive realignment of existing straightened channel would involve extensive earthworks, resulting in sediment release and short-term change to morphological diversity. Risk of accidental spillage of pollutants during construction of culvert, realignment and outfall.</p> <p>Hydrology: Medium Geomorphology and Water Quality: High</p>	High	Moderate/ Substantial
					<p>Operation</p> <p>Decrease to morphological diversity due to installation of culvert, outfall and realignment of channel. Length of culvert likely to affect water quality due to lack of light. Potential change to discharge regime due to road runoff outfall and channel realignment. Road runoff discharge to the burn may result in siltation and the requirement for dredging. Decreased water quality 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: Medium Water Quality: High</p>	High	Moderate/ Substantial
Limpet Burn	High	1 Bridge (buried structure)	Realigned length 123m (overall shortening of 1m)	No drainage outfall proposed	<p>Construction</p> <p>Construction of a buried structure and realignment of channel would involve major earthworks and vegetation clearance, which is likely to result in sediment release and loss of morphological diversity. Potential risk of accidental pollutant spillage during construction due to proximity of works to the watercourse.</p> <p>Hydrology and Water Quality: Medium Geomorphology: High</p>	High	Substantial
					<p>Operation</p> <p>Potential decrease to morphological diversity as a result of realignment of watercourse. Extensive reduction to channel sinuosity due to realignment, potentially resulting in channel instability and excessive erosion/deposition. Minimal change to flow as a result of bridge. No outfall is proposed, therefore negligible potential impact from diffuse pollution. Length of buried structure may affect water quality through lack of light.</p> <p>Hydrology: Low Geomorphology: High Water Quality: Negligible</p>	High	Substantial

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Network Culvert: Fishermyre Ch 2540					Construction: n/a	n/a	n/a
					Operation: Potential for increased flood risk. Hydrology: Low Geomorphology and Water Quality: Scoped out of the assessment	Low	n/a
Coneyhatch Burn	Low	Watercourse would be taken into pre-earthwork drainage.	Construction Watercourses would be re-directed into pre-earthworks drainage and a section of the watercourses would be lost to the proposed scheme. Release of fine sediment or pollutants may occur as a result of construction activities. Hydrology and Geomorphology: Low Water Quality: High			High	Moderate
			Operation A section of the watercourse downstream would be lost to the proposed scheme. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of the assessment			Negligible	Negligible
Fishermyre Wetland	High	Barrier effect of the AWPR and changes associated with road drainage system would remove some existing surface water drainage across the wetland.	Construction Assessment considers potential impacts of the scheme construction on the hydrology of this wetland site. The magnitude of impact on ground and surface water quality is, in the eventuality of accidental spillages events, high. Hydrology: Medium Geomorphology: Scoped out of assessment Water Quality: High			High	Substantial
			Operation The proposed scheme would sever the feature and act as a barrier to the supply of surface water runoff to approximately 6% of the wetland. Groundwater quality in the vicinity of Fishermyre Wetland is of high sensitivity and the magnitude of impact is, in the eventuality of accidental spillages events, high. Hydrology and Water Quality: High Geomorphology: Scoped out of assessment			High	Substantial

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Green Burn	Medium	2 Culverts ch3125 (84m) and side road (19m)	Realigned length 342m (overall shortening of 8m)	1 proposed outfall (draining approx 2ha)	<p>Construction</p> <p>Extensive culverting, construction of outfall and realignment of the channel would require earthworks that would result in sediment release and straightening of the channel. This would lead to a loss of morphological diversity and a short-term increase in suspended solid loads. A potential risk of accidental spillage of pollutants during construction exists due to the extent of works in close proximity to the watercourse.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: High</p>	High	Moderate/ Substantial
					<p>Operation</p> <p>Decreased morphological diversity due to two long sections of culverts, two proposed realignments and outfall structure, which would straighten the channel, reducing sinuosity and decreasing morphological diversity. Change to discharge regime due to lengthening and realignment. Major potential for decreased water quality and a change to the discharge regime resulting from untreated road runoff carrying sediment load, soluble and insoluble pollution. Increased accidental spillage risk due to traffic volumes. Installation of culverts may affect water quality due to lack of light.</p> <p>Hydrology: Medium</p> <p>Geomorphology and Water Quality: High</p>	High	Moderate/ Substantial
Green Ditch	Low	No crossing proposed.	Realigned length 36m (overall shortening of 59m)	No outfall proposed	<p>Construction</p> <p>Watercourse would be realigned. Release of fine sediment or pollutants may occur as a result of construction activities.</p> <p>Hydrology: Medium</p> <p>Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate
					<p>Operation</p> <p>A section of the watercourse downstream would be significantly realigned resulting in a loss of sinuosity and morphological diversity.</p> <p>Hydrology and Water Quality: Negligible</p> <p>Geomorphology: Low</p>	Low	Negligible

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Allochie Burn	Medium	Watercourse would be taken into pre-earthwork drainage.			<p>Construction</p> <p>Watercourse would be re-directed into pre-earthworks drainage and a section would be lost to the proposed scheme. Release of fine sediment or pollutants may occur as a result of construction activities.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate/ Substantial
					<p>Operation</p> <p>A section of the watercourse downstream would be lost to the proposed scheme.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	Negligible
Burn of Muchalls	High	1 Bridge (buried structure)	No realignment proposed	1 proposed outfall (draining approx. 6.5ha)	<p>Construction</p> <p>Construction of a buried structure across the existing channel would require earthworks, which would likely result in sediment release and short-term change to morphological diversity. There is potential for the spillage of potential pollutants during construction.</p> <p>Hydrology: Medium</p> <p>Geomorphology: High</p> <p>Water Quality: Low</p>	High	Substantial
					<p>Operation</p> <p>Potential change to sediment regime as a result of installation of the buried structure and proposed outfall. Potential for changes to the discharge regime and decreased water quality from untreated road runoff exists due to increased sediment load, soluble and insoluble pollution reaching the watercourse. Increased accidental spillage risk due to traffic volumes.</p> <p>Hydrology and Water Quality: Low</p> <p>Geomorphology: High</p>	High	Substantial
Burn of Blackbutts	Low	Watercourse would be taken into pre-earthwork drainage.			<p>Construction</p> <p>Watercourses would be re-directed into pre-earthworks drainage and a section would be lost to the proposed scheme. Release of fine sediment or pollutants may occur as a result of construction activities.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate
					<p>Operation</p> <p>A section of the watercourse downstream would be lost to the proposed scheme.</p> <p>Hydrology: Low</p> <p>Geomorphology and Water Quality: Scoped out of the assessment</p>	Low	Negligible

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Cookney Ditch	Low	2 Culverts Ch6480 (42m) and side road (53m)	Realigned length 244m (overall length maintained)	No drainage outfall proposed	<p>Construction</p> <p>Construction of culverts and realignment would require earthworks and vegetation clearance which would likely result in suspended solid release into the channel, decreasing morphological diversity. Activities in and around the channel would have an impact on the current hydrological regime and may result in impacts on water quality as a result of accidental spillage.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Slight
					<p>Operation</p> <p>Impacts on the flow and sediment regime are expected due to the installation of the culverts. Likely changes to the sediment regime and morphology are anticipated to be low due to the straightened nature of the channel. Water quality may be affected by the lack of light through the culvert.</p> <p>Hydrology, Geomorphology and Water Quality: Low</p>	Low	Negligible
Stoneyhill Ditch	Low	1 Culvert Ch6930 (36m)	Realigned length 203m (overall length maintained)	No drainage outfall proposed	<p>Construction</p> <p>Construction of culvert and realignment would require earthworks and vegetation clearance which would likely result in suspended solid release into the channel, decreasing morphological diversity. Activities in and around the channel would have an impact on the current hydrological regime and may result in impacts on water quality as a result of accidental spillage.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Slight
					<p>Operation</p> <p>Impacts on the flow and sediment regime are expected due to the installation of the culvert. Likely changes to the sediment regime and morphology are anticipated to be low due to the straightened nature of the channel. Water quality may be affected by the lack of light through the culvert.</p> <p>Hydrology ad Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Negligible

