

9 Water Environment

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, and the physical processes on which freshwater habitats are dependent.

The study area for the assessment includes the River Don, approximately 14 other watercourses or field ditches, six ponds or loch features, one surface water spring and one artificial waterbody, Mill Lade. Potential impacts on these watercourses include: realignment, culverting, bridging, and changes to hydrological and quality regimes as a result of drainage outfalls.

Residual operational impacts on most watercourses, including the River Don are reduced to Slight or Negligible significance with appropriate mitigation. However, although mitigation will reduce impacts on the Gough, Craibstone and Bogenjoss Burns, the overall significance of residual impacts remain Substantial due to their high sensitivity. The scheme proposals require extensive realignment and culverting of these water features, which will result in the permanent loss of sinuosity and a reduction of morphological diversity.

Mitigation is proposed for the construction phase, which reduces impacts to low magnitude on Gough and Craibstone, and medium magnitude on Bogenjoss Burn. However, due to their high sensitivity, the significance of these remain Moderate or Moderate/Substantial. Residual impacts on all other watercourses are reduced to Slight or Negligible significance.

9.1 Introduction

- 9.1.1 This chapter describes the baseline surface water environment, assesses the predicted 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 within the study area of the Northern Leg. The results of the assessment on groundwater and fisheries are reported in Chapter 8 and 10 respectively.
- 9.1.2 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.
- 9.1.3 The 2000/60/EC 'Water Framework Directive' (WFD) which is transposed into Scottish law by the 'Water Environment and Water Services (Scotland) Act 2003' (WEWS Act), aims to classify surface waters according to their ecological status and sets targets for restoring/improving the ecological status of water bodies. This is a radical departure from the traditional methods of measuring water quality using only chemical parameters. Under the WFD, the status of water is assessed using a range of parameters including chemical, ecological, physical, morphological and hydrological measures to give a holistic assessment of aquatic ecological health. Furthermore, there is a requirement under the WFD that natural water features must attain 'good ecological status' by 2015. Certain waterbodies may be designated as artificial/heavily modified and will have less stringent targets to meet, however these will still need to demonstrate 'good ecological potential' by the year 2015 (SEPA, 2002).
- 9.1.4 In addition to the WEWS Act, new legislation passed in 2005; the 'Controlled Activities Regulations (Scotland) 2005' (referred to hereafter as CAR), controls all engineering activity in or near watercourses, reinforcing the requirements of the WFD. The regulations came into force on 01 April 2006, and the proposed scheme will therefore require CAR authorisation. There are three different types of authorisation under CAR: General Binding Rules (GBR), Registration, and Licence (either simple or 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 for some

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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, 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 the Scottish Environment Protection Agency (SEPA) before construction can begin. Further guidance is provided in 'The Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide' (SEPA, 2007).

9.2 Approach and Methods

Structure of Assessment

9.2.1 As noted above, under the WFD the status of waterbodies are assessed using a range of parameters including hydrology, morphology, water quality and ecology. 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 which form them. Fluvial processes create a wide range of morphological forms which provide a variety of habitats within and around river channels; and
- Water quality: the assessment of the chemical and biological status of various parameters within the water column and their interactions such as dissolved oxygen, indicator metals such as dissolved copper, and suspended solids.

9.2.2 The following technical reports are provided as supporting appendices to the Water Environment chapter:

- Appendix A9.1: Surface Water Hydrology;
- Appendix A9.2: Hydrodynamic Modelling;
- Appendix A9.3: Fluvial Geomorphology (with technical annex: Sediment Modelling); and
- Appendix A9.4: Water Quality.

9.2.3 Appendix A9.5 contains 28 annexes, which support the technical reports, referenced as appropriate in this chapter and Appendices A9.1 to A9.4.

9.2.4 The information contained in these detailed technical reports has been summarised as appropriate for the overall assessment presented in this chapter. The methods for each of the technical assessments were agreed with the Scottish Environmental Protection Agency (SEPA) prior to commencement, and consultation with SEPA has continued throughout the EIA process.

9.2.5 The potential impacts on groundwater and associated potable water are considered in detail in Chapter 8 (Geology, Contaminated Land and Groundwater). Impacts on riparian amenity and riparian landscape are considered in detail within Chapter 11 (Landscape), Chapter 12 (Visual) and Chapter 16 (Pedestrians, Cyclists, Equestrians and Community Effects).

9.2.6 The water environment in the Aberdeen area supports a number of aquatic species that have been identified as scarce in Europe and the UK. One of these species is the atlantic salmon, which is present in the River Don and 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 10 (Ecology and Nature Conservation).

9.2.7 To undertake this impact assessment, the Water Environment, Geology/Groundwater and Freshwater Ecology teams worked together throughout the assessment process to ensure

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sufficient representation of the interaction of the physical processes and the habitats which they support. It should be noted that impacts on freshwater ecology have not formed part of the assessment within this chapter, as they are dealt with entirely within the ecology chapter.

Baseline Conditions

Study Area

- 9.2.8 The study area for the assessment includes the River Don, approximately 14 other watercourses or field ditches, six ponds or loch features, one surface water spring and one artificial waterbody, Mill Lade. Watercourses were considered within a distance of 200m-1km from the proposed scheme. The sensitivities assigned to each watercourse are relevant to the surveyed reach and not the entire catchment. Baseline conditions were identified through site visits, review of existing information and data, and detailed technical studies.
- 9.2.9 Desk-based studies followed the guidance of DMRB, Volume 11, Section 3, Part 10: Road Drainage and the Water Environment, and relevant legislation and regulations as referred to within the chapter.

Consultation

- 9.2.10 Extensive consultations, as described in Chapter 6 (Scoping and Consultation), were also undertaken with Regulatory bodies and key stakeholders such as:
- SEPA (water quality monitoring data, designated fisheries stretches, areas of flood risk, licensed point source discharges and abstractions, agreed assessment methodologies);
 - Scottish Natural Heritage (SNH) (key areas for sensitive species, e.g. salmonids);
 - Aberdeen City and Aberdeenshire Councils (floodplain identification, area with historical flood problems); and
 - Don District Fisheries Board.

Scope of Baseline Assessment

- 9.2.11 Baseline water features (comprising watercourses and waterbodies) within the study area are indicated on Figures 9.1a-g. The requirement for detailed technical assessment of each identified water feature was determined through a combination of desk-based assessment and site visits.
- 9.2.12 Three small ponds along the route were scoped out of detailed assessment due to their size. Several ecology surveys assessed these ponds for their potential habitat and the findings are presented in Chapter 10. The results of the ecological assessment of the ponds are included in this chapter for completeness, however it should be noted that they do not form part of this assessment.
- 9.2.13 The majority of field ditches were considered in terms of surface water hydrology but were scoped out of geomorphological and water quality assessment.
- 9.2.14 All remaining watercourses potentially affected by the proposed scheme were assessed for surface water hydrology, geomorphology and water quality. However, due to their importance within the study corridor, the River Don and Goval Burn were also subject to hydrodynamic modelling. Hydrodynamic models were not constructed for watercourses other than the River Don and Goval Burn due to their lesser size and importance. However, flood risk issues are addressed for all watercourses in Appendix A9.1 (Surface Water Hydrology).

Impact Assessment (General Approach)

- 9.2.15 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.
- 9.2.16 As described in Chapter 5 (Overview of Assessment Process), impact significance was determined with respect to the sensitivity/importance of the baseline conditions and the magnitude of potential impact during both construction and operation. This is described below.
- 9.2.17 Further assessments of the impacts of the engineering proposals on the water environment will be required pre-construction as part of the CAR process, as described in paragraph 9.1.4. Consultation with SEPA is ongoing with regard to CAR applications, which is a separate process to the EIA and submission of the ES.

Sensitivity/Importance

- 9.2.18 The criteria used to assess the sensitivity of surface water features are summarised in Table 9.1. In defining these criteria, guidance such as DMRB, Transport Analysis Guidance (TAG) and Scottish Transport Appraisal Guidance (STAG) has been consulted to ensure a holistic approach.
- 9.2.19 Each discipline (Surface Water Hydrology, Fluvial Geomorphology, Water Quality, and where appropriate Hydrodynamic Modelling) has evaluated the sensitivity or vulnerability of each watercourse or feature by a separate set of criteria. These are listed in Table 9.1. For the purposes of summarising the impacts on the surface water environment, this chapter then assigns an overall sensitivity to the feature, which defaults to the highest sensitivity identified by the separate disciplines.

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Table 9.1 – Criteria to Assess the Sensitivity of Water Features

Sensitivity	Surface Water Hydrology	Hydrodynamic Modelling (River Don assessment)	Fluvial Geomorphology Vulnerability	Water Quality (Chemistry and Biological indicators)
High	A watercourse/hydrological feature with hydrological importance to: i) sensitive and protected ecosystems; ii) critical economic and social uses (e.g. water supply, navigation, recreation, amenity etc); iii) the flooding of property (or land use of great value) that has been susceptible to flooding in the past or is likely to be flooded in the future. Or a watercourse/floodplain/hydrological feature that provides critical flood alleviation benefits.	A watercourse with direct flood risk to the adjacent populated areas and/or presence of critical infrastructure units such as hospitals, schools, safe shelters, etc. In this scenario, the watercourse with any new development is highly sensitive to increase in flood risk by the possible increase in the water levels.	<u>Sediment regime</u> A watercourse supporting a range of species and habitats sensitive to a change in suspended sediment concentrations and turbidity such as migratory salmon or freshwater pearl mussels. Includes sites with international and European nature conservation designations due to water dependent. <u>Channel morphology</u> Watercourses exhibiting a range of morphological features such as pools and riffles. <u>Natural fluvial processes</u> Dynamic rivers, those which show evidence of channel migration and other morphological changes such as bar evolution.	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. International and European nature conservation sites designated due to water dependent ecosystems e.g. Special Protection Area and EC designated freshwater fisheries. Includes all nature conservation sites of national and regional importance designated by statute including SSSI, National Nature Reserves and Regional BAP.
Medium	A watercourse/hydrological feature with some but limited hydrological importance to: i) sensitive or protected ecosystems; ii) economic and social uses (e.g. water supply, navigation, recreation, amenity etc); iii) the flooding of property (or land use of value) that may potentially be susceptible to flooding. Or a watercourse/floodplain/hydrological feature that provides some flood alleviation benefits.	A watercourse with a possibility of direct flood risk to less populated areas without any critical social infrastructure units such as hospitals, schools, safe shelters and/or utilisable agricultural fields. In this scenario, the watercourse with any new development is moderately sensitive to increase in flood risk by the possible increase in the water levels.	<u>Sediment regime</u> A watercourse supporting limited species sensitive to a change in suspended sediment concentrations or turbidity. Includes non-statutory sites of regional or local importance designated for water dependent ecosystems. <u>Channel morphology</u> Watercourses exhibiting limited morphological features such as pools and riffles. <u>Natural fluvial processes</u> Rivers, which may be vulnerable to changes in fluvial processes.	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. Includes non-statutory sites of regional or local importance designated for water dependent ecosystems.
Low	A watercourse with minimal hydrological importance to: i) sensitive or protected ecosystems; ii) economic and social uses (e.g. water supply, navigation, recreation, amenity etc); iii) the flooding of property (or land use of value). Or a watercourse/floodplain/hydrological feature that provides minimal flood alleviation benefits.	A watercourse passing through uncultivated agricultural land. In this scenario, the watercourse with any new development would be less sensitive to increase in the flood risk by the possible increase in the water levels.	<u>Sediment regime</u> A watercourse which does not support any significant species sensitive to changes to suspended solids concentration or turbidity. <u>Channel morphology</u> Watercourses exhibiting no morphological diversity; flow is uniform gravel bars absent and bank types uniform and stable. <u>Natural fluvial processes</u> Watercourse which shows no evidence of active fluvial processes and which is not likely to be affected by modification to boundary conditions.	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.

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Interaction with Ecology

- 9.2.20 In line with the WFD and as mentioned in paragraph 9.2.7 and 9.2.19, the individual discipline sensitivities and the overall water environment sensitivities assigned to each watercourse were discussed with the project team's ecological specialists to take into consideration the links between physical processes and their dependent habitats.
- 9.2.21 To avoid double counting during the assessment, all direct assessments of freshwater ecology are reported in Chapter 10. 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.
- 9.2.22 Direct impacts on the flow and sediment regime, morphological diversity and water quality of watercourses can cause indirect ecological impacts. For ease of interpretation, Table 9.2 therefore illustrates how the Water Environment sensitivity categories described in this section relate to those used in the baseline assessment of aquatic ecology (Chapter 10).

Table 9.2 – Classification of watercourse sensitivity (Water Environment in relation to Ecology)

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

Impact Magnitude

- 9.2.23 The magnitude of impact was determined in accordance with the criteria shown in Table 9.3.
- 9.2.24 In a similar manner to the sensitivity assessment presented above, each water environment discipline evaluated the potential impacts, according to a defined set of criteria as listed in Table 9.3. Where quantifiable thresholds or accepted standards were not available, impact magnitude was determined using professional judgement. The impact assessment 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.
- 9.2.25 Where appropriate, cumulative catchment effects are considered within this assessment. This has been assessed on a qualitative basis only.

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Table 9.3 – Criteria to Assess the Magnitude of the Potential Impact on Water Features

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

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

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Impact Significance

- 9.2.26 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 9.4.

Table 9.4 – 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

Impact Assessment (Specific Methodology)

- 9.2.27 The technical reports (Appendices A9.1 to A9.4) set out the specific methodologies that were adopted to assess the sensitivity or vulnerability of each watercourse and potential impacts. This is summarised below for each discipline.

Surface Water Hydrology

- 9.2.28 The impact assessment of hydrology and flood risk included baseline estimates of seasonal flow duration curves, 95-percentile flow (Q_{95}), mean flow (Q_{mean}), bank full (Q_{BF}) and embankment full flow (Q_{EBF}), median annual maximum flood (Q_{MED}), mean annual maximum flood (Q_{BAR}), and flood design peak flows including the 1% and 0.5% annual exceedence probability (AEP) flows (also known as the 100-year and 200-year flood design peak flows). Necessary hydrological catchment characteristics were obtained from OS maps (soils, geological and land use) as well as the Flood Estimation Handbook CD-ROM. Flood risk assessment for the AWPR river crossing points included the review of SEPA 'Indicative River and Coastal Flood Map (Scotland)' (SEPA, 2006). The SEPA indicative flood risk maps have been designed to show the flood extent from watercourses and the sea of the 0.5% AEP (1:200 year return period) event. The SEPA flood risk maps, however, do not show the flood risk for watercourses smaller than 3km².
- 9.2.29 Potential hydrological pressures and impacts arising from the proposed scheme were highlighted along with potential post-development changes to the calculated parameters and potential changes to flood risk (including watercourses with catchment of less than 3km² using the 1:25000 OS Map) and flood plain inundation. An assessment of likely culvert blockage increasing flood risk was also undertaken by assessment of a range of parameters including the land use of the upstream catchment. Further information regarding the methods undertaken can be found in Appendix A9.1 (Surface Water Hydrology).
- 9.2.30 Baseline surface water catchments are shown on Figures 9.2a-e.

Allowance for climate change in hydrological parameters

- 9.2.31 Guidance on allowance for climate change has been taken from a scoping study regarding climate change and hydrological parameters (SEPA, 2005). SEPA does 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 (Environmental Group Research Report, 2003).
- 9.2.32 The Scottish Executive (2004) states in SPP7 (Planning and Flooding) that the threshold annual probability floods 0.5% (1:200 year return period) and 0.1% (1:1000 year return period) 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.