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Balnagubs Burn	Low	1 Culvert ch7550 (48m)	Realigned length 117m (overall length maintained)	No drainage outfall proposed	<p>Construction</p> <p>Construction of culvert and realignment would require earthworks and vegetation clearance which would likely result in suspended solid release into the channel, decreasing morphological diversity. Activities in and around the channel would have an impact on the current hydrological regime and may result in impacts on water quality as a result of accidental spillage.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Slight
					<p>Operation</p> <p>Impacts on the flow and sediment regime are expected due to the installation of the culvert. Likely changes to the sediment regime and morphology are anticipated to be low due to the straightened nature of the channel. Water quality may be affected by the lack of light through the culvert.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Negligible
Tributary of the Burn of Elsick	Medium	1 Culvert ch7975 (53m)	Realigned length 150m (overall length maintained)	1 proposed outfall (draining approx 5.6ha)	<p>Construction</p> <p>Installation of culvert, outfall and realignment would involve major earthworks, resulting in sediment release, short/medium-term increases to sediment loading and changes to erosion and depositional patterns. Changes to the discharge regime would occur as a result of road runoff discharge and extensive realignment. Potential impact on water quality would likely result from accidental spillage.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Moderate
					<p>Operation</p> <p>Potential for long term decrease to morphological diversity as a result of installation of culvert, outfall and realignment of watercourse. Possible change to discharge regime due to lengthening and realignment of burn. Changes to the discharge regime and water quality anticipated from the outfall, resulting in untreated road runoff carrying sediment load, soluble and insoluble pollution. Increased risk from accidental spillage likely as a result of traffic volumes.</p> <p>Hydrology and Geomorphology: Medium</p> <p>Water Quality: High</p>	High	Moderate/ Substantial

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Whiteside Burn	Medium	1 Culvert ch8850 (62m)	Realigned length 121m (overall length maintained)	No drainage outfall proposed	<p>Construction</p> <p>Construction of culvert and realignment would require vegetation clearance and earthworks resulting in suspended solid release, decreasing morphological diversity and increasing turbidity over the short term. Activities in and around the channel may lead to a potential impact on the current hydrological regime and may result in impacts on water quality as a result of accidental spillage.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Moderate
					<p>Operation</p> <p>Impact to flow and sediment regime due to the installation of the culvert are anticipated. Potential for changes to the sediment regime and morphology are considered to be low due to the straightened nature of the channel. No drainage outfall is proposed therefore a low impact from potential diffuse pollution is anticipated. Water quality may also be affected due to lack of light through culvert.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Slight
Crossley Burn and Cairns Burn	Low	1 Culvert ch9170 (87m)	Realigned length through culvert 161m (overall length maintained) Cairns Burn realignment 192m (overall shortening of 40m)	No drainage outfall proposed	<p>Construction</p> <p>Installation of a culvert and realignment of Cairns and Crossley Burns would temporarily affect the discharge regimes by changing drainage patterns. Cairns Burn would be realigned while Crossley Burn would be culverted underneath the AWPR mainline. The extent of works in and around the channels would result in potential impacts on water quality.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Slight
					<p>Operation</p> <p>There would be a slight decrease in morphological diversity as a result of the channel realignment and culvert installation. No drainage outfall is proposed. Minimal impact on the water quality is anticipated over the long-term. Impacts on water quality may result from the lack of light through the length of culvert.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Negligible
Circle and Square Burn	Low	Watercourses would be taken into pre-earthwork drainage.			<p>Construction</p> <p>Watercourses would be re-directed into pre-earthworks drainage, therefore a section of the watercourses would be lost to the proposed scheme. Release of fine sediment or pollutants may occur as a result of construction activities.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: High</p>	High	Moderate

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
					<p>Operation</p> <p>A section of the watercourse downstream would be lost to the proposed scheme.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	Negligible
Wedderhill Burn	Low	Watercourse would be lost due to catchment severance.			<p>Construction</p> <p>Watercourses would be lost through catchment severance. Release of fine sediment or pollutants may occur as a result of construction activities.</p> <p>Hydrology: Low</p> <p>Geomorphology: Negligible</p> <p>Water Quality: High</p>	High	Moderate
					<p>Operation</p> <p>A section of the watercourse downstream would be lost to the proposed scheme.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of the assessment</p>	Negligible	Negligible
Craigenath Burn	Low	1 Culvert ch10630 (67m)	Realigned length 216m (overall length maintained)	No drainage outfall proposed	<p>Construction</p> <p>Construction of culvert and realignment would require earthworks and vegetation clearance resulting in the release of suspended solid release into the channel, decreasing morphological diversity and increasing turbidity over the short term. Activities in and around the channel may result in a potential impact on the current hydrological regime and impacts on water quality as a result of accidental spillage.</p> <p>Hydrology and Water Quality: Medium</p> <p>Geomorphology: Low</p>	Medium	Slight
					<p>Operation</p> <p>Impacts to the flow and sediment regime are expected due to the installation of a culvert. No drainage outfall is proposed therefore low impact due to diffuse pollution is anticipated. Water quality may also be affected due to lack of light through culvert.</p> <p>Hydrology and Geomorphology: Low</p> <p>Water Quality: Negligible</p>	Low	Negligible

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Water Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Potential Impacts Description (without mitigation)	Potential Impact	
						Overall Magnitude	Significance
Burnhead Burn	High	1 Culvert ch200100 (65m)	Realigned length 118m (overall length maintained)	1 proposed outfall (draining approx. 9ha)	<p>Construction</p> <p>Construction of culvert and realignment of the channel would require vegetation clearance and result in potential for suspended solid release into the channel, decreasing morphological diversity and increasing turbidity over the short term. There is high potential for suspended solids reaching the Crynoch Burn, which is part of a SAC. Activities in and around the channel may result in an impact on the current hydrological regime and potential impacts on water quality as a result of accidental spillage are anticipated.</p> <p>Hydrology, Geomorphology and Water Quality: Reported on in Chapter 24 (Water Environment, Southern Leg)</p>	Reported in Chapter 24 (Water Environment, Southern Leg)	
					<p>Operation</p> <p>Impacts on flow and sediment regime are expected from the installation of the culvert. Overall, impacts on geomorphology, as a result of culvert installation changing the sediment regime of this reasonable sized watercourse, are expected. Possible minor changes to the discharge regime due to realignment of burn are anticipated, as well as impacts from road drainage discharge. 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, Geomorphology and Water Quality: Reported on in Chapter 24 (Water Environment, Southern Leg)</p>	Reported in Chapter 24 (Water Environment, Southern Leg)	

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Summary

- 39.4.166 Table 39.8 identifies the overall magnitude and significance of potential impacts for each of the water features identified in Section 39.3. An overall magnitude and significance category has been assigned for each water feature based on the overall watercourse sensitivity assigned in the baseline section of this chapter.
- 39.4.167 In terms of the water environment, the following watercourse resulted in predictions of Substantial impact significance during operation and construction:
- Limpet Burn;
 - Fishermyre Wetland; and
 - Burn of Muchalls.
- 39.4.168 Megray Burn, Green Burn and the Tributary of the Burn of Elsick have been assessed as having potential for Moderate/Substantial impacts during operation of the proposed scheme. Green Burn, Megray Burn and Allochie Burn have predictions of Moderate/Substantial impacts during construction.
- 39.4.169 No water features are predicted to have Moderate impacts during the operational phase. It is anticipated that eight burns would be likely to experience Moderate impacts during the construction phase:
- Coneyhatch Burn;
 - Green Ditch;
 - Burn of Blackbutts;
 - Tributary of the Burn of Elsick;
 - Whiteside Burn;
 - Circle and Square Burns; and
 - Wedderhill Burn.
- 39.4.170 The assessment of Burnhead Burn is included in Chapter 24 (Water Environment). Potential impacts on all other burns are anticipated to be of Slight or Negligible impact significance for operation and construction.