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- 9.2.33 Instead of designing to the 1% AEP (1:100 year return period), which historically has been standard practice, the 0.5% AEP (1:200 year return period) design flood event has been adopted which includes an allowance for climate change, as stated in SPP7. No guidance on the other hydrological parameters has been published by SEPA. Research work to date on these parameters indicates no clear regional patterns. No climate change factor is therefore suggested for these parameters, rather the guidance set out in SPP7, which is specific for Scotland, is followed.

Hydrodynamic Modelling

- 9.2.34 This assessment was undertaken to identify the flood risk from the River Don that would potentially result from proposed AWPR crossing structures. A one-dimensional hydrodynamic model was constructed for the River Don using data from a channel cross-section survey carried out by Jacobs in 2004. Figure 9.3b illustrates the extent of the hydrodynamic model.
- 9.2.35 To improve the confidence in the model results, a calibration process was undertaken. This process takes known water levels for the river and compares it to model predictions. Low flow calibration of the mathematical model was undertaken using water levels measured during channel cross-section survey in 2004. To augment this calibration, a series of sensitivity runs were carried out to investigate the sensitivity of the models to changes in model parameters.
- 9.2.36 Simulations for a range of annual probability of occurrence flood events (e.g. 1:200 year return period) were modelled and the resulting flood risk was determined in the vicinity of the proposed river crossings. This was completed for the River Don and ascertained both the baseline flood levels and the potential flood level as a result of several of the river crossing options. Further information regarding the methods undertaken can be found in Appendix A9.2 (Hydrodynamic Modelling Assessment), and indicative flood extents are presented in Figure 9.3ci-cii.

Fluvial Geomorphology

- 9.2.37 The approach adopted for this assessment differs from that followed in the other technical reports, as fluvial geomorphology does not have any 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, and therefore sensitivity, magnitude and significance criteria are not applied. However, the geomorphological processes and forms associated with each watercourse are vulnerable to change as a result of the proposed scheme, and this was evaluated.
- 9.2.38 Baseline conditions were identified through desk study and field investigation. The desk study utilised existing data sources to provide an insight into current geomorphological conditions and trends in river behaviour. The field study built on the findings of the desk study in order to determine the geomorphological forms and processes at each site.
- 9.2.39 The potential impacts were assessed by evaluating the potential change in baseline conditions (sediment regime, channel morphology and natural fluvial processes) that could result from the proposed scheme. As DMRB does not outline a specific methodology to enable the geomorphological impacts to be evaluated, the method adopted in this assessment was developed using the guidelines from Research and Development Programmes of the National Rivers Authority, Environment Agency and SNH. These guidelines are outlined in the DEFRA/Environment Agency '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 A9.3 (Fluvial Geomorphology).

Sediment Modelling

- 9.2.40 In addition to the general fluvial geomorphology and water quality assessments, more detailed assessment of sediment transport was undertaken for the River Don and Red Moss Burn, as described in paragraphs 9.2.41-43 below.

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9.2.41 Detailed sediment modelling of sediment transport downstream in the River Don was undertaken to enable the assessment of the possible impact of suspended solid concentrations on sensitive migratory salmonids (e.g. *Salmo salar*) as a result of the construction of the mainline approach road (proposed to slope down towards the crossing points on the river). Further details of the method undertaken are detailed in Appendix A9.5 (Annex 28) and Figure 9.3b indicates the extents of the sediment model.

9.2.42 Due to the proximity of Red Moss Burn to Corby Loch (part of the Corby, Bishop and Lily Loch SSSI) additional geomorphological assessment was conducted as part of the current CAR application process, to enable detailed site specific mitigation measures to be devised. The studies combined a Fluvial Audit to review catchment land use and watercourse hydrology, and a Substrate Mobility Assessment to determine mobility of the bed sediments along the watercourse. The results of these assessments are reported within this chapter as appropriate.

Water Quality

Baseline Assessment

9.2.43 Baseline water quality conditions for watercourses were identified through consultation with statutory consultees, review of relevant published literature, site visits and freshwater habitat sampling undertaken in 2004/2005.

9.2.44 Baseline conditions for watercourses are reported by SEPA in accordance with their River Classification Scheme (Appendix A9.5, 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 determined from the water chemistry, biology, nutrient, aesthetics and toxicity assessments.

Impact Assessment

9.2.45 Routine runoff is surface water collected as a result of rain falling on the road and draining into the highway drainage system and contains some of the pollutants deposited on the road surface but does not include seriously major pollution events resulting from vehicular collision (addressed in accidental spillage risk assessment)

9.2.46 The impacts of road drainage on the quality of the receiving waters were quantified (by assessing accidental spillage and potential pollution from dissolved copper and total zinc). Copper and zinc are used as indicators of the level of impact as they are generally the main metallic pollutants associated with road drainage and can be toxic to aquatic life in certain concentrations. The assessment method for ascertaining likely pollutant levels in receiving watercourses or likely potential risks follows DMRB methods. Two separate calculations are undertaken:

- pollution calculations (routine run-off assessment); and
- accidental spillage risk calculations.

9.2.47 The potential impacts that may occur during construction are similarly diverse and may occur from a wide range of incidents such as accidental spillage from site compounds, waterproofing of bridge decks and diversion of sewage networks. The potential impacts of these activities have been made qualitatively as described in Appendix A9.4 (Water Quality) and Table 9.3.

Pollution Calculations (Operational Impacts)

9.2.48 Routine run-off is surface water collected from the road as a result of rain falling on the road and draining into the highway drainage system and contains some of the pollutants deposited on the road surface but does not include seriously major pollution events resulting from vehicular collision (addressed in accidental spillage risk assessment).

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- 9.2.49 Pollution calculations were undertaken following the methods set out in the DMRB. These specify that the potential pollution in the receiving watercourse should be calculated assuming a high rainfall event coinciding with a low flow event in the receiving watercourse (Q_{95} low flow parameter). DMRB states that this calculated concentration can then be compared to the statutory Environmental Quality Standards (EQS) that exist for the Freshwater Fisheries Directive (FWFD; 78/659/EEC). These are expressed as 95 percentile values.
- 9.2.50 In addition to the FWFD, the Dangerous Substance Directive (DSD; 76/464/EEC) sets statutory EQS for dissolved copper and total zinc. These are expressed as annual average values. To ensure that the drainage proposals conform to the Dangerous Substances Directive, in addition to the Freshwater Fisheries Directive, the DMRB methodology requires a modification to predict a likely annual average concentration in the receiving watercourse. Consultation and ongoing discussion with SEPA, for this and other projects, resulted in an agreed modification to predict potential, indicative, annual average values in the receiving watercourse (SEPA; pers. comm. Clark, 2004c; Abrams, 2005b). The modified methodology specifies that the potential pollution in the receiving watercourse is calculated assuming the annual average rainfall occurs on one day coinciding with a mean flow event in the receiving watercourse (Q_{mean} average flow in the watercourse).
- 9.2.51 As a precautionary approach has been adopted for the assessment of water quality along the route, both calculations were performed for all receiving watercourses. These predicted concentrations were then used to inform the impact assessment. More information on the methodology and the EQS used (SEPA; pers. comm. Caffery, 2005) and contained in Statutory Instrument Circular 34/1985 (SDD, 1985) are detailed in Appendix A9.4.Spillage Calculations (Operational Impacts).
- 9.2.52 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 A9.4 (Water Quality) provides detailed accidental spillage calculation results.

Limitations to Assessment

- 9.2.53 This chapter deals with potential impacts as a result of the proposed scheme on surface water features while groundwater and groundwater-fed features are dealt with in Chapter 8. Specific technical limitations, relevant to each water environment discipline are detailed in the appendices to this chapter.

9.3 Baseline Conditions

- 9.3.1 Twenty watercourses/waterbodies, one artificial waterbody, the Mill Lade system, and a surface water spring were identified within the study area, which would either be crossed by the Northern Leg of the proposed scheme, or be in close proximity to it and be potentially affected. Descriptions of each of the water features are provided in Table 9.5, and the assigned sensitivities are explained below.
- 9.3.2 Where waterbodies were unnamed features, these have been assigned names to aid clarity of the assessment (e.g. Red Moss Burn), generally related to adjacent named areas such as woodlands. Chainages are provided for the purposes of identifying the water features shown on Figure 9.1a-g; this additional reference is necessarily approximate for certain features such as those which follow the route of the proposed scheme or those that cross it several times. Figure 9.2a-d show the surface water catchments of each potentially affected water feature, and Figure 9.2e gives a detailed location plan of the catchments of Corby and Lily Lochs.
- 9.3.3 Overall, the watercourses in the vicinity of the proposed scheme are considered to be of good quality from a hydromorphological and water quality perspective. Watercourses were evaluated as being between low and high sensitivity and each watercourse has been assessed in detailed in the technical appendices (Appendix A9.1 to A9.4). A summary of this information is provided below

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and in Table 9.5. The sensitivity of the watercourse for each individual discipline is presented and then the overall sensitivity is identified.

- 9.3.4 In line with the WFD and as mentioned in paragraph 9.2.7, 9.2.19 and 9.2.21, the individual discipline sensitivities and the overall water environment sensitivities assigned to each watercourse were discussed with the project team ecological specialists to ensure a consistent approach between physical processes and their dependent habitats. A summarised version of the baseline ecological findings is provided in Table 9.5.

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Table 9.5 – Northern Leg Water Feature Baseline and Sensitivity

Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Kepplehill Burn 0.3km ² u/s 1.1km ² total	n/a A2 Good	Tributary of Bucks Burn which rises at the foot of Brimmond Hill and flows into the River Don through the suburban area of Bucksburn (Bucks Burn rises in Kingswells). A Scottish Water reservoir is located in the upstream headwaters of the Burn. In the area of interest the burn flows through predominantly agricultural land and is very small, consequently the burn is considered to be of low sensitivity.	Shallow vegetated field drain with little morphological diversity. The bed consists predominantly of coarse gravel although silt lies on the bed where the flow is slow. In some locations cattle poaching leads to an increase in fine sediment load. The highly modified nature of the channel and low morphological quality means that the vulnerability of the watercourse is considered to be low .	Upper catchment is part of a Brimmond Hill District Wildlife Site (DWS) and Site of Interest to Natural Science (SINS). Despite the A2 spot sampling classification (completed by Jacobs), it drains predominantly agricultural land in the vicinity of the proposed crossing, is likely to receive road runoff downstream and is highly impacted by anthropogenic factors consequently the burn is considered to be of low sensitivity.	The RHS (River Habitat Survey) score indicated that the burn is severely modified and comprises a straightened embanked land drain. Results of the macroinvertebrate communities present indicate good water quality. Consequently the watercourse is considered to be of local ecological value.	Hydrology, geomorphology and water quality all indicate that this watercourse is of low sensitivity. This is reflected by the freshwater ecology assessment.
Gough Burn 1.1km ² u/s 2.9km ² total	n/a A1 Excellent	Rural tributary of the Green Burn which flows into the River Don. The watercourse displays the potential to support trout and lamprey and there exists a few properties in the area of interest. The watercourse is considered to be of medium sensitivity.	Pools and riffles with protruding boulders provide good morphological diversity. Both upstream and downstream of the proposed crossing the watercourse has been modified through straightening and walling. This means that in the context of its small catchment, this section of the Gough Burn is an important morphologically diverse watercourse, hence the watercourse is considered to be of high vulnerability.	The burn forms part of the Gough Burn DWS and SINS in its upper reaches. At the point of proposed crossing the burn is known to receive road drainage currently. Spot sampling (completed by Jacobs) has indicated that the burn is considered to have excellent water quality and is not considered to be impacted heavily by anthropogenic factors. Consequently the burn is considered to be of high sensitivity.	The RHS score indicated that the burn is severely modified, while macroinvertebrate sampling indicated that the water quality is excellent. Additionally a nationally scarce stonefly <i>Brachyptera putata</i> was identified at this burn. Despite the modification of the watercourse it is considered to be of regional ecological value due the presence of good habitat for otter, macroinvertebrates and fish.	Geomorphology and water quality have classified this watercourse as high sensitivity due to the important habitat these processes form (reflected by freshwater ecology). Therefore despite the hydrological assessment the watercourse is considered, overall, to be of high sensitivity.

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Water feature	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Parkhead Burn and field ditch 0.3km ² u/s 0.4km ² total	n/a n/a	Very small, rural tributary of Craibstone Burn, which flows into the Green Burn and eventually the River Don. The watercourse is considered to be low sensitivity.	Assessed by hydrology only.			Since the geomorphological and water quality assessments scoped this watercourse out based on size. Overall the sensitivity is considered to be low based on hydrological assessment.
Craibstone Burn 0.5km ² u/s 2.9km ² total	n/a A1 Excellent	Rural tributary of Green Burn which flows to the River Don. The watercourse displays the potential to support trout, lamprey and other freshwater species. As a result the watercourse is considered to be of medium sensitivity.	Channel is relatively steep and sinuous, winding through a wooded valley. Important morphologically diverse section of channel within the sub-catchment is located within the study area. Hence the watercourse is considered to be of high sensitivity.	Watercourse drains a predominantly woodland area and is a small, natural tributary of the Gough Burn. The water quality assumed to be excellent based on the results of the spot sampling (completed by Jacobs). In the location of the proposed crossing it is not thought to receive road drainage. Consequently the burn is considered to be of high sensitivity.	A nationally scarce stonefly <i>Brachyptera putata</i> was identified at this burn. Excellent habitat was identified for otters, fish and macroinvertebrates, consequently the burn is considered to be of regional ecological importance.	Geomorphology and water quality have classified this watercourse as high sensitivity due to the important habitat these processes form (reflected by freshwater ecology). Therefore despite the hydrological assessment the watercourse is considered, overall, to be of high sensitivity.
Craibstone Pond and field ditch	n/a n/a	Assessed by freshwater ecologists Please see summary in text for more details.			An ecologically important pond supporting amphibian populations and habitat suitable for water voles or shrews. Due to its importance to otters (foraging) the water feature is considered to be of county importance. (Chapter 10, Table 10.10) Field ditch not explicitly assessed.	Refer to Chapter 10, Table 10.10 Section NL2

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Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Green Burn 2.8km ² u/s 8.7km ² total	n/a A1 Excellent	Tributary of the River Don; lower reaches flow through suburban area of Bankhead, approximately 2km downstream of the proposed road. The watercourse displays the potential to support trout and lamprey. At road crossing point the SEPA Flood Maps indicate 0.5% AEP flooding within 25m of the channel. Floodplain of arable/pasture farmland and a section of the A96, with no properties identified. Similar to the Craibstone and Gough Burns, the burn is considered to be of medium sensitivity.	Extensively straightened, upper reaches exhibit more morphological diversity than downstream reaches. The channel is of relatively low gradient and therefore an increase in sediment loading as a result of disturbance may lead to detrimental increases in channel siltation, however these increases are unlikely to be drastic. As a consequence of the sediment regime the watercourse is considered to be of medium sensitivity.	Both Craibstone and Gough Burns join the Green Burn along its length before it outfalls to the River Don. Currently it receives high anthropogenic pressure as a result of being culverted extensively underneath, and, receiving road drainage from, the A96. Consequently, despite the the A1 spot sampling results (completed by Jacobs) the watercourse is considered to be of medium sensitivity.	A nationally scarce stonefly <i>Brachyptera putata</i> was identified at this burn. Excellent habitat was identified for otters, fish and macroinvertebrates. The RHS survey indicated that the burn was severely modified. However, despite the modification the burn is considered to be of regional ecological importance due to the presence of the stonefly.	Hydrology, geomorphology and water quality have all assessed the burn to be of medium sensitivity due to the level of modification and anthropogenic pressure it receives. Therefore, the burn is considered to be of medium sensitivity overall , despite the ecological assessment of regional value.
Walton Field Ditch 0.1km ² u/s 1.1km ² total	n/a n/a	Rural field drainage ditch. This small ditch drains predominantly agricultural land although there are some small properties located in the vicinity of the area of interest. However these are located outwith the predicted active floodplain. The watercourse is considered to be low sensitivity.	Assessed by hydrology only.			Since the geomorphological and water quality assessments scoped this watercourse out based on size, the overall sensitivity is considered to be low according to the hydrological assessment.

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Water feature	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Howemoss Springs	n/a n/a	Spring line within agricultural field which feeds the burn. The groundwater assessment has also indicated that old maps suggest that natural springs are evident in the area (Chapter 8 Geology, Contaminated Land and Groundwater, Baseline section). Since the burn is dependent on these springs the feature is considered to be of medium sensitivity.	Assessed by hydrology only			Since the geomorphological and water quality assessments scoped out this feature (since it is of interest largely to hydrology and hydrogeology only), Howemoss Springs are considered to be of medium sensitivity.
Howemoss Burn 0.4km ² u/s 4.3km ² total	n/a n/a	Burn is a tributary of the River Don, which is fed by the Howemoss springs mentioned above. It is extensively culverted underneath the Airport. In the area of interest there are currently no properties. The watercourse is considered to be of low sensitivity.	Historically straightened and over-deepened watercourse. The highly modified nature of the channel and low morphological quality means that the vulnerability of this watercourse is considered to be low .	This is a small burn currently acting predominantly as a drainage channel. The burn drains agricultural land in its upper reaches but as it flows towards Dyce Drive it is known to receive road drainage. Due to its size and the runoff it is likely to receive, the watercourse is considered to be of low sensitivity.	Not explicitly assessed due to its size, however considered to be of county importance to otters as part of an otter commuting route.	Hydrology, geomorphology and water quality all consider the burn to be of low sensitivity. Consequently, despite its importance to otters, in the area of interest the burn is considered to have an overall sensitivity of low .
Bogenjoss Burn 1.2km ² u/s 2.2km ² total	n/a A2 Good	Rural tributary of the River Don displaying the potential to support trout, lamprey and other sensitive species. The watercourse drains mainly agricultural land which is at limited risk to flooding. The watercourse is considered to be of medium sensitivity.	Upper Bogenjoss is a narrow, low sinuosity, medium gradient stream. However the lower section of the watercourse is highly sinuous set within a shallow v-shaped valley with good morphological diversity. Natural burn unconstrained and not modified in the lower reaches. The high quality of the lower section of the Bogenjoss Burn means that each geomorphological element has high vulnerability to disturbance.	The Bogenjoss Burn drains a wooded and agricultural catchment before outfalling to the River Don. From spot sampling (by Jacobs) the burn is considered to have good water quality and is considered to receive little anthropogenic impact currently as a result of agriculture and road drainage. Consequently the burn is of high sensitivity along the whole length for which it may be impacted.	Both proposed crossing points of the burn were assessed as good ecological value for macroinvertebrates (presence of the nationally scarce stonefly (<i>Brachyptera putata</i>), otters and fish (especially towards the downstream end). Therefore the burn is considered to be of regional ecological importance.	Geomorphology and water quality have classified this watercourse as high sensitivity due to the important habitat these processes form (reflected by freshwater ecology). Therefore despite the hydrological assessment the watercourse is considered, overall, to be of high sensitivity.

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Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
River Don 1228km ² u/s 1318km ² total	Fintray Bridge A2 (2004) A2 (2003) A2 Good	<p><u>Hydrology</u> Lower reaches flow through suburban area and the estuary is a Local Nature Reserve. A designated fisheries river and consequently of high sensitivity. At road crossing point the SEPA Flood Maps indicate 0.5% AEP flooding within 150m of channel. Floodplain of arable/pasture farmland, with no properties identified.</p> <p><u>Hydrodynamic Modelling</u> The River Don in this area is not predicted to pose a direct risk to flooding to critical infrastructure. For the purposes of the hydrodynamic modelling exercise the watercourse was considered to be of medium sensitivity.</p>	Clean, fast flowing watercourse with good morphological diversity. Riffles and pools are present and marginal emergent and submerged channel vegetation is common. The high geomorphological and ecological quality of the River Don means it has high vulnerability to disturbance.	SEPA sampling and the results of the spot sampling exercise (undertaken by Jacobs) indicate that the watercourse has A2 Good water quality with excellent oxygen saturation. The River Don is heavily managed, however water quality has improved in recent years. Watercourse is designated as a DWS. No known drinking water abstractions. Designated salmonid river. Consequently the watercourse is considered to be of high sensitivity.	This major watercourse is a designated fisheries river, a District Wildlife Ste (DWS) and supports an otter population, however the river is considered to be modified but of good ecological health, consequently it is considered to be of national ecological importance to fish but of international importance to otter.	From a hydrological, geomorphological and water quality perspective the river is considered to be of high sensitivity therefore the water environment sensitivity rating is high . This is supported by the freshwater habitat, fish and otter assessment.

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Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
<p>Goval Burn</p> <p>37km² u/s 40km² total</p>	<p>B977 Bridge B (2004) B (2003)</p> <p>A2 Good</p>	<p><u>Hydrology</u> Rural tributary of the River Don which is designated as a fisheries river. The burn is considered to be of high sensitivity. Flood inundation at proposed bridge crossing locations shown on SEPA Flood Maps to vary between 400-50m of channel. One property at risk of flooding (Goval Villa) and two roads (B977 and A947).</p> <p><u>Hydrodynamic Modelling</u> The Goval Burn in this area is not predicted to pose a direct risk to flooding to critical infrastructure. For the purposes of the hydrodynamic modelling exercise the watercourse was considered to be of medium sensitivity.</p>	<p>Watercourse has been realigned and deepened in the past but has re-naturalised. The channel bed comprises cobbles and gravels and exhibits good morphological diversity, consequently the watercourse is considered to be of high vulnerability.</p>	<p>Upstream of its confluence with the Goval Burn the Elrick Burn is classified by SEPA as Class B while spot sampling (undertaken by Jacobs) indicates that it is of A2 Good quality. Downstream on the Goval Burn the water quality is classified as B fair. Designated salmonid river, which discharges directly to the River Don, which is another designated salmonid River. Consequently the watercourse is considered to be of high sensitivity.</p>	<p>Despite being severely modified (RHS assessment) the watercourse was found to have good ecological value. It is a designated fisheries river, supports an active otter community and offers a good spawning habitat for salmonids. Consequently the burn is considered to be of regional importance to fish but of international importance to otter.</p>	<p>From a hydrological, geomorphological and water quality perspective the river is considered to be of high sensitivity, therefore the water environment sensitivity rating is high. This is supported by the freshwater habitat, fish and otter assessment.</p>

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Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Mill Lade (Parkhill Aqueduct)	n/a n/a	Artificial watercourse system with a shallow gradient. Please refer to Appendix A9.5 Annex 20 for a fuller description. Since a small change may impact the hydrological functioning of the Lade it is considered to be of medium sensitivity.	Artificial watercourse with no flow variation and poor morphological diversity. Therefore the watercourse is considered to be of low vulnerability.	Artificial watercourse, slow flow and likely to have poor water quality due to lack of dissolved oxygen. The burn is an artificial watercourse and hence is considered to be of low sensitivity.	Since this feature is artificial it was not surveyed using the RHS methodology, but its link to the Goyal Burn makes it an important habitat for fish and otters. It is considered to be of local value due to its macroinvertebrate communities.	From a water quality and geomorphological perspective the watercourse is considered to be of low sensitivity, while the hydrological assessment indicates that it is of medium sensitivity. Since this sensitivity rating is not based on potential flood risk, the overall sensitivity of the burn from a water environment perspective is considered to be low .
Corsehill Pond	n/a n/a	Assessed by freshwater ecologists. Please see summary in text for more details.			Due to its importance to otters (foraging and commuting) the water feature is considered to be of county importance (Chapter 10, Table 10.10)	Refer to Chapter 10, Table 10.10 Section NL4

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Water feature	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Corsehill Burn 1.8km ² u/s 2.6km ² total	n/a A2 Good	Rural tributary of the Goval Burn which joins the River Don. Watercourse displays the potential to support trout and has a confluence with the Goval Burn, a designated fisheries river, in the area of interest. The burn is considered to be of medium sensitivity.	Extensively straightened and realigned to follow field boundaries. As the channel has been subject to significant past modification both the morphological diversity and fluvial processes operating are of low vulnerability. However, as this watercourse joins the Goval Burn, which is of high vulnerability, changes to the sediment regime, which can be transmitted downstream, may have some impact on the Goval Burn. This means the vulnerability of the sediment regime is medium , as is the overall vulnerability of the watercourse.	This is a small burn with a confluence with the Goval Burn. Currently it flows through predominantly agricultural land and may receive road drainage along its length. However spot sampling (undertaken by Jacobs) indicates that the water is likely to be of good quality. Since the area of interest is directly adjacent to its confluence with the Goval Burn (a fisheries river) and despite the anthropogenic pressure on the burn, the watercourse is considered to be of medium sensitivity.	The Corsehill Burn is considered to be important to otter, acting as an important commuting route near the River Don. In terms of macroinvertebrates the watercourse is considered to be in good ecological health, however in combination with its modified nature, the watercourse is of local ecological importance.	Hydrology, geomorphology and water quality have all classified the watercourse to be of medium sensitivity. This is reinforced by the ecological assessment of the watercourse. Therefore the overall sensitivity of the watercourse is considered to be medium .
Lochgreens pond	n/a n/a	Assessed by freshwater ecologists Please see text for more information			Due to its importance to otters (foraging and commuting) the water feature is considered to be of county importance. (Chapter 10, table 10.10)	Refer to Chapter 10, Table 10.10 Section NL5

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Water feature	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Red Moss Burn 1.3km ² u/s 1.5km ² total	n/a B Fair	Rural burn draining from Red Moss to Corby Loch (SSSI), the outfall of which is the Burn of Mundurno. The loch is considered together with the watercourse and is consequently considered to be of medium sensitivity.	Channel is straightened and over-deepened with limited morphological diversity. The sediment regime of the burn is an important control on the quality of the marsh habitat at the Loch inlet (Corby Loch SSSI). The vulnerability of the sediment regime is medium, while the low morphological diversity and walled nature of the channel means that the channel morphology and natural fluvial processes are of low vulnerability. Consequently the overall geomorphological vulnerability of the watercourse is considered to be medium .	The Red Moss Burn is a highly modified watercourse receiving run-off polluted by local agricultural activities and potentially road runoff. The water quality of the burn is likely to be a control on the quality of the habitats in the SSSI located downstream. Spot sampling results (undertaken by Jacobs) indicate that the watercourse is likely to have fair water quality. A combination of the important SSSI downstream, anthropogenic pressure and fair water quality meant that the burn is considered to be of medium sensitivity.	The fish assessment indicated that a partial barrier to fish movement is present on the Red Moss Burn, consequently the burn is considered to be of local value. However, the fair ecological value demonstrated by the macroinvertebrate communities present indicated that the burn is considered to be of county importance. The burn is also considered to be of importance to commuting otters.	From a hydrological, geomorphological and water quality perspective the burn is considered to be of medium sensitivity principally for its control over the SSSI habitats located downstream. The overall sensitivity of the watercourse is considered to be medium .
Corby Loch 3.6km ² total (including Lily Loch 1.2km ² catchment)	n/a n/a	Forms part of a SSSI, and shares a basin with Lily Loch. Red Moss Burn feeds Corby Loch. The loch is also fed by groundwater, rain directly falling on the loch and surface runoff. There is no surface channel connecting Corby and Lily Lochs. Consequently this loch was considered to be of high sensitivity.	Assessed explicitly by Hydrology only, although potential impacts from the scheme would only arise from changes to Red Moss Burn. Consequently refer to the Red Moss Burn assessment.		Not explicitly surveyed for macroinvertebrates however the sites are identified as important areas for otters.	From a hydrological perspective the loch is considered to be of high sensitivity. Since the geomorphological and water quality assessments have evaluated the sensitivity of Red Moss Burn, rather than the loch separately, the loch is considered to be of overall high sensitivity.

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Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Lily Loch 1.2km ² total	n/a n/a	Forms part of a SSSI. Thought to be fed by a combination of an inflow channel (Lily Loch Inflow Channel), groundwater, rain directly falling on the loch and surface runoff. Water level measurements taken in the field suggest Lily Loch provides water to Corby Loch. Although both lochs are likely to be groundwater-fed the higher water levels recorded on Lily Loch indicate that surface water may flow from Lily to Corby Loch. This loch was considered to be of high sensitivity.	Assessed by hydrology only.		Not explicitly surveyed for macroinvertebrates however the sites are identified as important areas for otters.	From a hydrological perspective the loch is considered to be of high sensitivity. Refer to Figure 9.2e
Bishops Loch 0.5km ² total	n/a n/a	Designated SSSI, AWPR is not within its catchment therefore this has not been specifically assessed.				

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Water feature Catchment area (total, and upstream of AWPR only: u/s)	SEPA Class (where classified) and Spot Sampling (by Jacobs)	Surface Water Hydrology	Fluvial Geomorphology Vulnerability	Water Quality	Freshwater Ecology (refer to Chapter 10 for more information)	Overall Sensitivity/ Vulnerability
Blackdog Burn 5.4km ² u/s 8.1km ² total	U/S Tarbothill Landfill A2 (2004) A2 Good	The watercourse drains directly to the North Sea and the downstream reaches fringe a coastal Aberdeen DWS. The burn displays a potential to support trout and lamprey (present near outfall to sea only). At the road crossing point the SEPA Flood Maps indicate 0.5% AEP flooding. There appears to be no properties in the flood risk area with the floodplain consisting of arable and pasture farmland. In the areas of interest the burn is considered to be of medium sensitivity.	Narrow gravel bed stream which has been subjected to past modification. The highly modified nature of the channel and low morphological quality means that the vulnerability of this watercourse is low .	The watercourse receives pollution from Tarbothill Landfill, agriculture, road drainage (A90) and urban run-off (Potterton). However, the watercourse is of a reasonable size and sampling from SEPA indicates that it has good water quality, which is also reflected in the spot sampling results (undertaken by Jacobs). Therefore the burn is considered to be of medium sensitivity.	At the upstream end of the area of interest, it is considered that during low flows, there exists a partial barrier to fish, hence the burn is of local importance. However due to the macroinvertebrate population present the burn is considered to be of county importance.	Both the hydrological and the water quality assessments have indicated that the burn is of medium sensitivity. The geomorphological assessment suggests that the burn is of low sensitivity. Based on the precautionary approach adopted the burn is considered to be of medium sensitivity.
Blackdog Ditch 0.2km ² u/s 0.2km ² total	n/a n/a	Small straightened tributary of the Blackdog Burn, flood risk detailed above includes this tributary (low)	Small straightened tributary of the Blackdog Burn (low)	Small, straightened field tributary of the Blackdog Burn. Due to proximity of Blackdog Burn the sensitivity is considered to be the same (medium)	Not explicitly assessed due to size, however it should be considered in conjunction with the Blackdog Burn	Due the proximity of the watercourse to the Blackdog Burn the overall sensitivity is considered to be similar and therefore of medium sensitivity.
Middlefield Burn 0.4km ² u/s 1.5km ² total	D/S Blackdog Ind. Estate SWS A2 (2004) n/a	Very small rural burn and drainage ditches. Unlikely to be critical to flood risk in the area. The burn is considered to be of low sensitivity .	Straight, narrow ditch carrying field drainage. The highly modified nature of the channel and low morphological quality means that the vulnerability of this watercourse is low .	Agricultural drainage channel. Receives high anthropogenic pressure; receives road drainage from A90 currently; culverted extensively underneath the A90. Consequently, despite SEPA monitoring good water quality, based on its size and receiving pressures it is considered to be of low sensitivity from a water quality perspective.	Not explicitly assessed due to its size.	All three technical assessments have assessed this burn to be of low sensitivity. Consequently the burn is considered to be of low sensitivity.