39.5 Mitigation

Introduction

- 39.5.1 The objectives of the mitigation measures outlined in this section are to prevent, reduce or offset the predicted impacts described in Section 39.4.
- 39.5.2 Mitigation includes those measures to convey surface water runoff from the road to receiving water features 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.
- 39.5.3 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 further develop effective mitigation. Some areas where extensive realignments are proposed are subject to ongoing design development to further reduce impacts. Mitigation requirements detailed in this section will be undertaken as part of the scheme, however some areas will require further design developments to minimise impacts further. These requirements will continue to develop through the CAR application process and ongoing liaison with SEPA.

Guiding Principles

- 39.5.4 Mitigation is used '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' according to the EIA (Scotland) Regulations 1999. Mitigation measures are proposed as part of this assessment, where practicable, to address adverse impacts assessed as being of greater than Slight significance.
- 39.5.5 The requirements of the WFD have also been taken into account in the formulation of mitigation strategies. Mitigation measures for all water features aim to contribute to achieving and preserving the 'good' water quality and ecological status of any watercourse. SEPA requires any construction activities near watercourses or waterbodies to be undertaken in line with the requirements of the Water Environment (Controlled Activities) (Scotland) Regulations 2005 and road drainage outfalls (if draining more than 1km of carriageway) will require a licence for construction and operation of the proposed scheme. The requirements of EC Freshwater Fisheries and the Dangerous Substances Directives have also been taken into consideration when selecting the appropriate level treatment for road runoff.

Approach to Mitigation

- 39.5.6 Mitigation measures typically comprise solutions aimed at the source of the impact. The risk of causing deterioration to the status of a watercourse can be reduced by 'designing out' any risk. This approach was implemented during the selection of the preferred route and road alignment, for example by avoiding important/sensitive water features where possible.
- 39.5.7 In some situations, such as where there is a need for road runoff to be discharged to local watercourses and drainage ditches, potential adverse impacts cannot be prevented. In order to minimise these impacts, mitigation measures have been developed continually throughout the design process. 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 noted previously, the assessment has found that further design work is required at some sites in order to reduce potential impacts.

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39.5.8 Consultation with SEPA and SNH has been undertaken throughout the design stage to seek guidance on appropriate levels of road drainage, culverting and watercourse realignment. Relevant key stakeholders, such as local fisheries boards have also been contacted, where appropriate. Further information on the consultation process is provided in Chapter 6 (Scoping and Consultation).

39.5.9 The mitigation proposed to address potential impacts is summarised in Table 39.10.

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

39.5.10 Prior to construction, most activities associated with the scheme that would affect the water environment will require some form of license application under the CAR regulations. The application will require detailed information on:

- 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.

39.5.11 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

39.5.12 The drainage system for the proposed scheme has been designed in accordance with the SUDS Manual CIRIA C697 (Construction Industry Research and Information Association, 2007), Sustainable Urban Drainage Systems (SUDS): Design Manual for Scotland and Northern Ireland CIRIA C521 (Construction Industry Research and Information Association, 2000) and Sustainable Urban Drainage Systems: Hydraulic, Structural and Water Quality Advice CIRIA C609 (Construction Industry Research and Information Association, 2004).

39.5.13 Where a requirement for discharging road runoff via an outfall to a receiving water feature has been identified as necessary, 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 reduce the road runoff to pre-development rates as well as the polluting load carried within the runoff to acceptable levels.

39.5.14 Road drainage and pre-earthworks drainage will not increase flood event runoff into streams compared to the pre-development situation. An allowance for storage and attenuation before an outfall discharges to a water feature has been made in the proposed design. This can be achieved within the road ditches and pipes or in specially designed storage basins.

39.5.15 Road drainage and pre-earthworks drainage have been designed to minimise the transfer of water across catchments. Outfalls will be located to avoid the transfer of surface water from one catchment to another. An effective drainage system will avoid, where possible, storage/flooding of water on land next to the road on the upstream side of newly created embankments.

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

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Filter Drains and Catchpits

- 39.5.17 Filter drains usually consist of a perforated pipe laid in a trench backfilled with gravel, generally 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.
- 39.5.18 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.
- 39.5.19 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 greater than 90m) along filter drains and at the junctions of carrier drains.
- 39.5.20 The road and pre-earthworks drainage networks are to be designed to current standards contained in DMRB. The carriageway drainage is designed to carry the 50% AEP (1 in 2 year event) and is checked for surcharging at the 10% AEP. Above the 10% AEP (10 year event), the water is expected to spill into the pre-earthwork drainage ditches, which run alongside the road at the toe of embankments and at the top of cuttings. These ditches are designed to convey the 1.33% AEP (1 in 75 year return period event) and this includes all network culverts required to pass drainage under the proposed scheme. Above the 1.33% AEP, flood flow routes would be identified to ensure that flooding is directed either down the carriageway or down the overflowing ditches to the attenuation features (described below) before discharging into the receiving watercourses. Further proposed mitigation would include online attenuation features on pre-earthworks drainage features.

Detention Basins/Treatment Ponds

- 39.5.21 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. Attenuation basins are principally used to attenuate flows, while 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 unless otherwise agreed with SEPA.
- 39.5.22 The proposed detention basins would mitigate flows up to the 0.5% AEP (1 in 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 in 100 year event) back to pre-development runoff rates (Qmed Greenfield runoff rate). Then, to account for climate change (as detailed in paragraphs 39.2.28 to 39.2.30), the freeboard allowance on the basins is checked to ensure that the 0.5% AEP (1 in 200 year) can be held within the basin.
- 39.5.23 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. Studies have shown that a detention time beyond 24 hours does not result in a significant improvement in quality (CIRIA, 2004). In general, all treatment systems are designed to attenuate flows for between 39 and 192 hours (design dependent).

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- 39.5.24 The required storage volume to treat road drainage (the treatment volume) is calculated based on the guidance contained in the CIRIA SUDS Design Manual (CIRIA, 2000) and the design guidance given in Treatment of Highway Runoff 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 be designed for storage volume $4V_t$. Best design practice for pollutant removal, as detailed in CIRIA C609 (2004) and CIRIA C697 (2007) will be adhered to.

Swales

- 39.5.25 Swales are vegetated surface features that drain water evenly from 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). Swales can be 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.
- 39.5.26 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% annual exceedence probability (1 in 2 and 1 in 10 year return period), swales can act as a storage and conveyance mechanism. For larger storms with an annual probability of less than 10% AEP (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. Swales are reported to remove 70-90% 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.

Outfall Structures

- 39.5.27 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.

Maintenance of Road Drainage Network

- 39.5.28 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 regular inspection and weed control, annual sediment removal and clearance of vegetation build-up, replacement of clogged filter material typically once in 10 years or more;
 - maintenance of filtration devices include regular inspections, grass cutting and site rubbish removal, annual reinstatement of eroded areas or damaged vegetation and removal of sediment;
 - 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 regular inspections and site rubbish removal, bank side and pond vegetation clearance at least every 3 years, removal of sediment from the 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 water features and culverts to reduce the risk of blockages and increased flood risk;

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- if herbicides are used, those recommended by SEPA for use near water features are to be applied in line with manufacturer's instructions to reduce pollution of water features; and
- provision of scour protection at the drainage discharge outfall to protect the banks and bed of the receiving ditch and to limit erosion, where required.