Summary of Watercourse Sensitivity

Kepplehill Burn (ch315200)

Parkhead Burn and Field Ditch (ch316700)

Walton Field Ditch (ch317825)

- 9.3.5 Kepplehill Burn is a tributary of Bucks Burn, which eventually drains to the River Don. This watercourse is a shallow vegetated field drain that has been evaluated as being of low sensitivity from a geomorphological perspective due to its size and extensively modified nature. Similarly, the water quality assessment and hydrology assessment classed the burn as low sensitivity. Consequently, the overall sensitivity is considered to be low.
- 9.3.6 Walton field ditch and Parkhead Burn and field ditch are narrow, vegetated drainage lines that were scoped out of the water quality and geomorphological assessment based on their size. From a hydrological perspective, neither of these burns are considered to present a risk of flooding to sensitive areas or to support sensitive species. Consequently, these burns were both considered to be of overall low sensitivity for the water environment assessment.

Howemoss Springs/Burn (ch318600)

- 9.3.7 Howemoss Burn is a tributary of the River Don and is fed by Howemoss Springs in its upper catchment. It is a small drainage channel that was assessed as being of low sensitivity from a hydrological, geomorphological and water quality perspective due to its extensively straightened and modified nature. Consequently, the overall sensitivity of the watercourse was considered to be low.
- 9.3.8 However, the groundwater springs at its upstream end (Howemoss Springs) are considered to be of medium hydrological sensitivity. Water quality and geomorphological assessments did not include the springs, but the water feature was assessed once it became a watercourse (Howemoss Burn). Consequently, the overall sensitivity of the water feature is considered to be medium. Groundwater is considered in Chapter 8.

Gough Burn (ch316390)

Craibstone Burn (ch316990)

Green Burn (ch317300)

- 9.3.9 These three burns in the Craibstone area are considered individually, but also on a sub-catchment basis. Together, Gough, Craibstone and Green Burns form a small sub-catchment eventually draining to the River Don near Waterton House (OS ref: NJ 897105).
- 9.3.10 The morphological diversity, excellent water quality and sinuous nature of the Gough and Craibstone Burns results in these watercourses being considered to be of high sensitivity. The upper reaches of the Gough Burn run through a District Wildlife Site (DWS) and Site of Interest to Natural Science (SINS) designated partially for geomorphological interests. The SEPA Indicative River and Coastal Flood Maps (Scotland) suggest that, for the 0.5% AEP (1:200 year return period) event, areas of floodplain surrounding these burns may be flooded (which consists of arable/pasture farmland and a section of the A96). From a hydrological perspective, both burns are considered to be of medium sensitivity as there are limited areas potentially at risk from flooding. Based on the precautionary approach explained earlier, the overall sensitivity for the water environment is considered to be high.
- 9.3.11 Green Burn is more modified in nature than Gough or Craibstone Burns and in its upstream reaches it also runs through a DWS and SINS. It is extensively walled with moderate morphological diversity and was therefore assessed to be of medium sensitivity for geomorphology. Similarly, both water quality and hydrology assessed the watercourse to be of medium sensitivity due to the level of anthropogenic pressure the burn receives from the A96. The overall sensitivity assessment for this burn is consequently medium.

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- 9.3.12 Parkhead Burn, discussed previously, is a small contributor to the sub-catchment, and considered to be of low sensitivity.

Bogenjoss Burn (ch320100-320870)

- 9.3.13 Bogenjoss Burn runs through Kirkhill Forest and along the eastern boundary of East Woodlands. It drains to the River Don and was evaluated as being of overall high sensitivity due to its largely unmodified state. The burn displays good morphological diversity and at both the upstream and downstream crossing points is sinuous and natural in nature. The burn has good water quality, as presented in the water quality assessment, and is expected to provide valuable habitats in its lower reaches as discussed in Chapter 10 (Ecology). The hydrological assessment classified the burn as medium sensitivity due to limited areas at risk for potential flooding. However, following the precautionary approach presented, the overall sensitivity of the watercourse is considered to be high. For consistency, the burn at both proposed crossing points is assessed as a high sensitivity feature.

River Don (ch323150)

- 9.3.14 The River Don is considered to be of high sensitivity due to good morphological diversity and water quality. The watercourse is sampled regularly by SEPA and these records show that for both 2003 and 2004 the watercourse has Class A2 'good' water quality. Additionally, the River Don is designated as a salmonid fishery river under the Freshwater Fisheries Directive (78/659/EEC) and is identified as a DWS. There are no known drinking water abstractions from the River Don. The River Don is a large watercourse which has active floodplains and is known to flood in the area of interest. Figure 9.3a shows the extent of these historic floodplains in the proximity of the proposed scheme crossing. The SEPA Indicative River and Coastal Flood Maps (Scotland) suggest that in the vicinity of ch323150 the River Don will flood at the 0.5% AEP (1:200 year return period) event within 150m of the channel. This flood risk area consists of arable and pasture farmland, with no properties identified. The results of the flood risk assessment for the River Don is provided in Appendix A9.2 (Hydrodynamic Modelling).

- 9.3.15 The hydrological, geomorphological and water quality assessment indicated that the river was of high sensitivity. However, the hydrodynamic modelling exercise indicated that due to the absence of critical infrastructure located in areas of flood risk, the watercourse was of medium sensitivity. Adopting the precautionary approach, the watercourse is considered to be of overall high sensitivity.

Goval Burn (ch324520)

Mill Lade and associated reservoir (ch323950)

- 9.3.16 Goval Burn, the largest of the burns in the Northern Leg, was evaluated as being of overall high sensitivity. The Goval Burn is a tributary of the River Don flowing through a rural area and is designated as a salmonid fishery river under the Freshwater Fisheries Directive. There are no known drinking water abstractions from the Goval Burn in the area of interest. SEPA water quality sampling data indicate that the water quality is Class B 'fair'. The watercourse has been heavily modified and it displays poor morphological diversity. However, due to the important habitats (both salmonids and otters) present along this watercourse, it has been classed as high sensitivity.

- 9.3.17 In a similar manner to the River Don, the hydrological, geomorphological and water quality assessments have classified the burn to be high sensitivity, however the hydrodynamic modelling exercise classified the burn of medium sensitivity. This is because much of the floodplain supports agricultural land rather than critical infrastructure. Adopting the precautionary approach, the overall sensitivity of the watercourse is considered to be high. As the Goval Burn has a confluence with the River Don it was included in the hydrodynamic modelling assessment, reported in Appendix A9.2.

- 9.3.18 The Mill Lade is associated with the Goval Burn through a complicated, historic pumping system, which includes a reservoir upstream of the study area. The height difference between the Mill Lade and Parkhill Aqueduct pumping station provided sufficient hydraulic head to pump spring water

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from Kennel Park, Aryburn and Todhill springs to Dyce (more information on this structure can be found in Chapter 13 (Cultural Heritage). Due to its constructed, artificial nature and slow flow regime, it was evaluated as being of low water quality and geomorphological sensitivity. However, its surface water hydrology was considered to be of medium sensitivity due to its complicated hydraulic nature. As the sensitivity of the hydrological assessment is not driven by flood risk, the overall sensitivity of the artificial watercourse is considered to be low.

Corsehill Burn (ch324950)

- 9.3.19 Despite being a heavily modified watercourse with moderate morphological diversity, Corsehill Burn was considered to be of medium sensitivity due to its proximity to the Goval Burn which is a designated salmonid river. This is reflected by all three technical discipline assessments.

Red Moss Burn (ch327400)

Corby/Lily Loch (ch327800)

Bishops Loch (ch326400)

- 9.3.20 Red Moss Burn is a small straightened field ditch which feeds into Corby Loch and Lily Lochs. These lochs form part of the Corby, Lily and Bishops Lochs SSSI. Therefore potential impacts on hydraulic regime, water quality and geomorphology may impact on the SSSI. All three separate assessments have suggested a burn sensitivity of medium, consequently the overall sensitivity assessment defaults to medium sensitivity.
- 9.3.21 Corby and Lily Lochs are located in a local depression with an approximate overall surface water catchment of 4.8km². Red Moss Burn drains into Corby Loch, and Lily Loch Inflow Channel drains into Lily Loch. Both lochs are also thought to be fed by groundwater, rain directly falling on the lochs and surface run-off. Water level measurements suggests that water in Lily Loch (76.46m OAD) flows to Corby Loch (76.16m AOD) before outfall into the Burn of Munduro, although there is no surface channel connecting these lochs.
- 9.3.22 Bishops Loch is located to the west of these lochs, yet its catchment falls entirely outwith the road corridor and therefore is not considered further.
- 9.3.23 For the purposes of assessment, the water quality and geomorphological assessments dealt with the Red Moss Burn only as it was considered to be the main control on the loch features. However, the hydrological assessment considered the lochs separately in order to identify the hydrological controls on the water bodies. The hydrological assessment suggested that these features should be treated as high sensitivity, consequently Corby and Lily Lochs are also assessed as of high overall sensitivity.

Blackdog Burn and Blackdog Ditch (ch329950 and ch330065)

- 9.3.24 Blackdog Burn is a heavily modified watercourse with low geomorphological diversity and consequently considered to be of low geomorphological sensitivity. The burn currently receives untreated road drainage from the existing A90 in the vicinity of the area of interest. Both the hydrological and water quality assessments suggest medium sensitivity based on the presence of sensitive species, good water quality and no properties at risk from flooding. Blackdog ditch is a very small tributary of this watercourse.
- 9.3.25 Overall, Blackdog Burn and Ditch were considered to be medium sensitivity.

Middlefield Burn (crossing the A90 at the proposed Blackdog Junction)

- 9.3.26 Middlefield Burn was evaluated as being of low sensitivity due to its size and extensively modified nature for all three assessments. Middlefield Burn currently receives untreated road drainage from the A90 in the vicinity of the area of interest. Overall, the burn is considered to be of low sensitivity.

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Craibstone Pond and field ditch (ch317150)

Corsehill Pond (ch 3251300)

Lochgreens Pond (ch326500)

- 9.3.27 These ponds are very small and have been assessed by the project team's freshwater ecologists as well as having been surveyed for otters, water voles, amphibians, bats and water shrew (Ecology Appendices A10.6, A10.8, A10.9, A10.13 and A10.14, respectively). A summary of the baseline assessment is included below. It should be noted that this has not specifically formed part of the assessment for the water environment.

Craibstone Pond

- 9.3.28 An ecologically important waterbody, Craibstone Pond has abundant aquatic and marginal plant species and areas of willow scrub and wet woodland in its immediate vicinity. A large irregular shaped artificial pond (approximately 1048m²). In places, the pond is shallow dropping approximately 1m towards the centre. The feature was surveyed for otters and amphibians; palmate newts were recorded. No otters were recorded, however, evidence of otters was recorded on a small drainage ditch that links the pond to Craibstone Burn.

Corsehill Pond

- 9.3.29 Corsehill Pond is an isolated small rectangular artificial shaped pond (approximately 223m²) surrounded by marshy grassland. The water depth ranged from approximately 30cm to 1.5m. There is a lack of shading around the pond, and a low proportion of nearby terrestrial habitat. The feature was surveyed for otters and amphibians. A common frog was recorded. No other signs were recorded, however, evidence was recorded on Corsehill Burn approximately 100m to the south.

Lochgreens Pond

- 9.3.30 This is an isolated small oval artificial pond (approximately 400m²) surrounded by marshy grassland. The depth at the water's edge was approximately 30cm. There is a lack of shading around the pond and a low proportion of nearby terrestrial habitat. Surveys for otters and amphibians did not record any evidence of their presence.

Groundwater Baseline

- 9.3.31 The details of the groundwater baseline assessment are provided in Chapter 8 (Geology, Groundwater and Contaminated Land), including details of wells and springs used for domestic and/or agricultural water supply, and of relevance to the Water Environment assessment, also considers the groundwater connectivity of Lily, Corby and Bishops Lochs SSSI.

9.4 Potential Impacts

- 9.4.1 Potential impacts on surface water features as a result of road construction are described for each of the four specialist disciplines described in Section 9.2 (Approach and Methods). While impacts upon groundwater are summarised here, the assessment is reported in full in Chapter 8.
- 9.4.2 This section provides a description of generic impacts that may potentially occur due to the proposed scheme, which then forms the basis for the specific impacts for each water feature identified in the baseline conditions.
- 9.4.3 It is emphasised that the potential 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. The residual impacts of the scheme, following mitigation, are presented in Section 9.6.

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Generic Impacts

9.4.4 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 run-off or accidental spillage;
- Watercourse crossings: constriction or severing of established flow paths leading to increased flood risk, and changes to sediment regime via changes to gradient and size of watercourse, leading to impact on geomorphology and subsequently water quality;
- Watercourse realignments: can change the catchment of the watercourse leading to increased local flood risk, and change sedimentation patterns along the watercourse;
- Watercourse re-direction to pre-earthworks, or catchment severance; and,
- Construction: changes to surface water hydrology may lead to localised flood risk, potential for increased sediment release and changes to erosion/depositional patterns as a result of the construction of culverts/realignments, and the potential for increased accidental spillage of pollutants such as concrete or oils during the construction process.

9.4.5 It should be noted that the Water Environment assessment of the Southern Leg (Chapter 24) and Fastlink (Chapter 39) includes consideration of the potential impact of network culverts. These are pipes forming part of the road drainage system, necessary to convey drainage underneath the road. However, in the Northern Leg of the proposed scheme, the only network culvert required is as a mitigation measure for severance of the Lily Loch catchment, and this is therefore discussed in Section 9.5 (Mitigation).

9.4.6 Potential impacts are discussed further below.

Road Drainage Impacts

Surface Water Hydrology

9.4.7 The proposed scheme would introduce new impermeable areas to the watercourse catchment. It is estimated that the road surface area of the proposed scheme would be approximately 0.37km². 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 run-off 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). 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. Additionally, in some cases small watercourses may be redirected into pre-earthworks drainage ditches. This may result in the transfer of water from one catchment to another via the drainage system and could increase flows to some watercourses while reducing flows in others.

9.4.8 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 Red Moss Burn could result in indirect impacts on bird populations in Corby Loch. Any potential ecological impacts on habitats of this type are assessed in Chapter 10.

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

Fluvial Geomorphology

9.4.10 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:

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

9.4.11 The polluting load carried in road run-off 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.

9.4.12 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 run-off is directed.

9.4.13 There is the potential for scour to occur at drainage structure outfalls. This may lead to local increases in sediment supply/deposition, localised alterations to flow, and changes to channel morphology. These potential impacts are likely to be highly localised and can be minimised or avoided through design, as described in Section 9.5 (Mitigation).

Water Quality

9.4.14 Impacts on water quality are principally caused by pollutants carried in road run-off 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
- rock salt and alternative de-icing agents.

9.4.15 Metals in road run-off contaminants include copper, zinc, lead, and nickel. As noted in Section 9.2 (Approach and Methods), dissolved copper and total zinc concentrations are used as indicators to assess the pollution levels from road run-off. 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 both the DSD (76/464/EEC) and the FWFD (78/659/EEC).