39.5.29 Monitoring of water quality, sedimentation and/or ecological conditions downstream of key outfalls will be undertaken to provide an indication for problems should they arise. Monitoring would particularly be required at the drainage outfall on the Burn of Muchalls, due to its size and sensitivity, in order to monitor any potential long-term impacts on the watercourse.

Network Culverts

39.5.30 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)

Watercourse Crossings (Bridges and Buried Structures)

39.5.31 As described in Section 39.4, bridges in the form of buried structures are proposed to cross the Burn of Muchalls and Limpet Burn. Bridging these high sensitivity watercourses will minimise adverse impacts to water quality, hydrological regime, geomorphological diversity and construction phase risks. Details of design features are provided in Chapter 4 (The Proposed Scheme), with aspects specific to water quality, quantity and geomorphology outlined below.

39.5.32 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 to convey at least the 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 affected.

39.5.33 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 in 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.

39.5.34 The crossing structure proposed for the Burn of Muchalls does not require any piers to be located in the water column, which will avoid the need for in-channel works. During construction, this significantly reduces the potential for accidental spillage and sediment release within the water channel and also avoids the requirement for watercourse diversion or pumping water away during construction. During the operational phase, the design of the bridge will minimise the impact on the morphological diversity of the watercourse and retain, where possible, the natural sinuosity of the watercourse as a realignment of the channel is not required.

39.5.35 The abutments of the bridge structure would be set back approximately 8m from the top bank of the watercourse. In addition to reducing risk of increased flood risk, this will also allow sufficient light through the structure in order to maintain riparian vegetation, thereby reducing the risk of erosion and minimising adverse impacts on water quality.

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- 39.5.36 The proposed structure for Limpet Burn will require the realignment of the channel into the middle of the valley. At the point of the proposed crossing, the channel would be situated at the toe of the northern valley side. For ease of construction and to reduce the requirement for hard engineering works, it is proposed to relocate the channel to the centre of the valley and then construct the bridge over the newly formed channel. This will effectively provide a barrier across the geological valley feature, prevent the egress of groundwater springs underneath the structure, but will still allow water to pass underneath the road and travel downstream.
- 39.5.37 In general terms, the structure proposed for crossing Limpet Burn follows the design principles set out above for the Burn of Muchalls. There will be no piers in the channel and the structure has been designed to ensure minimal impacts on hydrology and long-term geomorphology. The abutments will be set back from bank top ensuring that a strip of soft bank is maintained through the structure. Due to a lack of light, it may not be possible to ensure riparian vegetation is established along the banks as the structure is proposed to be approximately 70m long. While the design of the structure will provide some mitigation of impacts, the associated required realignment will result in impacts on geomorphology in the short term.

Watercourse Crossings (Culverts)

- 39.5.38 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 39.2.29). Culvert design will follow SEPA policy and the guidelines set out in 'Culvert Design Manual: Report 168' (CIRIA, 1997) and the DMRB. 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 40 (Ecology and Nature Conservation).
- 39.5.39 The decision to install depressed invert culverts at all crossings (with the exception of Limpet Burn and the Burn of Muchalls) 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 Green Burn will remain affected as the culvert will reduce the sinuosity and morphological diversity of the watercourse in the long term.
- 39.5.40 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 the effectiveness of this as a mitigation design element, the channel bed substrate must be formed prior to the routing of flow through the culvert. This will ensure morphological continuity and prevent localised changes in bed elevation. 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). No fine sediment will be placed in the new channels.
- 39.5.41 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 requires 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 ensure that gradients do not differ markedly from existing conditions to avoid excessive siltation or erosion.

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- 39.5.42 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 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.

Watercourse Realignments

- 39.5.43 Watercourse realignments are generally required to direct watercourses away from the road or to 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.
- 39.5.44 A list of proposed realignments is provided in Section 39.4, with more detailed information provided in Appendix A39.2 (Fluvial Geomorphology). The following broad principles were adhered to in the design of watercourse realignments:
- 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.

- 39.5.45 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

- 39.5.46 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

- 39.5.47 Although watercourse diversions and culverts would 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 water features which may lead to adverse impacts on water quality. Details of the monitoring approach are given in Appendix A39.2 (Fluvial Geomorphology)

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but must include regular inspections after construction to monitor watercourse for any areas of new erosion or deposition.

Construction

Adherence to Best Practice

- 39.5.48 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 ensuring 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;
 - 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.
- 39.5.49 Measures to avoid, minimise or control pollution of surface water and groundwater will incorporate SEPA requirements for pollution control, including the Pollution Prevention Guidelines (PPGs) detailed below:
- PPG01 General Guide to the Prevention of Water Pollution;
 - PPG04 Disposal of Sewage Where No Mains Drainage 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.
- 39.5.50 Mitigation requirements for works in the vicinity of water features (incorporating PPG recommendations) are identified below in Table 39.9.

Table 39.9 – Mitigation Measures During Construction

Potential 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; silt fences 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 prepared and submitted to SEPA detailing proposed measures to mitigate release of suspended solids prior to commencement of construction.</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 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 an exposed river banks will be vulnerable to erosion.</p> <p>Where possible provide sediment fences to prevent sediment being washed into the watercourse, and limit the extent of disturbance on the banks of the watercourse.</p>
Sewerage	<p>If service diversions need to be carried out, the diversion should be undertaken prior to construction and will be undertaken using good engineering practices to ensure spillage risk is minimised.</p> <p>Arrangements for safe storage and disposal of sewage effluent from workers on site will be agreed with SEPA 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.</p>

*Watercourse Realignment*s

- 39.5.51 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. In addition to smaller watercourse that would be culverted, the construction of the crossing structure proposed for Limpet Burn will require diversion works. Further investigations on this burn are on-going.
- 39.5.52 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

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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 are halted when watercourses are in spate.

Programme of Works

- 39.5.53 The impact of the proposed scheme can be greatly reduced or avoided through the 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.
- 39.5.54 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 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.

Monitoring

- 39.5.55 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). Monitoring locations, parameters, frequency of sampling and discharge limits will be agreed with SEPA in advance of construction.

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Groundwater Mitigation

39.5.56 As mentioned previously, road drainage features along the Hillock area of high well density identified in the baseline conditions will be lined. Where an impermeable liner is included in the filter drains, infiltration of road runoff into the surrounding groundwater is prevented, effectively preventing pollution of the groundwater in these areas. In addition, the areas around wells where potential Substantial to Moderate impacts have been assessed will also be lined:

- ch0 to 600 near East Lodge and Hill of Megray (wells F2 and F39),
- ch2900 to 4000 near Hillock (F8, F9, F10);
- ch4800 to 5200 near Elrick Farm (spring F14);
- ch6000 to 6550 near along Cookney cut (well F21 and F38);
- ch6900 to 7300 along Burnside of Newhall cut (wells F22 and F23);
- ch9800 to 9950 along Stranog Hill cut (well F27); and
- ch1150 to 1400 near Greens of Crynoch (well F29).

Site Specific Mitigation

39.5.57 The mitigation for all of the water features have been discussed in Section 39.4. Specific mitigation, in addition to these measures, must be applied to the high sensitivity watercourses, the Burn of Muchalls and Limpet Burn:

- preparation of detailed method statement for agreement with SEPA prior to commencement of works;
- use of plastic sleeve and double falsework/shuttering when working over watercourses to ensure minimal concrete spillage;
- enclosed spraying when waterproofing preventing chemicals from entering watercourses;
- works with a high potential of sediment release should be carried out between May and September, where practicable (refer to Chapter 40)
- no in-channel works will be conducted between 14 October and 31 May to avoid migratory and spawning salmon (refer to Chapter 40); and
- long-term water quality/ecological monitoring before, during and after construction (to be agreed with SEPA prior to work commencement).