9.4.16 Research has demonstrated that the fine fraction (< 63µm) of sediments is the most important source of pollution (Hamilton & Harrison, 1991). DMRB indicates that fine sediments can adversely affect fish, invertebrates and plants by smothering them. 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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- 9.4.17 Oil and related compounds represent 70-80% of hydrocarbons found in surface run-off; this contamination can have both 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.
- 9.4.18 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 river bottom, also leading to the death of aquatic species.
- 9.4.19 Rock salt, used during the winter months, can cause localised impacts on the environment, as increased chloride levels in the environment may have impacts on fish and freshwater invertebrates.
- 9.4.20 Appendix A9.4 (Water Quality) provides detailed pollution and accidental spillage calculation results.

Watercourse Crossing Impacts

- 9.4.21 As described under Specific Impacts (paragraphs 9.4.46 onwards), bridges are proposed at the crossing over the River Don and the Goval Burn. At all other locations culverts are proposed. For the purposes of identifying potential impacts, culverts are assessed assuming a box-shaped concrete structure containing no bed substrate. However, it should be noted that modification of this basic design to a depressed invert box culvert incorporating bed substrate is included in the road design as mitigation (Section 9.5) to reduce the potential impacts identified in this section.

Surface Water Hydrology

- 9.4.22 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, wetlands). Impacts of watercourse crossings on the surface hydrology could occur through alteration of the physical flow and water level regimes:
- potential for localised increased flood risk upstream as a result of proposed watercourse crossing (either as a direct result of the crossing or as a result of culvert blockage); 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

- 9.4.23 Watercourses would generally be culverted underneath the road, although at certain locations a bridge would be constructed.
- 9.4.24 Culverts would be sized to convey a range of flows. This assessment assumes a culvert would be installed level with the existing watercourse bed, effectively providing artificial bed and banks. Impacts on the geomorphology have been predicted on the basis that the iterative approach adopted by Jacobs during outline design has enabled scheme development of culverts that would be appropriately sized for hydraulic purposes.
- 9.4.25 An artificial bed such as a culvert 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, leading to sedimentation within the culvert and therefore reducing capacity over time, which may increase flood risk and lead to sediment starvation downstream. Where culverting increases channel

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gradient, scour of the bed and banks at culvert outlets often occurs leading to an increase in the supply of sediment to the watercourse.

- 9.4.26 The morphological diversity of a watercourse within the culvert is greatly reduced due to artificial bed and banks. Interruption of morphological continuity will also segment the watercourse. Culverts would constrain the channel preventing lateral and vertical adjustment, and soils may be more susceptible to erosion, where light deficiency limits the potential for roots to bind the bankside material.
- 9.4.27 Where watercourses are to be bridged, geomorphological impacts are reduced. A bridge will not constrain the bed in the same way that a depressed invert culvert does, although banks may still be constrained. Bridging watercourses tends to allow for the continuity of the riparian zone along both sides of the watercourse, maintaining morphological diversity and channel sinuosity.

Water Quality

- 9.4.28 Construction of the Northern Leg of the proposed scheme involves approximately 28 crossings of the previously identified watercourses (in addition to a proposed reconstruction of the Parkhill Aqueduct). As noted above, culverting could potentially change the riverbed morphological diversity and sediment regime of the watercourses, and this may have an associated impact on water quality by releasing previously locked contaminants into the water column. As bridge structures are likely to have a lesser geomorphological impact, they are also likely to have a reduced impact on water quality.
- 9.4.29 Culverts may also impact on water quality due to oxygen sags caused by the lack of light and rapid microbiological degradation of biodegradable matter. Bridge structures will tend to allow better light penetration and therefore have less impact on water quality.

Watercourse Realignment Impacts

Surface Water Hydrology

- 9.4.30 Realignment would 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. Where catchments are severed, impacts may occur from the changes to the current response of the catchment and watercourse, leading to a potential increase to the flood risk of the affected watercourse.
- 9.4.31 At certain locations along the proposed scheme, watercourses and drainage ditches have been designed to discharge directly to the drainage system, rather than installing a culvert to allow connectivity across the route. This would impact on the hydrology of the downstream watercourse, which would lose any input from the upstream catchment. However, this has only been proposed on very small watercourses/drainage ditches, all of which are considered to be of low sensitivity and ecological value. As part of the CAR application process this would be agreed with SEPA.

Fluvial Geomorphology

- 9.4.32 Watercourse realignment may lead to a change in the geomorphological behaviour of the watercourse over time. Realignment can result in changes to sediment supply, rate of sediment transfer downstream and deposition zones. Changes to watercourse bank materials through the realignment to more erodible types would be likely to increase the volume of sediment supplied to the channel. Increases in channel gradient as a result of realignment would result in an increase in stream power, leading to greater erosion rates which generally reduces channel stability and promotes sedimentation downstream. Conversely, a reduction in channel gradient is likely to lead to increased deposition within the channel, leading to negative impacts on morphological diversity and potential changes to flood regime.

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- 9.4.33 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

- 9.4.34 As with culverting, 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.

Watercourse Redirection into Pre-earthworks Drainage, or Catchment Severance

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

- 9.4.36 Pre-earthworks ditches are a series of drains which would run along the edge of the proposed scheme, either at the toe of embankments or at the top of cuttings, collecting clean water runoff from the surrounding land. The ditches then discharge to local larger watercourses.

Surface Water Hydrology

- 9.4.37 Where watercourses, or the flow from severed catchments would be redirected into pre-earthworks drainage, two main potential impacts may occur:

- loss of watercourse downstream due to change of channel; and
- potential increase to flood risk (this may have an associated impact on watercourses receiving road drainage outfalls).

Fluvial Geomorphology and Water Quality

- 9.4.38 The watercourse that currently exists downstream would be lost due to redirection into pre-earthworks drainage. Therefore, an assessment of the impacts on 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 both the operational and construction phase.

Construction Impacts

- 9.4.39 The majority of construction impacts upon the water environment are of short-term duration, although in some cases these may have longer term indirect impacts upon dependent freshwater habitats. For example, during construction the geomorphological and water quality assessments have considered the potential for an accidental spillage or short, intense release of suspended solids. This would tend to be released in a plume which may have a short-term impact upon the watercourse which lasts as long as the pulse of the contamination. Specific potential impacts assessed for each discipline are described below.

Surface Water Hydrology

- 9.4.40 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.

- 9.4.41 During the construction phase other temporary works that potentially may affect surface hydrology include the following:

- watercourse diversions to facilitate culvert or bridge construction and any associated temporary works;
- watercourse diversions and re-direction through constructed realignments;

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

Fluvial Geomorphology

- 9.4.42 Potential impacts during the construction phase are similar to those of the operational phase except they are short-term and generally more intense. There are a higher number of sources of impacts relating to suspended solids, and include run-off from plant and vehicle washing, excavations and blasting and excavation of road drains. Vegetation near the watercourse would also be cleared for construction works, which would influence bank stability.
- 9.4.43 The magnitude of impact is dependent on the scale of excavations and need for blasting at each location. Blasting for example is only likely to be used near Bogenjoss Burn for the construction of the cutting. The magnitude of impacts is also dependent on the scale of the works, for example if realignment and several culverts are required on one watercourse, the extensive nature of the works in one area would lead to an increased risk to the watercourse. Weather conditions would also influence the magnitude of impacts, as impacts would generally be far more severe if there are intense or prolonged rainfall events during the construction phase.
- 9.4.44 Table 9.6 summarises potential geomorphological impacts during construction. As discussed previously, geomorphological impacts would also affect water quality.

Table 9.6 – Potential Construction Impacts on Fluvial Geomorphology

Source of Impact	Potential Effects
<u>Suspended Solids</u> Can result from excavations, blasting, run-off from stockpiles, plant and wheel washing, run-off from site roads, run-off during embankment construction, earthworks and landscaping. The risk of release of suspended solids into watercourses or drainage ditches is greatest where the proposed road crosses such features.	A possible increase in turbidity and siltation may occur, and a reduction in diversity is likely due to increased fine sediment supply. The ecology of gravel bed rivers will also be severely affected. Loss of dynamic activity due to siltation may result. 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 A9.3 and A9.4 (Fluvial Geomorphology and Water Quality respectively).
<u>Vegetation Clearance</u> May reduce the stability of the river channels, increasing the potential for erosion and associated sediment release. Sediment release is likely to be greatest where vegetation clearance is required on slopes and will be particularly significant where woodland clearance is required.	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 A9.3 (Fluvial Geomorphology).
<u>Watercourse / Drain Crossings and Diversions, Realignment of Watercourses or Outfall Construction</u> Construction of structures such as culverts is a potential source of pollution and construction debris can block land drains.	Increase to fine sediment supply may occur. Blockage of land drains could result in water logging of soils. Culverts may occasionally cause localised flooding problems upstream. Diversions could cause long-term impacts on the watercourse. More details can be found in Appendix A9.3 (Fluvial Geomorphology).

Water Quality

- 9.4.45 In addition to sedimentation impacts on water quality identified in Table 9.6, construction activities may also impact on water quality through accidental spillages or disturbance of contaminated land. Table 9.7 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 10: Ecology and Nature Conservation).

Table 9.7 – Potential Sources of Impact and Effects on Water Quality from Construction Activities

Source of Impact	Potential Effects
<u>Oils, Fuels and Chemicals</u> Spillage from storage tanks or leakage from mobile or stationary plant.	Oils form a film on the water surface resulting in an adverse effect on water quality. These oils can interfere with the gills of fish and cause loss of buoyancy to water birds as well as toxicity to other organisms. The oils/chemicals may also enter groundwater, reducing the potential for local groundwater utilisation and affecting ecological habitats supported by groundwater.
<u>Concrete, Cement and Admixtures</u> Accidental release into watercourses of the materials or from the washings of plant and machinery or spillage during concrete pour.	Concrete/cement is highly alkaline and must not be allowed to enter any drain, watercourse or groundwater. Potential for adverse effects on aquatic organisms if pH elevated to / maintained above 8.5.
<u>Sewerage</u> Accidental / uncontrolled release of sewage from sewers through damage to pipelines during service diversion.	Pollution to watercourses / groundwater (refer to Chapter 8: Geology, Contaminated Land and Groundwater).
<u>Contaminated Land and Sediment</u> If not managed properly, disturbance of contaminated materials could lead to pollution of ground and surface waters.	Dependent on types and concentrations of contaminants. Potential loss of aquatic fauna and flora. Deterioration of groundwater quality reducing its resource potential and potentially affecting groundwater-supported habitats (refer to Chapter 8: Geology, Contaminated Land and Groundwater).

Specific Impacts

9.4.46 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

9.4.47 There would be no outfall to Kepplehill Burn, Gough Burn, Craibstone Burn, Howemoss Burn and Mill Lade. However, road drainage would outfall to:

- Green Burn;
- Bogenjoss Burn;
- River Don;
- Goval Burn;
- Red Moss Burn;
- Corsehill Burn;
- Blackdog Burn; and
- Middlefield Burn.

9.4.48 Although there is no direct outfall into either Corby or Lily Loch, any associated impact on the lochs as a result of outfall into the Red Moss Burn, or changes to their surface water catchment, are discussed further in Table 9.8. All drainage runs and their associated outfalls are marked clearly on Figures 9.4a-g.

Watercourse Crossings

9.4.49 Bridges are proposed at the crossing over the River Don and the Goval Burn, due to both the size of these watercourses and their environmental sensitivity. The River Don would be bridged by a five span viaduct structure which avoids piers/supports within the watercourse. Three bridge structures are required at the Goval Burn and one spanning the Mill Lade, to allow for both the mainline and ancillary roads. All crossings are marked clearly on Figures 9.4a-g.

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- 9.4.50 At all other locations, a culvert is proposed, as described above in paragraph 9.4.21. A total of 23 culverts are required, as follows:
- one culvert at Kepplehill Burn, Craibstone Burn, Red Moss Burn, and Blackdog Ditch;
 - two culverts at Gough Burn, and Blackdog Burn;
 - three culverts at Green Burn, Corsehill Burn and Middlefield Burn; and
 - six culverts at Bogenjoss Burn.

- 9.4.51 The existing Mill Lade associated with Parkhill Aqueduct would be dismantled during construction of the road and then re-constructed and extended over the road. This is discussed in terms of Cultural Heritage in Chapter 13.

Watercourse Realignments

- 9.4.52 The following watercourse realignments would be required:
- Kepplehill Burn (one realignment of 200m, overall length maintained);
 - Gough Burn (two realignments totalling 208m, overall length maintained);
 - Craibstone Burn (one realignment of 196m, resulting in 11m shortening of the channel);
 - Green Burn (one extensive realignment of 595m, resulting in 2m lengthening of the channel);
 - Bogenjoss Burn (two extensive realignments totalling 1188m, resulting in a 177m shortening of the channel);
 - Corsehill Burn (one realignment of 585m resulting in a 15m lengthening of the channel);
 - Red Moss Burn (one realignment of 81m, overall length maintained);
 - Blackdog Burn (two realignments totalling 146m, overall length maintained);
 - Blackdog Ditch (one realignment of 96m, resulting in a 2m shortening of the channel); and
 - Middlefield Burn (one realignment of 460m, resulting in a 65m shortening of the channel).
- 9.4.53 The Bogenjoss Burn would be extensively realigned in its upper reaches, whilst the Green Burn and Corsehill Burn would also experience major realignments between proposed culvert structures. The Gough Burn, Craibstone Burn and Bogenjoss Burn (lower section) would all require extensive realignment of the existing watercourse to allow the installation of a culvert.

Pre-earthworks Drainage and Catchment Severance

- 9.4.54 As noted in the general discussion of potential impacts, certain minor watercourses and drainage ditches would not be culverted, and would instead be routed into pre-earthworks ditches and subsequently into the road drainage system. This is proposed for a limited number of very small ephemeral ditches, and for the following named ditches:
- Kepplehill Field Ditch;
 - Parkhead Burn;
 - Parkhead Field Ditch;
 - Craibstone Field ditch; and
 - Walton Field Ditch.
- 9.4.55 The catchment of Howemoss Burn would be severed by the proposed scheme, and flow from the catchment on the upstream side of the road would therefore be caught by pre-earthworks drainage ditches. Approximately 70% of the catchment would be lost, however it is not considered to result in a significant impact to the burn since Howemoss Springs contribute to the watercourse in this

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location. As a consequence of the scheme, part of the watercourse on the downstream side of the road would be lost.

- 9.4.56 The catchment of Lily Loch would also be severed by the proposed scheme, resulting in a 40% reduction to the overall catchment. This water will be gathered by the pre-earthworks drainage ditches and transferred into the Red Moss Burn through the drainage system. The Red Moss Burn is known to drain to the Corby Loch and field measurements of loch water level indicate that water flows from the Lily Loch into the Corby Loch rather than vice versa. By re-directing the catchment into Red Moss Burn, the Lily Loch catchment is effectively severed.
- 9.4.57 In addition to the features listed above, Loch Greens Pond and Corsehill Pond would be backfilled to enable construction of the proposed scheme, and the water sources feeding these would therefore also be directed to the drainage system.
- 9.4.58 These proposals, as with all those mentioned above, would require agreement with SEPA through the CAR application process.

Impact Assessment

- 9.4.59 An overall sensitivity of the watercourse was assigned in the baseline section of this chapter. This section will report the separate predicted impact magnitudes as presented by each discipline for each watercourse during both construction and operation. An overall impact magnitude will then be assigned to the watercourse for both the construction and operation phases. The methodology adopted for assigning this impact is detailed in paragraph 9.2.24 and adopts a precautionary approach. Consequently, the overall impact magnitude will be assigned based on the highest impact predicted by each of the technical disciplines. This overall impact will then be combined with the overall sensitivity of the watercourse to provide an impact significance for each watercourse. Indirect impacts on the ecology are presented in Chapter 10.
- 9.4.60 The potential impacts are described below, for both the operation and construction phases, detailed in the relevant technical appendices and summarised in Table 9.8.