39.5.58 Additionally the following mitigation must be applied to the sensitive Fishermyre Wetland area:

- construction materials beneath the road should allow the lateral transfer of groundwater and bunds should be incorporated to prevent the flow of groundwater in a southerly direction (parallel to the proposed) to maintain the existing lateral West to East supply of water. (Chapter 38.5.15);
- detailed monitoring of the surface water hydrology using water level recorders prior to, during and following the construction of the road;
- preparation of detailed method statement for agreement with SEPA prior to commencement of works;
- detailed monitoring of the groundwater processes (see Chapter 38); and
- creation of water vole habitat (Appendix 10.7) will be designed to minimise potential alterations to groundwater and hydrological connectivity in that area.

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Table 39.10 – Summary of Mitigation Measures

Water Feature	Potential Impact	Mitigation Measures
Megray Burn	Road Drainage	Treatment train consists of filter drains, 1 detention basin with two treatment ponds. Storage volume Vt. The outfall will be correctly positioned to limit the potential for scour around the structure.
	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	Adherence to general principles set out in text will be applied (refer to Appendix A39.2: 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Limpet Burn	Road Drainage	n/a
	Crossing	Buried structure will not require piers in the channel. Length and height of structure likely to result in poor light penetration and inhibit riparian vegetation growth, which may lead to poor bank stability. However bed continuity and hydrological and hydrogeological connections will be maintained through the structure. Water quality and water level monitoring of the fishing ponds downstream should be carried out to identify any impacts of the road during operation.
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Network culvert: Fishermyle	Road Drainage	Network culvert must be 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.
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA.
Coneyhatch 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches.
Fishermyle Wetland	Road Drainage	Road drainage treatment train will protect water quality of Fishermyle. 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. Materials used for construction of road alignment along this section will maintain groundwater connectivity between eastern and western sides of the scheme.
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches. Where possible, increasing the channel dimensions and gradients of existing channels or the addition of a temporary channel during periods of high flow will be avoided. Water vole habitat (Appendix 10.7) creation will be designed to avoid alterations to surface water and groundwater flows.
Green Burn	Road Drainage	Treatment train consists of filter drains with 2 x 60m swales. The outfall will be correctly positioned to limit the potential for scour around the structure.
	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	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Green Ditch	Road Drainage	n/a
	Crossing	n/a
	Realignment	Adherence to general principles set out in text will be applied. 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. Regular maintenance and clearance of debris.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches.
Allochie 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches.
Burn of Muchalls	Road Drainage	Treatment train consists of filter drains and one detention basin with one treatment pond. Storage volume Vt. The outfall will be correctly positioned to limit the potential for scour around the structure.
	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. Crossing would be high enough to maintain reasonable light penetration which will assist in maintaining riparian vegetation.
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert. No in-channel works will be required during construction, which will reduce the risk of accidental spillage, water diversion and sediment release.
Burn of Blackbutts	Road Drainage	n/a
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches.
Cookney Ditch	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.
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Stoneyhill Ditch	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.
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Balnagubs 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.
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Tributary of the Burn of Elsick	Road Drainage	Treatment train consists of filter drains and one detention basin with one treatment pond. Storage volume Vt. The outfall will be correctly positioned to limit the potential for scour around the structure.
	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	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Whiteside 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.

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Water Feature	Potential Impact	Mitigation Measures
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Crossley Burn and Cairns 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.
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Circle and Square Burn	Road Drainage	n/a
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches.
Wedderhill Burn	Road Drainage	n/a
	Crossing	n/a
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. Cut-off ditches, sediment fencing and treatment ponds will be used to reduce sediment release when diverting watercourse into drainage ditches.
Craigentath Butn	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.

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Water Feature	Potential Impact	Mitigation Measures
	Realignment	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.48 – 39.5.55. Development of detailed method statement for agreement with SEPA. 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 the culvert.
Burnhead Burn	Road Drainage	Treatment train consists of filter drains, detention basin and 2 treatment ponds. Filter drains in the area will be lined to prevent infiltration to groundwater. Storage volume Vt. The outfall will be correctly positioned to limit the potential for scour around the structure.
	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	Adherence to general principles set out in text will be applied. 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 – paragraph 39.5.56 – 39.5.63. Development of detailed method statement for agreement with SEPA. 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 the culvert.

39.6 Residual Impacts

39.6.1 Following the successful implementation of the mitigation proposed, the potential for impacts on the water environment would be reduced. Residual impacts are summarised in Table 39.11 with supporting information provided in the technical appendices and summarised below.

Impact Assessment

39.6.2 The methodology adopted for assigning residual impact adopts a precautionary approach. Consequently, the overall residual impact magnitude was assigned based on the highest residual impact predicted by each of the technical disciplines following the adoption of the mitigation measures detailed in section 39.5. This residual magnitude impact is 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 40 (Ecology and Nature Conservation).

Operational Residual Impacts

Megray Burn (ch600)

39.6.3 With the careful design of the major realignment, proposed drainage outfall and culvert (plus existing culvert extension), impacts on hydrology of the channel would be reduced to a negligible magnitude. Impacts on geomorphology would be reduced to a low magnitude. The provision of two treatment ponds and an attenuation feature before outfalling into the watercourse would remove pollutants to meet EQS and reduce accidental spillage rates to acceptable limits. The residual impact on the water quality is considered to be of negligible magnitude.

39.6.4 Overall, the residual impact on Megray Burn during the operational phase is considered to be of low magnitude and Slight significance.

Limpet Burn (ch1500)

39.6.5 Limpet Burn is currently in a relatively undisturbed condition at the proposed crossing point. The scheme proposals would require the construction of a buried structure to bridge across the gorge and an extensive realignment. This would affect the current hydrological regime with direct impacts on fluvial geomorphology. Consequently, indirect impacts on water quality and freshwater ecology would occur in the short term while the new alignment stabilises.

39.6.6 The provision of a buried structure with an associated realignment is considered to have a negligible residual impact magnitude on the hydrology of the watercourse. Similarly, the transfer of water from one catchment to another through the drainage system would have a negligible magnitude of impact on the watercourse. These activities would result in a low residual impact magnitude on geomorphology.

39.6.7 There is no proposal to discharge treated road runoff to this watercourse. Overall, the residual impact on the water environment of Limpet Burn has been assessed as low magnitude and Moderate significance driven by impacts on geomorphology.

Network Culvert: Fishermyme (ch2540)

39.6.8 At chainage 2540, road drainage would be transferred from one side of the road to the other via a culvert servicing the drainage network. The hydrological assessment has assessed the residual risk of flood risk as negligible with the implementation of appropriate mitigation.

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Coneyhatch Burn (ch2600)

- 39.6.9 As the watercourse is taken into pre-earthwork drainage ditches in the operational phases, providing the drainage design is designed correctly, the residual impact on the hydrology is considered to be negligible. The overall impact is considered to be of Negligible magnitude and significance.

Green Burn (ch3100)

- 39.6.10 Provision of depressed invert culvert and adequately designed attenuation through SUDS would reduce the impact on hydrology to a negligible magnitude. Installation of depressed invert culverts and sensitive realignments are considered to reduce the impact to geomorphology to a low magnitude.
- 39.6.11 Provision of a 120m long swale before outfall is predicted to remove significant proportions of pollutants such that environmental quality standards are likely to be met and accidental spillage rates are reduced to acceptable limits. The residual impact on water quality is considered to be of low magnitude.
- 39.6.12 The overall impact on Green Burn is considered to be of low magnitude and Slight significance.