Operational Impacts

Kepplehill Burn and field ditch

- 9.4.61 Hydrological impacts on the burn are likely to result from the building of a culvert to pass the watercourse under the mainline of the proposed scheme and the incorporation of the small field ditch into pre-earthworks drainage design. The impact magnitude of this is expected to be low since the culvert design is assumed to be correctly sized and the catchment lost to pre-earthworks is very small.
- 9.4.62 From a geomorphological perspective, the impacts on the burn are considered to result from the culvert provision and its associated realignment. Since the realignment may lead to a change in gradient and consequently a change to the sediment regime (erosion and depositional patterns) the impact is considered to be of low magnitude.
- 9.4.63 Kepplehill Burn would not receive direct drainage outfall as a result of the drainage design, consequently impacts may occur as a result of diffuse pollution reaching the watercourse. Additionally the provision of a culvert 154m long may impact water quality due to the lack of light reaching the water. The operational impacts are considered to be of negligible magnitude.
- 9.4.64 Consequently the overall magnitude of impact on the watercourse, from the water environment perspective, is driven by the impact on hydrology and geomorphology and is considered to be of low magnitude. When combined with the overall sensitivity of low, this gives an overall significance of Negligible.

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Gough Burn

- 9.4.65 Hydrological impacts on the burn are likely to result from the construction of two culverts and associated realignments. The impact magnitude of this is classed as negligible since the crossing would be appropriately designed; however the potential for culvert blockage in this area increases the potential impact magnitude to medium.
- 9.4.66 The culverts are likely to have a high magnitude of impact on the geomorphology of the watercourse. The culvert and associated realignment would significantly alter the channel morphology and result in a reduction of the overall channel morphological diversity and sinuosity in this location. The provision of a culvert may also interrupt sediment transfer to the downstream reaches. The loss of morphologically diverse watercourses in this area is considered to be extremely undesirable due to the widespread occurrence of highly modified channels in the vicinity.
- 9.4.67 No direct drainage outfall is planned to this watercourse due to its environmental sensitivity (refer to Section 9.5: Mitigation). Therefore the main impact on the water quality results from the provision of culverts to allow the watercourse to pass underneath the AWPR mainline. This length of culverted watercourse may impact on water quality due to lack of light and any associated changes to geomorphology (discussed above). The impact on water quality is considered to be of negligible magnitude. This would result in indirect impacts on freshwater ecology habitats.
- 9.4.68 The overall magnitude of impact on the watercourse is largely driven by the impact to the geomorphology of the watercourse. The overall sensitivity of the watercourse is high and, when combined with a high magnitude of impact, this leads to an overall impact of Substantial significance.

Parkhead Burn and field ditch

- 9.4.69 These small watercourses would be taken into pre-earthworks drainage. From a hydrological perspective the magnitude of impact on these watercourses is considered to be negligible. As the water quality and geomorphological assessment have been scoped out for these watercourses the overall significance of impact is Negligible.

Craibstone Burn

- 9.4.70 Hydrologically, the provision of a correctly sized culvert is considered to have a negligible magnitude of impact on the watercourse, however the potential for culvert blockage in this area, given the forested nature of the upstream catchment, increases the potential impact magnitude to medium.
- 9.4.71 The realignment and culvert would reduce the morphological diversity and natural sinuosity of the burn. The loss of morphologically diverse watercourses in this area is considered to be extremely undesirable due to the widespread occurrence of highly modified channels in this area. Changes to the overall gradient of the watercourse through the realignment may lead to a change in erosion and depositional patterns and, in combination with the culvert installation, may impede sediment transfer downstream. These impacts are considered to have a high magnitude of impact on the geomorphology of the watercourse, which would result in indirect impacts on freshwater ecology.
- 9.4.72 There is no planned direct outfall to the Craibstone Burn due to its environmental sensitivity (refer to Section 9.5 Mitigation), hence the magnitude of impact on the watercourse is considered to be negligible for water quality. The majority of the impact on water quality is driven by the length of the proposed culvert and any changes to the sediment regime as a result of the impact on the fluvial geomorphology.
- 9.4.73 The overall significance of impact on the watercourse is considered to be Substantial. This is a result of the high impact to the geomorphology from culverting and realigning a morphologically diverse section of watercourse.

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Craibstone Pond and small tributary

- 9.4.74 The proposed design has been developed to avoid Craibstone Pond and therefore no direct impact is anticipated. However, the small tributary would be connected to pre-earthworks which may change the drainage pattern of the pond and hence modify the current habitat types associated with the pond and small tributary. These potential indirect impacts on the pond are discussed in Chapter 10.

Green Burn

- 9.4.75 The provision of three culverts is considered to have a negligible impact on the hydrology of the watercourse. An extensive realignment in conjunction with a proposed drainage outfall is judged to have a low impact on the hydrology of the watercourse, since it is likely to change the hydrological response of the watercourse. The potential for a culvert blockage to increase flood risk to property is considered to be of medium impact magnitude.
- 9.4.76 From a geomorphological perspective three culverts and the extensive realignment combines to result in a medium magnitude of impact on the watercourse. Since the watercourse is generally less morphologically diverse and sinuous in plan form, changes to the geomorphology are likely to result in a lesser impact to the watercourse.
- 9.4.77 An outfall taking surface water run-off from approximately 12.6 hectares (ha) of road drainage (including area from the Southern Leg drainage) is proposed to discharge to the Green Burn. Pollution calculations indicate that this outfall, without mitigation, is likely to increase levels of indicator metals, copper and zinc, above EQS, polluting water downstream above statutory accepted levels. Additionally, the spillage risk calculations indicate that the risk to the watercourse is elevated above acceptable levels. Consequently the impact to the watercourse has been classified to be of high magnitude.
- 9.4.78 Overall the magnitude of impact to the watercourse is high due to the effects on water quality downstream of the proposed outfall. When combined with the medium sensitivity watercourse the significance of impact is Moderate/Substantial for the Green Burn.

Walton field ditch

- 9.4.79 This small watercourse would connect into pre-earthworks drainage. From a hydrological perspective the impact on this watercourse is considered to be negligible. Since the water quality and geomorphological assessment has scoped out Walton field ditch from the assessment, the overall significance of impact is Negligible.

Howemoss Springs

- 9.4.80 It is proposed that this feature would connect into pre-earthworks drainage. This would lead to a loss of approximately 72% of its surface water catchment, although the spring is unlikely to be dependent on its catchment for rainfall supply and it is therefore not expected to be lost. The impact to the hydrology of the springs is considered to be of low magnitude.
- 9.4.81 Howemoss Springs was scoped out of geomorphology and water quality assessment, although potential impact to Howemoss Burn was considered, which is fed by the springs. The overall impact is considered to be of low magnitude and therefore of Slight significance.

Howemoss Burn

- 9.4.82 The hydrological impact of severing the catchment is considered to have a medium magnitude impact on the burn since part of it will be lost downstream of the road. Howemoss Burn was scoped out of both the geomorphological and water quality assessments.

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- 9.4.83 The overall impact on the watercourse is driven by the loss of surface water catchment by catchment severance, which is considered to be of medium magnitude. When combined with the overall sensitivity of low, the significance of impact on the watercourse is Slight.

Bogenjoss Burn

- 9.4.84 The requirement for six culverts on this burn, provided they are correctly sized, is considered to result in a negligible impact to the surface water hydrology. However, the potential for culvert blockage in this area increases the potential impact magnitude to medium given the forested nature of the upstream catchment. The associated realignment and reduction in natural sinuosity, in combination with a direct outfall from road drainage, would impact on the discharge regime of the watercourse. These impacts are of low magnitude.
- 9.4.85 The geomorphology of the watercourse would be severely impacted as a result of six culverts and the proposed extensive realignment. The realignment would involve significant alterations to the gradient of the watercourse which would lead to changes in stream power with impacts on sediment transfer downstream. Culverting would involve the introduction of an artificial bed and banks to a watercourse which would lead to a loss in the morphological diversity. The loss of morphologically diverse watercourses in this area is considered to be extremely undesirable due to the widespread occurrence of highly modified channels in this area. Consequently, the impact on the geomorphology of Bogenjoss Burn during the operational phase is of high magnitude.
- 9.4.86 The proposed direct outfall of approximately 2ha of road drainage is considered to present a high magnitude impact to Bogenjoss Burn. Pollution calculations indicate that this outfall, without mitigation, is likely to increase levels of indicator metal copper by over 100%, polluting water downstream.
- 9.4.87 The overall impact to the water environment of Bogenjoss Burn is considered to be high, which results in a Substantial significance impact on the burn. As discussed in Chapter 10 (Ecology), this impact would have indirect impacts on freshwater ecology as it provides important habitat for many freshwater species including some fish and otters.

River Don

- 9.4.88 The proposals for this watercourse include the construction of a major bridge structure across the watercourse, which has been designed such that it does not require piers within the channel, and a direct outfall of approximately 4ha of road drainage. From a hydrological perspective, the bridge is unlikely to change the regime of the watercourse during low flow. A hydrodynamic model was constructed to investigate the potential change to water levels from the baseline during the 0.5% AEP. The results of the assessment indicated that for a 0.5% AEP (1:200 year return period) the impact on the flood regime is of negligible magnitude (please refer to Appendix A9.2 Hydrodynamic Modelling).
- 9.4.89 The potential for suspended solid increase to the River Don as a result of impact to its tributaries or from the outfall may cause smothering of the river bed, decreasing morphological diversity. This is considered to have a high magnitude impact on the geomorphology of the watercourse.
- 9.4.90 Due to the size of the watercourse and the available dilution for the direct outfall, predicted downstream concentrations of indicator metals suggest that there would be a low magnitude of impact on the watercourse. Similarly, the risk of accidental spillage to the watercourse without mitigation is predicted to be above acceptable levels resulting in a low impact.
- 9.4.91 Consequently, the overall impact to the water environment for the River Don is driven by the potential impact on geomorphology and is of Substantial significance. As discussed in Chapter 10, this impact would have indirect impacts on freshwater ecology, as it is designated salmonid river.

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Goval Burn

- 9.4.92 During low flows, the construction of three bridges with no piers in the channel would have a minimal impact on the hydrology of the watercourse. To test the impact on the flood regime during high flows Goval Burn was included within the River Don hydrodynamic model and the proposed structures incorporated. The results indicated that for a 0.5% AEP (1:200 year return period) the proposals are likely to have a negligible impact on the watercourse.
- 9.4.93 However, the potential for suspended solid release and the change to sediment release means that the potential impact to the geomorphology of Goval Burn is considered to be of high magnitude.
- 9.4.94 In a similar manner to the River Don, the available dilution afforded by Goval Burn reduces the potential risk from chronic and acute pollution impacting the watercourse. The results of the pollution and spillage calculations indicate that the impact to the watercourse is of negligible magnitude. However, there may be a low magnitude of impact as a result of the potential increase to accidental spillage.
- 9.4.95 The overall impact on the water environment to Goval Burn is considered to be of high magnitude. Since the burn is a designated fisheries watercourse and is of high sensitivity the impact is of Substantial significance and would have indirect impacts on the freshwater ecology and associated habitats.

Mill Lade

- 9.4.96 The replacement of the existing aqueduct with a new, slightly extended one and the proposed A947 crossing, has the potential to result in a low magnitude impact on the existing hydrology of the Mill Lade. The form of the aqueduct extension will mirror the existing structure and can be considered to be similar to a watercourse realignment. On this basis, the impact to geomorphology is considered to be of medium magnitude.
- 9.4.97 No direct outfall to the Mill Lade is proposed and the mainline of the proposed scheme passes underneath the watercourse.
- 9.4.98 The Mill Lade is an artificial watercourse of low sensitivity, and impacts are therefore assessed as being of Slight significance. However, it should be noted that the hydrological sensitivity of this watercourse was considered to be medium and hence the impact significance on the hydrology is also of Slight significance.

Corsehill Burn

- 9.4.99 An extensive realignment, three culverts and a direct outfall to Corsehill Burn is likely to have a low impact on the hydrology of the burn.
- 9.4.100 The proposed realignment is likely to have a medium impact on the geomorphology of the burn since it has the potential to significantly change the erosion and depositional patterns along the new channel. When considered in combination with the installation of three culverts, the sediment transfer downstream may be impacted over the longer-term.
- 9.4.101 The proposed outfall of approximately 4ha of road is likely to have a high impact on Corsehill Burn. The pollution calculations indicate that there is a potential for an increase of 180% of dissolved copper and 119% increase of zinc downstream of the outfall. Accidental spillage calculations indicate that there may be a low impact to the burn.
- 9.4.102 Overall the impact on Corsehill Burn is of high magnitude. The impact is driven by the impact to water quality and is considered to be of Moderate/Substantial significance.

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Corsehill Pond

- 9.4.103 It is proposed to fill in this small pond as a result of the road construction. No potential impacts are therefore reported in this assessment, although ecological impacts on freshwater habitat are assessed in Chapter 10.

Lochgreens Pond

- 9.4.104 It is proposed to fill in this small pond as a result of the road construction. No potential impacts are therefore reported in this assessment, and as noted in Chapter 10, no significant ecological impact on freshwater habitats is anticipated.

Red Moss Burn

- 9.4.105 Impacts on the hydrology of the watercourse are considered to be low. However, the potential for culvert blockage in this area increases the potential impact magnitude to medium.
- 9.4.106 The provision of a culvert and its associated watercourse realignment would impact the geomorphology of the watercourse. If the realignment is not completed sensitively then the sediment regime (erosion and deposition patterns, sediment transfer downstream or release of suspended solids) may be impacted. This has been assessed as of low magnitude. However the provision of a road drainage outfall is considered to present a high potential impact magnitude given the risk of suspended solid release or scour around the structure.
- 9.4.107 The proposed direct outfall to Red Moss Burn is predicted to have a high impact on the watercourse and consequently Corby and Lily Lochs downstream. The pollution calculations indicate that the watercourse may fail EQS if no mitigation is installed before outfall. Potential levels of indicator metals may increase by over 100%.
- 9.4.108 The overall long-term magnitude of impact on the Red Moss Burn is likely to be high without mitigation. Since the watercourse is of medium sensitivity the significance of impact is Moderate/Substantial due to the potential impact to the water quality. This is likely to have indirect, long-term impacts on the freshwater environment not only of the Red Moss Burn but also of Corby and Lily Lochs downstream.

Corby and Lily Lochs SSSI

- 9.4.109 The impacts on these features were assessed by hydrology only. Any impacts on Red Moss Burn from water quality and geomorphology can be considered to impact these lochs as described above.
- 9.4.110 It has been identified that approximately 15% of Corby Loch catchment is taken into pre-earthworks drainage and discharged to the Red Moss Burn.
- 9.4.111 Without appropriate mitigation Lily Loch potentially may lose approximately 40% of its catchment which is not considered to be replaced given the severance of catchment. This is considered to have a high impact on the high sensitivity waterbodies resulting in a Substantial significant impact. These impacts are also likely to cause indirect ecological impacts on the dependent habitats (Chapter 10, Table 10.12).

Blackdog Burn

- 9.4.112 The provision of two new culverts is predicted to have a negligible impact to the hydrology, however there may be an associated increase to flood risk if a culvert blockage occurs. This potential impact is considered to be of medium magnitude.
- 9.4.113 The changes to channel morphology and potential siltation as a result of the culverting and realignment may lead to an impact of medium magnitude on the watercourse.

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9.4.114 The direct outfall of approximately 8ha of road drainage is likely to have a high impact on the watercourse. Predictions of downstream concentrations of indicator metal copper is likely to increase by up to 128%.