Green Ditch (ch3150)

- 39.6.13 As this watercourse would be significantly realigned, the implementation of appropriate mitigation (as set out in Section 5) would reduce the impact on hydrology, geomorphology and water quality to negligible. The overall impact is considered to be of negligible magnitude and Negligible significance.

Fishermyre Wetland (ch3100)

- 39.6.14 Providing suitable hydrological connectivity is incorporated into the scheme design to ensure that groundwater flows will continue with the scheme in place, the impacts on the wetland area would result in a residual impact significance of Slight/Negligible.

Allochie Burn (ch4000)

- 39.6.15 As the watercourse would be taken into pre-earthworks drainage ditches in the operational phases, providing that the drainage system is designed correctly, the residual impact on hydrology would be negligible. The overall impact is considered to be of negligible magnitude and Negligible significance.

Burn of Muchalls (ch4700)

- 39.6.16 With careful design, proposed bridge and drainage outfall impacts on hydrology and geomorphology of the channel would be of a negligible magnitude. Provision of a treatment pond and an attenuation feature before outfall is predicted to remove pollutants such that environmental quality standards are likely to be met and accidental spillage rates are reduced to acceptable limits. The residual impact on water quality is considered to be of negligible magnitude.
- 39.6.17 Overall, the residual impact on the Burn of Muchalls during operation of the proposed scheme would be of negligible magnitude and Slight/Negligible significance.

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Burn of Blackbutts (ch5600)

- 39.6.18 As this watercourse would be taken into pre-earthworks drainage, providing the drainage design is designed correctly, the residual impact on hydrology is considered to be negligible. The overall impact is considered to be of negligible magnitude and Negligible significance.

Cookney Ditch (ch6500)

- 39.6.19 With the implementation of appropriate mitigation, the potential impacts on hydrology, geomorphology and water quality of this watercourse are considered to be of negligible magnitude. Overall, the impact on the water environment of the Cookney Ditch is considered to be of Negligible significance.

Stoneyhill Ditch (ch6900)

- 39.6.20 With the implementation of appropriate mitigation, the potential impacts on the hydrology, geomorphology and water quality of this watercourse would be of negligible magnitude. Overall, the impact on the water environment of the Stoneyhill Ditch is considered to be of Negligible significance.

Balnagubs Burn (ch7550)

- 39.6.21 With careful design of the culvert and associated realignment of this watercourse, the potential impacts on hydrology, geomorphology and water quality would be of negligible magnitude. Overall, the impact on the water environment of the Balnagubs Burn is considered to be of Negligible significance.

Tributary of the Burn of Elsick (ch7950)

- 39.6.22 Impacts to hydrology and geomorphology of the Tributary of the Burn of Elsick from the proposed outfall and crossing would be reduced to a negligible magnitude. Provision of a treatment pond and an attenuation feature before outfall is predicted to remove significant proportions of pollutants such that environmental quality standards are likely to be met. The residual impact on water quality is considered to be of low magnitude.

- 39.6.23 Overall, the impacts on the water environment are of low magnitude and Slight significance.

Whiteside Burn (ch8850)

- 39.6.24 With careful design of the culvert and associated realignment, impacts on hydrology, geomorphology and water quality of the watercourse would be reduced to negligible magnitude. Overall, the impact on the water environment of Whiteside Burn is considered to be of Negligible significance.

Crossley Burn (ch9150) and Cairns Burn (ch9200)

- 39.6.25 With careful design of the culvert, associated realignment of Crossley Burn and the major realignment of Cairns Burn, the impacts on hydrology, geomorphology and water quality of these watercourses would be reduced to negligible magnitude. Overall, the impact on the water environment of these burns is considered to be of Negligible significance.

Circle Burn (ch9950) and Square Burn (ch10150)

- 39.6.26 These watercourses would be taken into pre-earthworks drainage. As the road runoff system has been designed with the capacity to accommodate these flows, the residual

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impacts on hydrology would be of negligible magnitude. The overall impact is predicted to be of Negligible significance.

Wedderhill Burn (ch10400)

- 39.6.27 As the catchment of this watercourse would be severed and a portion of the watercourse downstream of the road would be lost, providing the specified mitigation is employed, the residual impact on hydrology is considered to be of negligible magnitude. The overall impact is considered to be of Negligible significance.

Craigentath Burn (ch10600)

- 39.6.28 With the implementation of appropriate mitigation, the potential impacts on the hydrology, geomorphology and water quality would be of negligible magnitude. Overall, the residual impacts on the water environment of Craigentath Burn are anticipated to be of Negligible significance

Burnhead Burn (ch200100)

- 39.6.29 The impacts on this burn are considered in detail in Chapter 24 (Water Environment, Southern Leg). This burn would receive road drainage, require the installation of a culvert and would be realigned as part of the scheme proposals.

Catchment Cumulative Impacts (Operational)

Burn of Muchalls

- 39.6.30 Potential residual catchment impacts on the Burn of Muchalls may arise from direct impacts on the Burn of Muchalls, Green Burn and Burn of Blackbutts. These potential impacts would be reduced to negligible magnitude for the operational phase and when combined they are considered to be of negligible magnitude. This leads to an assessment of Slight/Negligible significance over the long term.

Burn of Elsick

- 39.6.31 Potential residual, catchment impacts on the Burn of Elsick may arise from direct impacts on Balnagubs Burn, Tributary of the Burn of Elsick, Whiteside Burn, Crossley Burn and Cairns Burn. These burns would be affected in the upper section of their catchments.

- 39.6.32 Individually, it is predicted that the potential impacts on these burns would be of negligible magnitude over the long term. With the potential dilution available from the sub-catchments, the overall impact to the water environment is anticipated to be of negligible magnitude and Negligible significance.

Crynoch Burn

- 39.6.33 Potential residual catchment impacts on Crynoch Burn may arise from direct impacts on Circle Burn, Square Burn, Craigentath Burn and Wedderhill Burn, which are minor watercourses that contribute only a small area to the overall catchment of Crynoch Burn. Some of these burns may be connected to Crynoch Burn through pipes or underground connections, however no obvious connections were observed on site, and they are not thought to transport sediment downstream.

- 39.6.34 In general, the potential impacts on each burn individually are considered to be of negligible magnitude and given their small contribution to Crynoch Burn catchment, impacts are considered to be of overall negligible magnitude. These impacts are reported in the Southern Leg Water Environment chapter (Chapter 24), along with impacts on Burnhead Burn.

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- 39.6.35 Due to its importance, potential catchment impacts on the River Dee are discussed in Part E (Cumulative Scheme Impacts) of this Environmental Statement.

Construction Residual Impacts

Megray Burn (ch600)

- 39.6.36 Sensitive construction techniques, such as providing a temporary flow diversion and ensuring that the channel works are completed before the flow is routed along the new channel, would reduce the short term impacts on the geomorphology of Megray Burn to low magnitude. Impacts on water quality would be reduced to low magnitude, while those on hydrology would be reduced to negligible magnitude.

- 39.6.37 Overall, the construction impacts to Megray Burn are considered to be of low magnitude and Slight significance over the short term.

Limpet Burn (ch1500)

- 39.6.38 The residual impacts on surface water hydrology are likely to be reduced to negligible magnitude. However, the construction of the bridge and realignment is considered to present a low, short term, localised impact magnitude on geomorphology. Minimisation of sediment release through best practice is expected to reduce the impact to a certain extent, but this is not expected to reduce the impact below low magnitude. This is based on the requirement for such extensive works within and in the vicinity of the channel.

- 39.6.39 Provided that measures are taken to minimise sediment and pollutant release into watercourse, the potential impacts on water quality would be reduced to a negligible magnitude.

- 39.6.40 The overall impact to the water environment of the burn and its potential dependent habitats downstream would be of low magnitude and Moderate significance. This is driven by the potential impacts on geomorphology and potential sediment release.

Coneyhatch Burn (ch2600)

- 39.6.41 The implementation of construction mitigation practices, including sediment control, would reduce the impact on the water environment to negligible significance. This is considered to be the case for hydrology, water quality and geomorphology. Overall, impacts are considered to be of Negligible significance.

Green Burn (ch3100)

- 39.6.42 Potential impacts on the hydrology of Green Burn would be minimised, through best practice, to a negligible magnitude. These practices would reduce the potential impact on geomorphology to low magnitude. The risk of sediment and pollutant release will be minimised through best practice and in combination with ongoing monitoring impacts on water quality are considered to reduce to a low magnitude.

- 39.6.43 Overall, the magnitude of impact on Green Burn is driven by the short term impacts on geomorphology and is considered to be of low magnitude and Slight significance.

Green Ditch (ch3150)

- 39.6.44 Implementation of construction mitigation practices, including sediment control, is considered to reduce the potential impacts to the water environment to negligible magnitude and Negligible significance. This is considered to be the case for all three disciplines.

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Fishermyre Wetland (ch3100).

- 39.6.45 General construction methods and the adoption of best practice would reduce the potential for impact to this wetland to negligible magnitude resulting in Slight/Negligible residual impact significance.

Allochie Burn (ch4000)

- 39.6.46 Implementation of construction mitigation practices, including sediment control, is considered to reduce the impact on the water environment to Negligible magnitude and significance. This is considered to be the case for all three disciplines.

Burn of Muchalls (ch4700)

- 39.6.47 The construction of an outfall and a bridge with no in channel supports is considered to present a negligible impact magnitude to the hydrology, geomorphology and water quality of the Burn of Muchalls, providing best practice mitigation is employed (as detailed above). The overall impact to the burn is considered to be of negligible magnitude and Slight/Negligible significance.

Burn of Blackbutts (ch5600)

- 39.6.48 Implementation of construction mitigation practices, including sediment control, is considered to reduce the impact on the water environment to negligible magnitude and significance. This is considered to be the case for all three disciplines.

Cookney Ditch (ch6500)

- 39.6.49 Implementation of construction mitigation practices, including sediment control, is considered to reduce the potential impacts from the construction of two culverts and a realignment to Negligible magnitude and significance. This is considered to be the case for all three disciplines.

Stoneyhill Ditch (ch6900)

- 39.6.50 Implementation of construction mitigation practices, including sediment control, is considered to reduce the impacts from the construction of a culvert and a realignment to Negligible magnitude and significance. This is considered to be the case for all three disciplines.

Balnagubs Burn (ch7550)

- 39.6.51 The potential impacts on the hydrology of the burn, from the construction of the culvert and associated realignment, would be minimised to a negligible magnitude through the implementation of best practice. Similarly short term impacts on geomorphology and water quality are considered to be reduced to negligible magnitude.

- 39.6.52 Overall, the impact to water environment is considered to be of Negligible magnitude and significance.

Tributary of the Burn of Elsick (ch7950)

- 39.6.53 The risk of sediment and pollutant release would be minimised through the implementation of best practice on site and in combination with ongoing monitoring through the construction phase impacts on water quality are considered to reduce to a negligible magnitude.

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- 39.6.54 Overall, the impact to water environment is considered to be of Negligible magnitude and significance.

Whiteside Burn (ch8850)

- 39.6.55 The potential impacts on the hydrology of Whiteside Burn, from the construction of the culvert and associated realignment, would be minimised to a negligible magnitude through the implementation of best practice. Similarly, short term impacts on geomorphology and water quality are considered to be reduced to negligible magnitude.

- 39.6.56 Overall, the potential impact to water environment is considered to be of Negligible magnitude and significance.

Crossley Burn (ch9150) and Cairns Burn (ch9200)

- 39.6.57 The proposed realignment and culvert activities are considered to have a residual impact of negligible magnitude on geomorphology and hydrology of the watercourses, provided the mitigation measures detailed above are adhered to.

- 39.6.58 The risk of sediment and pollutant release will be minimised through best practice and in combination with ongoing monitoring through the construction phase impacts on water quality are considered to reduce to a negligible magnitude.

- 39.6.59 Overall, the potential impact to water environment is considered to be of Negligible magnitude and significance.

Circle Burn (ch9950)

- 39.6.60 Implementation of construction mitigation practices, including sediment control, is considered to reduce the impact on the water environment to Negligible magnitude and significance. This is considered to be the case for all three disciplines.

Square Burn (ch10150)

- 39.6.61 Implementation of construction mitigation practices, including sediment control, is considered to reduce the potential impact on the water environment to negligible magnitude and significance. This is considered to be the case for all three disciplines.

Wedderhill Burn (ch10400)

- 39.6.62 Implementation of construction mitigation practices, including sediment control, is considered to reduce the potential impact on the water environment to Negligible magnitude and significance. This is considered to be the case for all three disciplines.

Craigentath Burn (ch10600)

- 39.6.63 The potential impacts on the hydrology of the burn, from the construction of the culvert and associated realignment, would be minimised to a negligible magnitude through the implementation of best practice. Similarly, short term impacts on geomorphology and water quality are considered to be reduced to negligible magnitude.

- 39.6.64 Overall, the potential impact to water environment is considered to be of Negligible magnitude and significance.

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Burnhead Burn (ch200100)

- 39.6.65 The potential impacts to this burn are considered in detail in the Southern Leg Water Environment Chapter (Chapter 24). This burn would be culverted, realigned and would receive road drainage as a result of the proposed scheme.

Catchment Impacts (Construction)

Burn of Muchalls

- 39.6.66 Potential residual catchment impacts on the Burn of Muchalls may arise from direct impacts on the Burn of Muchalls, Green Burn and Burn of Blackbutts. As the majority of these potential impacts would be reduced to negligible magnitude over the construction phase, when combined they are considered to be of negligible magnitude. The residual impacts on Green Burn would be localised and are not anticipated to result in impacts downstream on the Burn of Muchalls. This leads to a Slight/Negligible significance over the short term.

Burn of Elsick

- 39.6.67 Potential catchment impacts on the Burn of Elsick may arise from direct impacts on Balnagubs Burn, Tributary of the Burn of Elsick, Whiteside Burn, Crossley Burn and Cairns Burn. These burns would be affected in their upper catchments.
- 39.6.68 Individually, these impacts on these burns would be of low-negligible magnitude over the short term. Therefore, despite the potential dilution available from the sub-catchment, the overall impact to the water environment is considered to be of negligible magnitude and Negligible significance over the long term.

Crynoch Burn

- 39.6.69 Potential catchment impacts on Crynoch Burn may arise from direct impacts on Circle Burn, Square Burn, Craigentath Burn and Wedderhill Burn, which are minor watercourses that contribute only a small area to the overall catchment of Crynoch Burn. Additionally, it is thought that some of these burns are connected to Crynoch Burn through pipes or underground connections, but they are not thought to transport sediment downstream.
- 39.6.70 In general, the impacts on each burn individually are considered to be of negligible magnitude and, given their small contribution to Crynoch Burn catchment, they are considered to be of overall negligible magnitude. For consistency of approach, these impacts are reported in the Southern Leg Water Environment chapter (Chapter 24), along with impacts on Burnhead Burn.
- 39.6.71 Due to its importance, catchment impacts on the River Dee are discussed in Part E (Cumulative Scheme Impacts) of this Environmental Statement.

Groundwater Residual Impact

- 39.6.72 Chapter 38 (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 to Slight.