9.4.115 Overall the impact on the water environment of Blackdog Burn is predicted to be of high magnitude due to water quality, leading to Moderate/Substantial significance.

Blackdog Ditch

9.4.116 The provision of a new culvert and associated realignment is predicted to have a low impact on hydrology, a low impact on geomorphology and a negligible impact on water quality. Overall the long-term impact on the watercourse is considered to be of low magnitude and therefore of Slight significance.

Middlefield Burn

9.4.117 Three culverts, the associated realignment and drainage outfall are considered to have a medium impact on the hydrology of the watercourse. The same modifications are predicted to have a potential impact of medium magnitude on the geomorphology of the watercourse over the long-term. The potential for sediment release or siltation from the modification channel may impact downstream habitats.

9.4.118 The proposed outfall of road drainage from approximately 0.3ha of road would impact the downstream water quality by increasing the concentrations of certain indicator metals by up to 63%. Since the pollution calculations indicate that the environmental quality standards may be exceeded the impact on the water quality without mitigation is considered to be medium.

9.4.119 The overall impact on the water environment is likely to be of medium magnitude due predominantly to the impact on water quality, resulting in an impact of Slight significance.

Potential Catchment Impacts (Operation)

Gough/Green/Craibstone Subcatchment (including smaller watercourses)

9.4.120 Extensive straightening, realigning and culverting of the watercourses in combination with an outfall to Green Burn is considered to have a large impact on the water environment in the area. The combined impact to the geomorphology and water quality of the three burns as a result of the proposed scheme results in an overall impact of Substantial significance.

9.4.121 Due to the regional importance of the River Don, catchment impacts are discussed in Part E (Cumulative Assessment) of this ES.

Construction Impacts

Kepplehill Burn and field ditch

9.4.122 Hydrological impacts of the culvert construction are likely to be of medium magnitude. Similarly the short-term impacts on the geomorphology of the watercourse during the works are considered to be of medium magnitude.

9.4.123 The installation of a culvert would involve extensive works in the vicinity of the watercourse. The construction impact on the water quality is considered to be of high magnitude

9.4.124 The overall construction impact on Kepplehill Burn and field ditch is predicted to be of high magnitude and Moderate significance.

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Gough Burn

- 9.4.125 Hydrological impacts of the culvert construction are considered to be of medium magnitude, and geomorphological impacts of the same activity are considered to be of high magnitude. The extent of vegetation clearance and potential for release of suspended solids may impact the morphology of the watercourse and decrease the bank stability over the short-term. The extent of the activities required in the vicinity of the watercourse results in the potential impact to water quality being considered to be of high magnitude.
- 9.4.126 The overall impact on Gough Burn during construction is of high magnitude due to geomorphology and water quality, and therefore of Substantial significance.

Parkhead Burn and field ditch

- 9.4.127 The general construction impacts to the hydrology and the flood risk to Parkhead Burn and field ditch are considered to be of low magnitude since the watercourse is proposed to be re-directed into pre-earthworks. Hence the overall impact during construction is of Negligible significance.

Craibstone Burn

- 9.4.128 Hydrologically, the construction of one culvert underneath the mainline of the proposed scheme is considered to result in a medium magnitude of impact on Craibstone Burn.
- 9.4.129 The potential impact to the morphological diversity as a result of suspended solid release is considered to be high. Vegetation clearance, realignment, and culvert installation all have a large potential to promote slope instability, smothering of habitats due to siltation of the bed or increase erosion locally over a short period of time.
- 9.4.130 In a similar manner to the Gough Burn the extent of the activities required in the vicinity of the watercourse results in the potential impact to water quality being considered to be of high magnitude.
- 9.4.131 The overall impact to Craibstone Burn is driven by the potential for sediment release during the construction period and the direct impact on the geomorphology of the watercourse and associated impact to water quality (turbidity). The overall impact is considered to be of Substantial significance.

Green Burn

- 9.4.132 The extensive proposals for the Green Burn (3 culverts, extensive realignment and large outfall) mean that the potential construction impacts on the hydrology of the watercourse is judged to be of medium magnitude.
- 9.4.133 Morphological impacts to Green Burn are considered to be lower than for other watercourses in this area (Gough and Craibstone Burns), since the watercourse is currently straightened and less vulnerable to change. The release of suspended solids and vegetation clearance is likely to result in a medium impact on the geomorphology since the gradient of the watercourse would limit the impact on morphological diversity downstream.
- 9.4.134 The extensive works considered in the vicinity of the watercourse results in a potentially high magnitude of impact on water quality during the construction phase.
- 9.4.135 The overall impact to the watercourse is therefore driven by the potential impact to water quality in the short-term. The impact is considered to be of Moderate/Substantial significance.

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Walton field ditch

- 9.4.136 The general construction impact to the hydrology and the flood risk to this small watercourse is considered to be of low magnitude since the watercourse is proposed to be re-directed into pre-earthworks drainage. Hence the overall impact to Walton field ditch during construction is of Negligible significance.

Howemoss Springs

- 9.4.137 Potential impacts on the hydrology of the surface water feature are considered to be of Slight significance.

Howemoss Burn

- 9.4.138 The general construction impact to the hydrology and the flood risk to this watercourse is considered to be of low magnitude since the watercourse is proposed to be re-directed into pre-earthworks. Hence the overall impact to Howemoss Burn during construction is of Negligible significance.

Bogenjoss Burn

- 9.4.139 The extensive proposals for the Bogenjoss Burn (6 culverts, extensive realignment and proposed drainage outfall) mean that the potential construction impacts on the hydrology of the watercourse are considered to be of medium magnitude.

- 9.4.140 Short-term morphological change to this watercourse is considered to constitute a high impact. The extent of the earthworks proposed and vegetation required as part of this works have a high potential to release large volumes of sediments into the watercourse. Excavation of the new channel and the temporary realignment may result in large scale sediment release which results in direct impacts on the geomorphology (morphological diversity) and water quality of the watercourse. Associated indirect impacts on freshwater ecology are also likely.

- 9.4.141 The extensive works considered in the vicinity of the watercourse results in a potentially high magnitude of impact on water quality during the construction phase.

- 9.4.142 The potential overall impact on Bogenjoss Burn is therefore driven by water quality and geomorphology impacts during the construction phase; this is considered to be of Substantial significance.

River Don

- 9.4.143 Construction activities occurring on the floodplain may have the potential to impact on the hydrology and flood risk of the river, particularly if sections of the floodplains are used to store construction material, reducing floodplain capacity. The hydrology assessment considered this potential impact to be of medium magnitude.

- 9.4.144 The construction of the mainline approach roads and bridge across the River Don have the potential to allow turbid runoff to reach the designated fisheries river which may have impacts on spawning habitats for fish and impact the water quality and geomorphology of the watercourse over the short-term. The sediment modelling and geomorphological assessment has indicated that this is likely to be of high magnitude without mitigation.

- 9.4.145 Major earthworks adjacent to the floodplain and construction activities on the floodplain for up to 36 months would create potential for accidental spillage into the watercourse. Available dilution for this pollution is large, however the sensitivity of the watercourse (designated fisheries watercourse and DWS) means that the indirect impacts may be far ranging. The potential impact on water quality is considered to be of high magnitude.

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- 9.4.146 The overall potential impact on the River Don due to construction is considered to be of high magnitude and therefore of Substantial significance.

Goval Burn

- 9.4.147 Construction of three bridges over the Goval Burn may have a medium magnitude impact on the hydrology and flood risk of the watercourse, due to activities undertaken on the floodplains. However, from a geomorphological perspective the impacts may be of a high magnitude due to the potential for sediment to reach the watercourse. Suspended solid release may have a large impact on this designated watercourse, smothering habitats and increasing turbidity over the short-term.

- 9.4.148 Bridging of the burn would reduce potential for accidental spillage into the watercourse when considered in preference to culverting. Therefore, the impact on water quality is considered to be of low magnitude.

- 9.4.149 The overall potential impact on Goval Burn due to construction is considered to be of high magnitude due to the potential impact to geomorphology and overall impact significance is assessed as Substantial over the shorter term.

Mill Lade

- 9.4.150 Temporary storage of water required during the reconstruction of the Mill Lade aqueduct and the proposed A947 crossing would result in a potential medium magnitude impact on the hydrology of the artificial watercourse. Similarly, potential impacts to the geomorphology are expected to be of medium magnitude as a result of sediment release. Potential impacts on water quality as a result of accidental pollution are considered to be of medium magnitude without mitigation.

- 9.4.151 Overall, a medium magnitude impact of Moderate significance is predicted.

Corsehill Burn

- 9.4.152 The construction of 3 culverts, long associated realignment and outfall (approximately 4ha), is assessed to have a medium impact on the hydrology over the short-term.

- 9.4.153 The same activities are assessed to have a potential for medium impact on the geomorphology of the watercourse. Vegetation clearance, the amount of works in the vicinity of the watercourse and the requirement for a new constructed channel would result in volumes of fine sediment being washed into the watercourse which may be deposited downstream with negative consequences.

- 9.4.154 Extensive works considered in the vicinity of the burn results in a potentially high magnitude of impact on water quality during the construction phase.

- 9.4.155 Overall, the impact to Corsehill Burn during construction is assessed to be of Moderate/Substantial significance.

Corsehill Pond

- 9.4.156 It is proposed to fill in this pond as a result of the road construction. Due to its size it was scoped out of this assessment and its loss is not anticipated to impact significantly on freshwater habitats (Chapter 10, Table 10.11). However, impacts to amphibians are considered to be high (Appendix A10.9).

Lochgreens Pond

- 9.4.157 It is proposed to fill in this pond as a result of the road construction. Due to its size it was scoped out of this assessment and its loss is not anticipated to impact significantly on freshwater habitats (Chapter 10, Table 10.11).

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Red Moss Burn

- 9.4.158 The construction of one culvert and a road drainage outfall is assessed to have a medium impact on the hydrology of Red Moss Burn. Geomorphologically, the construction of the culvert and associated realignment is considered to present a high potential impact, partly due to the potential for the suspended solids to be transported downstream to the lochs and negatively impact the SSSI habitats downstream. Since the proposed works only require the construction of one culvert and its associated realignment, the works in the vicinity of the watercourse are not as extensive as for Corsehill Burn for example. However, the potential impact to water quality during the construction phase is considered to be of medium magnitude.
- 9.4.159 Overall, the potential impact to the water environment during the construction phase is assessed to be of Moderate/Substantial significance.

Corby and Lily Lochs

- 9.4.160 Geomorphology and water quality was considered in the context of Red Moss Burn which supplies the lochs, as described above. Hydrological assessment was undertaken for the lochs and baseflow is considered to be an important control to the lochs. The potential to interrupt hydrological pathways to the loch during construction are assessed to result in an impact of medium magnitude. Construction impacts to the hydrology of the lochs are assessed to be of Moderate/Substantial significance.

Blackdog Burn

- 9.4.161 Construction of two culverts on Blackdog Burn may present a medium impact to the watercourse hydrology in the short-term. Excavating the new channel and constructing the new culverts (which would include vegetation clearance locally) would result in the release of suspended solids over the short term. This may result in negative impacts on channel morphology downstream which are assessed to be of medium magnitude. Impacts to water quality are considered to be of medium magnitude. The available dilution and extent of the works in the vicinity of the floodplain means that there may be a medium chance of accidental spillage reaching the watercourse.
- 9.4.162 Overall, the impact to the water environment of Blackdog Burn is considered to be of medium magnitude and Moderate significance.

Blackdog Ditch

- 9.4.163 Construction of a culvert on the Blackdog Ditch may result in a medium magnitude impact to the watercourse hydrology in the short-term. Excavating the new channel and constructing the new culvert (which would include vegetation clearance locally) would result in the release of suspended solids over the short-term. This may result in negative impacts on channel morphology downstream which is assessed to be of medium magnitude. Construction impacts on the water quality over the short-term are considered to be of high magnitude.
- 9.4.164 The overall magnitude of impact on Blackdog Ditch is therefore high, due primarily to potential reduction of water quality. The impact significance is assessed as Moderate/Substantial.

Middlefield Burn

- 9.4.165 The construction of three culverts, associated realignment and drainage outfall is considered to have a medium magnitude impact on both the hydrology and geomorphology of the watercourse over the short-term. Due to the extent of activities proposed in the watercourse, the impact on the water quality in the construction phase is considered to be of high magnitude in the short-term.
- 9.4.166 The overall magnitude of impact on Middlefield Burn is therefore high, due primarily to potential reduction of water quality. The impact significance is assessed as Moderate.

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Potential Catchment Impacts (Construction)

Gough/Green/Craibstone Subcatchment (including smaller watercourses)

- 9.4.167 Extensive construction activities proposed to this subcatchment leads to a potential Substantial significance impact to the water environment in this area. This principally arises as a result of the potential for suspended solid release impacting the fluvial geomorphology and water quality of the receiving watercourses.
- 9.4.168 As noted in paragraph 9.4.121, catchment impacts on the River Don are discussed in Part E (Cumulative Assessment) of this ES.

Groundwater

- 9.4.169 Details of the groundwater potential impact assessment are provided in Chapter 8 (Geology, Contaminated Land and Groundwater).

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Table 9.8 – Summary of Potential Impacts on Water Features

Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
Kepplehill Burn	Low	1 culvert: ch315200 (154m)	Realigned length 200m (length maintained)	No road drainage discharge to burn	<p><u>Construction:</u> Culverting of existing straightened channel will involve earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Risk of accidental spillage of pollutants during construction.</p> <p>Hydrology and Geomorphology: Medium Water Quality: High</p>	High	Moderate
					<p><u>Operation:</u> Long-term slight decrease to morphological diversity due to culverting and realignment of channel. No outfall planned therefore negligible impact as a result of diffuse pollution.</p> <p>Hydrology and Geomorphology: Low Water Quality: Negligible</p>	Low	Negligible
Gough Burn	High	2 culverts: ch316390 (66m) Ch316430 (11m)	Realigned length 208m (length maintained)	No road drainage discharge to burn	<p><u>Construction:</u> Culverting and realignment will involve major earthworks, 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.</p> <p>Hydrology: Medium Geomorphology and Water Quality: High</p>	High	Substantial
					<p><u>Operation:</u> Long-term decrease to morphological diversity as a result of culverting and realignment of watercourse. Reduction of sediment transfer through the culvert and major alteration to the morphology. Extensive reduction to channel sinuosity due to realignment potentially resulting in channel instability & excessive erosion/deposition. Minimal change to flow as a result of culvert. No outfall planned therefore negligible impact as a result of diffuse pollution.</p> <p>Hydrology: Medium Geomorphology: High Water Quality: Negligible</p>	High	Substantial
Parkhead Burn Parkhead Field Ditch	Low	No culverting	No realigning	None. Watercourse taken into pre-earthworks drainage.	<p><u>Construction:</u> Watercourse would be re-directed into pre-earthworks drainage design, therefore a very short section of the watercourse downstream of the proposed road may be lost.</p> <p>Hydrology: Low Geomorphology and Water Quality: scoped out of assessment</p>	Low	Negligible
					<p><u>Operation:</u> Very short section of the watercourse downstream of road may be lost.</p> <p>Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment</p>	Negligible	Negligible
Craibstone Burn	High	1 culvert over mainline: ch316990 (106m)	Realigned length 196m (11m shortening)	No road drainage discharge to burn	<p><u>Construction:</u> Major culverting and realignment will involve major earthworks, which is likely to result in sediment release and loss of morphological diversity. Potential risk of accidental spillage of pollutants during construction due to proximity and extent of works to watercourse.</p> <p>Hydrology: Medium Geomorphology and Water Quality: High</p>	High	Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
Craibstone Burn [cont'd]	see above	see above	see above	see above	<u>Operation</u> : Long-term major decrease to morphological diversity as a result of culverting and realignment. Reduction of sediment transfer through the culvert. 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 culvert. No outfall planned therefore negligible impact as a result of diffuse pollution. Hydrology: Medium Geomorphology: High Water Quality: Negligible	High	Substantial
Green Burn	Medium	3 culverts: ch317330 (113m) A96 (29m) Dyce Drive (23m)	Realigned length 595m (2m lengthening of the burn)	2 proposed outfalls. Total of 12.6Ha draining to Green Burn at the A96 link road and ch317470.	<u>Construction</u> : Extensive culverting and realignment will involve earthworks, possibly resulting in sediment release and straightening of the channel, leading to loss of morphological diversity and short-term increase in suspended solid loads. Potential risk of accidental spillage of pollutants during construction due to the length of works in close proximity to the watercourse. Hydrology and Geomorphology: Medium Water Quality: High	High	Moderate/ Substantial
					<u>Operation</u> : Long-term decreased morphological diversity due to 3 long culverts and associated proposed realignments which straighten the channel, reducing sinuosity and morphological diversity. Change to discharge regime due to lengthening, realignment and road run-off discharge to the burn may lead to siltation and the requirement for dredging. Major potential for decreased water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution may occur. Increased accidental spillage risk due to traffic loadings. Number and length of culverts may impact on water quality due to lack of light. Hydrology and Geomorphology: Medium Water Quality: High	High	Moderate/ Substantial
Walton Field Ditch	Low	No culverting	No realignment	None. Watercourse taken into pre-earthworks drainage.	<u>Construction</u> : Watercourse would be re-directed into pre-earthworks drainage; therefore a section of the watercourse downstream of road may be lost. Hydrology: Low Geomorphology and Water Quality: scoped out of assessment	Low	Negligible
					<u>Operation</u> : Section of the watercourse downstream of road may be lost. Hydrology: Negligible Geomorphology and water Quality: scoped out of assessment	Negligible	Negligible
Howemoss Spring	Medium (assessed by hydrology only)	n/a	n/a	None	<u>Construction</u> : Construction over the spring line may have an impact on the functioning of the spring during construction. Hydrology: Low Geomorphology and Water Quality: scoped out of assessment	Low	Slight