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Table 39.11 – Residual Impacts

Feature	Overall Sensitivity	Residual Impacts Description (with mitigation)	Overall Residual Impact	
			Magnitude	Significance
Megray Burn	Medium	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Low</p>	Low	Slight
		<p>Operation</p> <p>Depressed invert culvert allows natural substrate through the culvert on an already modified burn. Long term decrease to morphological diversity as a result of culverting and major realignment offset where possible by pool and riffle sequences. Change to discharge and flood regime minimised through careful design of realignment, SUDs and culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event). 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.</p> <p>Hydrology and Water Quality: Negligible</p> <p>Geomorphology: Low</p>	Low	Slight
Limpet Burn	High	<p>Construction</p> <p>Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. However as a major realignment is proposed along with a buried structure the risk of sediment release into the channel remains.</p> <p>Hydrology and Water Quality: Negligible</p> <p>Geomorphology: Low</p>	Low	Moderate
		<p>Operation</p> <p>Bridge structure allows watercourse to meander through structure. However, long term changes to morphology of the watercourse due to the proposed realignment. Change to discharge and flood regime minimised through careful design of realignment and bridge. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event).</p> <p>Hydrology and Water Quality: Negligible</p> <p>Geomorphology: Low</p>	Low	Moderate
Network Culvert: Fishermyre	n/a	<p>Construction – n/a</p>	n/a	n/a
		<p>Operation</p> <p>Regular maintenance and clearance of debris should reduce the potential for culvert blocking.</p> <p>Hydrology: Negligible</p> <p>Geomorphology and Water Quality: Scoped out of assessment</p>	Negligible	n/a

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Feature	Overall Sensitivity	Residual Impacts Description (with mitigation)	Overall Residual Impact	
			Magnitude	Significance
Coneyhatch 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 Impact significance remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of assessment	Negligible	Negligible
Fishermyre Wetland	High	Construction Change to hydrological pathways minimised through best practice. Hydrology and Water Quality: Negligible Geomorphology: Scoped out of assessment	Negligible	Slight/Negligible
		Operation Provision of suitable connectivity of groundwater flows through the AWPR. Hydrology and Water Quality: Negligible Geomorphology: Scoped out of assessment	Negligible	Slight/Negligible
Green Burn	Medium	Construction Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology: Negligible Geomorphology and Water Quality: Low	Low	Slight
		Operation Depressed invert culvert allows natural substrate through the culvert. 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, SUDs and culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event). 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 and Water Quality : Low	Low	Slight

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Feature	Overall Sensitivity	Residual Impacts Description (with mitigation)	Overall Residual Impact	
			Magnitude	Significance
Green Ditch	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 Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of realignment. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Negligible
Allochie Burn	Medium	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 Impact significance remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of assessment	Negligible	Negligible
Burn of Muchalls	High	Construction Risk of sediment and pollutant release minimised through best practice. Ongoing monitoring during the construction phase will identify any impacts at an early stage. Bridge design would require no in channel works therefore minimising risk of sediment and pollution risk to the channel. Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Slight/Negligible
		Operation No channel supports and abutments set back from the channel, ensure no direct impacts on the watercourse morphological diversity. Change to discharge regime and flood risk minimised through careful design of bridge. 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, Geomorphology and Water Quality: Negligible	Negligible	Slight/Negligible
Burn of Blackbutts	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 Impact significance remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of assessment	Negligible	Negligible

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Feature	Overall Sensitivity	Residual Impacts Description (with mitigation)	Overall Residual Impact	
			Magnitude	Significance
Cookney Ditch	Low	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation</p> <p>Change to discharge and flood regime minimised through careful design of culverts and realignment. No outfall planned therefore no impact to water quality expected from drainage. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and realignment. Morphological continuity maintained through the culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event).</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
Stoneyhill Ditch	Low	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation</p> <p>Change to discharge and flood regime minimised through careful design of culvert and realignment. No outfall planned therefore no impact to water quality expected from drainage. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and realignment. Morphological continuity maintained through the culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event).</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
Balnagubs Burn	Low	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation</p> <p>Change to discharge and flood regime minimised through careful design of culvert and realignment. No outfall planned therefore no impact to water quality expected from drainage. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and realignment. Morphological continuity maintained through the culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event).</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible

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Feature	Overall Sensitivity	Residual Impacts Description (with mitigation)	Overall Residual Impact	
			Magnitude	Significance
Tributary of the Burn of Elsick	Medium	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation</p> <p>Depressed invert culvert allows natural substrate through the culvert. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and realignment. Change to discharge and flood regime minimised through careful design of realignment, SUDs and culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event). 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.</p> <p>Hydrology and Geomorphology: Negligible</p> <p>Water Quality: Low</p>	Low	Slight
Whiteside Burn	Medium	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation</p> <p>Change to discharge and flood regime minimised through careful design of culvert and realignment. No outfall planned therefore no impact to water quality expected from drainage. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and realignment. Morphological continuity maintained through the culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event).</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
Crossley Burn and Cairns Burn	Low	<p>Construction</p> <p>Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage.</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible
		<p>Operation</p> <p>Change to discharge and flood regime minimised through careful design of culvert and realignment. No outfall planned, therefore no impact to water quality expected from drainage. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and major realignment. Morphological continuity maintained through the culvert. Long term decrease to morphological diversity as a result of culverting and realignment offset where possible by pool and riffle sequences Culvert capacity for 0.5% AEP flow (1 in 200 year flood event).</p> <p>Hydrology, Geomorphology and Water Quality: Negligible</p>	Negligible	Negligible

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Feature	Overall Sensitivity	Residual Impacts Description (with mitigation)	Overall Residual Impact	
			Magnitude	Significance
Circle and Square 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 Impact significance remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of assessment.	Negligible	Negligible
Wedderhill 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 Impact significance remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: Scoped out of assessment.	Negligible	Negligible
Craigentath Burn	Low	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	Negligible	Negligible
		Operation Change to discharge and flood regime minimised through careful design of culvert and realignment. No outfall planned, therefore no impact to water quality expected from drainage. Watercourse already straightened therefore minimal long-term change to morphological diversity as a result of culvert and realignment. Morphological continuity maintained through the culvert. Culvert capacity for 0.5% AEP flow (1 in 200 year flood event). Hydrology, Geomorphology and Water Quality: Negligible	Negligible	Negligible

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Summary of Residual Impacts

- 39.6.73 Potential impacts, pre-mitigation, on Limpet Burn were predicted to be of Substantial significance and although certain aspects of mitigation would reduce impacts, the overall significance of residual impacts would reduce to Moderate level during both the operational and construction phase. The residual significance, for both operation and construction, is a reflection of the inherent sensitivity of the watercourse.
- 39.6.74 Limpet Burn is currently in a relatively undisturbed condition at the proposed crossing point. The scheme proposals require extensive realignment and construction of a buried structure to bridge across the gorge. This would affect the current hydrological regime with direct impacts on fluvial geomorphology. Consequently, indirect impacts on water quality and freshwater ecology would occur in the short term while the new alignment evolves. Bridging of the watercourse using a buried structure would provide effective mitigation in the long term, providing that enough light can penetrate through the length of the structure in order to maintain riparian vegetation
- 39.6.75 All remaining impacts on the watercourses and wetland areas included in the assessment are assessed as Negligible, Slight/Negligible or Slight significance with the application of mitigation.
- 39.6.76 As mentioned previously, the assessment has adopted a precautionary approach throughout. Overall sensitivities, and therefore potential and residual impacts, have been reported by defaulting to the highest assessment determined by either of the disciplines (Hydrology, Fluvial Geomorphology, or Water Quality).

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