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
Howemoss Spring [cont'd]	see above	see above	see above	see above	<u>Operation:</u> Part of surface water catchment severed as a result of the proposed scheme though spring is not likely to depend on the surface water catchment. However potential impact on the functioning of the spring possible unless mitigated. Hydrology: Low Geomorphology and Water Quality: scoped out of assessment	Low	Slight
Howemoss Burn	Low	No culverting	No realignment	None. Catchment severed.	<u>Construction:</u> Watercourse catchment would be severed and re-directed into pre-earthworks drainage; therefore a section of the watercourse downstream of road may be lost. Hydrology: Low Geomorphology and Water Quality: scoped out of assessment	Low	Negligible
					<u>Operation:</u> Section of the watercourse downstream of road may be lost. Hydrology: Medium Geomorphology and water Quality: scoped out of assessment	Medium	Slight
Bogenjoss Burn	High	6 culverts ch320500 (56m) ch320870 (160m). side roads: (9m) ch320100 (8m) ch320215 (11m) ch320260 (10m) ch320475	2 realignments: 1188m length resulting in substantial channel straightening & shortening of burn by 177m.	1 outfall: Total of 1.8ha draining to Bogenjoss Burn at ch320710.	<u>Construction:</u> Extensive culverting and realignment will involve major earthworks, possibly resulting in sediment release and straightening of the channel, leading to loss of morphological diversity and increasing short-term suspended solid loads. Construction of six culverts may increase risk of accidental spills/pollution due to major construction activity near watercourse. Hydrology: Medium Geomorphology and Water Quality: High	High	Substantial
					<u>Operation:</u> Long-term decreased geomorphological diversity and sinuosity due to burn realignment, shortening and straightening combined with extensive culverting. Potential change to discharge regime due to road run-off outfall and realignment. Additionally road run-off discharge to the burn may lead to siltation and the requirement for dredging. Decreased water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes. Number/length of culverts likely to impact on water quality due to lack of light. Hydrology: Low Geomorphology and Water Quality: High	High	Substantial
River Don	High	Bridge spanning River and floodplain	No realignment planned	1 outfall: total of 4.1ha draining to ch322500, ch322650, & ch322930.	<u>Construction:</u> Bridging will involve extensive earthworks, possibly resulting in sediment release leading to short-term increase to suspended sediment loads and turbidity within the channel potential impacts on water quality and geomorphological diversity. Sediment modelling assessed potential impact as a result of the construction of the mainline approach roads as high magnitude. Potential impact of pollutant spills due to proximity and duration of construction activities (both mainline approach road and bridge construction). Hydrology: Medium Geomorphology and Water Quality: High	High	Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
River Don [cont'd]	see above	see above	see above	see above	<u>Operation:</u> Potential long-term impact on flood risk. Change to morphological diversity possible as a result of bridging. Changes to flow regime likely as a result of increased input from road run-off. Potential decrease to water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution, with increased risk from accidental spillage likely from traffic. Hydrology and Water Quality: Low Hydrodynamic Modelling: Negligible Geomorphology: High	High	Substantial
Goval Burn	High	3 bridges: 1. B977 approx 400m from Don Floodplain 2. Ch324600. 3. A947 at confluence of Goval Burn with Corsehill Burn.	No realignment	1 outfall: Total of 3.5ha draining to Goval Burn at ch323900.	<u>Construction:</u> Bridging at three locations will involve limited earthworks, possibly resulting in sediment release leading to short-term increases to suspended sediment loading in the water column. Potential for spillage of pollutants due to proximity, duration and amount of works proposed. Hydrology: Medium Geomorphology: High Water Quality: Low	High	Substantial
					<u>Operation:</u> Potential long-term impact on flood risk. Change to morphological diversity possible as a result of bridging. Potential changes to flow regime as a result of increased input from road run-off. Decreased water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage from traffic. Hydrology: Negligible Geomorphology: High Water Quality: Low	High	Substantial
Mill Lade	Low (Medium for hydrology)	1 bridge under A947 1 aqueduct (to replace existing)	No realignment is proposed	No outfall planned	<u>Construction:</u> Temporary realignment and storage of water during aqueduct construction may impact on flow regime. Construction activities close to watercourse may result in accidental spillage of construction sourced pollutants such as concrete, oils etc. Hydrology, Geomorphology and Water Quality: Medium	Medium	Moderate
					<u>Operation:</u> Impact to flow and sediment regime expected due to bridging of watercourse. However changes to sediment regime may occur where new aqueduct is proposed. No outfall planned therefore negligible impact due to diffuse pollution. Hydrology: Low Geomorphology: Medium Water Quality: Scoped out of assessment	Medium	Slight

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
Corsehill Burn	Medium	3 culverts: Ch325085 (77m) Link 1 (32m) Link 2 (55m)	Realignment of 585m resulting in channel straightening and increase by 15m	1 outfall: Total of 3.9ha draining South East of proposed roundabout near Little Goval	<u>Construction</u> : Culverting and realignment will involve major earthworks, possibly resulting in sediment release and short/medium-term increases to sediment loading within the water column, and changes to erosion/deposition patterns. Changes to the discharge regime as a result of road run-off discharge and extensive realignment. Potential impact to water quality from accidental spillage. Hydrology and Geomorphology: Medium Water Quality: High	High	Moderate/ Substantial
Corsehill Burn [cont'd]					<u>Operation</u> : Long-term decrease to morphological diversity as a result of culverting and realignment. Possible minor change to discharge regime due to lengthening and realignment of burn. Decreased water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental road traffic spillage. Hydrology: Low Geomorphology: Medium Water Quality: High	High	Moderate/ Substantial
Red Moss Burn	Medium	1 culvert: ch327500 (58m)	Realignment of 81m (length maintained)	1 outfall: Total of 2.3ha draining to Red Moss Burn at ch327240.	<u>Construction</u> : Culverting and realignment will involve earthworks, possibly resulting in sediment release and short-medium term changes to suspended sediment loads and erosion and depositional patterns. Impacts on Corby Loch downstream possible if sediment is transported downstream, and flows increased/reduced as a result of drainage. Proximity of construction works to watercourse poses a risk of pollution from accidental spillage i.e. concrete, oil, etc. However the works will only involve the construction of one culvert. Hydrology and Water Quality: Medium Geomorphology: High	High	Moderate/ Substantial
					<u>Operation</u> : Minor long-term decrease to morphological diversity due to culverting and realignment, and minor changes to flow regime as a result of increased input from road run-off - these are discussed in more detail below. Impacts on Corby Loch downstream are possible if sediment is transported downstream, and flows changed as a result of drainage outfall. Decreased water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes. Hydrology: Medium Geomorphology and Water Quality: High	High	Moderate/ Substantial
Corby Loch	High	n/a	n/a	n/a	<u>Construction</u> : Culverting and realignment of the Red Moss Burn may result in sediment/pollutant release or changes to the discharge regime lead to associated indirect impacts on the lochs as a result of sediment/pollutant release or changes to the discharge regime of Red Moss Burn. Hydrology: Medium Geomorphology and Water Quality: scoped out of assessment NOTE: indirect impact magnitude as a result of Red Moss Burn impact.	Medium	Moderate/ Substantial

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
Corby Loch [cont'd]					<p><u>Operation:</u> Negligible long-term (indirect) changes to flow regime due to increased input from road run-off to the Red Moss Burn – approx 15% of Corby Loch catchment affected upstream. However, as Red Moss Burn is culverted and road drainage outfalls to the watercourse, overall water quantity is expected to be largely maintained. Loch also thought to be partially groundwater fed. Indirect impacts possible if sediment is transported downstream, and flows changed as a result of drainage outfall. Decreased water quality resulting from untreated road run-off carrying sediment load reaching the lochs from Red Moss Burn.</p> <p>Hydrology: Low Geomorphology and Water Quality: scoped out of assessment NOTE: indirect impact magnitude as a result of Red Moss Burn impact.</p>	Low	Moderate
Lily Loch	High	n/a	n/a	n/a	<p><u>Construction:</u> Severing of hydrological paths to the loch during construction may detrimentally impact the loch.</p> <p>Hydrology: Medium Geomorphology and Water Quality: scoped out of assessment</p>	Medium	Moderate/ Substantial
					<p><u>Operation:</u> Proposed scheme would sever catchment. Although groundwater is believed to be of importance to the loch, the loss of approximately 40% of the catchment may result in lowered loch water level.</p> <p>Hydrology: High Geomorphology and Water Quality: scoped out of assessment</p>	High	Substantial
Blackdog Burn	Medium	2 culverts: Ch329950 (74m) East of A90 North (39m)	2 realignments: total 146m (length maintained).	2 outfalls: Total of 8.3ha draining to Blackdog Burn at ch329940 and A90 (S of Blackdog Estate)	<p><u>Construction:</u> Culverting and realignment earthworks may cause sediment release and short-medium term changes to sediment load, and erosion/deposition. Proximity of construction works to watercourse poses a risk of pollution from accidental spillage i.e. concrete, oil, etc.</p> <p>Hydrology, Geomorphology and Water Quality: Medium</p>	Medium	Moderate
					<p><u>Operation:</u> Long-term decrease to morphological diversity due to culverting and realignment. Changes to flow regime due to increased road run-off. Decreased water quality resulting from untreated road run-off 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
Blackdog Ditch	Medium	1 culvert: ch 330065 (47m)	Realigned length 96m (resulting in a shortening of 2m)	None	<p><u>Construction:</u> Culverting of existing straightened channel will involve some earthworks, possibly resulting in sediment release and short-term change to morphological diversity and turbidity of the water column. Potential for small scale spillage of potential pollutants.</p> <p>Hydrology and Geomorphology: Medium Water Quality: High</p>	High	Moderate/ Substantial
					<p><u>Operation:</u> Minimal change to flow and sediment regime as a result of culvert. No outfall planned therefore small impact as a result of diffuse pollution.</p> <p>Hydrology and Geomorphology: Low Water Quality: Negligible</p>	Low	Slight

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Feature	Overall Sensitivity	Crossing	Realignment	Road Outfall	Impact Description Summary	Potential Impact (unmitigated)	
						Overall Magnitude	Significance
Middlefield Burn	Low	3 culverts: A90 widening (93m) Side road to the west (47m) Side road to the east (54m)	Realignment of 460m length resulting in the shortening of burn by 65m	1 outfall: Total of 0.3ha draining to Middlefield Burn at the A90 north of Fifehill	<p><u>Construction:</u> Culverting and realignment earthworks may cause sediment release and short-medium term changes to sediment load, and erosion/deposition. Proximity of construction works to watercourse poses a risk of pollution from accidental spillage i.e. concrete, oil, etc. Hydrology and Geomorphology: Medium Water Quality: High</p>	High	Moderate
					<p><u>Operation:</u> Long-term change to erosion and deposition patterns due to culverting and realignment. Minor change to flow regime due to increased road run-off input. Decreased water quality resulting from untreated road run-off carrying sediment load, soluble and insoluble pollution may occur and increased risk from accidental spillage likely as a result of traffic volumes. Hydrology, Geomorphology and Water Quality: Medium</p>	Medium	Slight

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Summary of Potential Impacts

- 9.4.170 Table 9.8 identifies the overall magnitude and significance of potential impacts for each of the water features identified in Section 9.3 (Baseline Conditions) in the absence of mitigation, as summarised below. An overall magnitude and significance category has been assigned for each water feature based on the watercourse sensitivity assigned in the baseline section of this chapter.
- 9.4.171 Substantially significant potential impacts have been identified for five watercourses in both the operational and constructional phases. These watercourses are identified as:
- Gough Burn;
 - Craibstone Burn;
 - Bogenjoss Burn;
 - Goval Burn; and
 - River Don.
- 9.4.172 In addition to this, the Gough, Green and Craibstone subcatchment would be substantially impacted as a result of the proposed works. Lily Loch would be substantially impacted in the operational phase due to catchment severance.
- 9.4.173 Moderate/Substantially significant potential impacts during construction have been identified for:
- Green Burn;
 - Corsehill Burn;
 - Red Moss Burn;
 - Blackdog Ditch; and
 - Corby and Lily Lochs.
- 9.4.174 These burns, as well as, Blackdog Burn may also experience impacts of Moderate/Substantial significance during operation.
- 9.4.175 Moderately significant potential impacts during to construction have been identified for
- Mill Lade;
 - Middlefield Burn;
 - Kepplehill Burn; and
 - Blackdog Burn.
- 9.4.176 Moderately significant impacts may persist in the operational phase for:
- Mill Lade;
 - Middlefield Burn; and
 - Corby Loch.
- 9.4.177 All other potential impacts on water features were assessed as being of Negligible or Slight significance.

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9.5 Mitigation

Introduction

- 9.5.1 The objective of the mitigation measures outlined in this section is to prevent, reduce or offset the potential impacts described in Section 9.4.
- 9.5.2 Mitigation measures include those to convey surface water run-off from the road surface to receiving watercourses without detrimental effect on water quality and quantity, associated ecosystems and the underlying groundwater, those to minimise impact on geomorphological features through required culverting and realignments, and those to avoid impacts during the construction phase.

Guiding Principles

- 9.5.3 Mitigation is proposed to assess any adverse impact where practicable, including all impacts assessed as being of greater than slight significance and in accordance with the EIA (Scotland) Regulations 1999. These regulations are intended *'to prevent, reduce or where possible, offset any significant adverse impacts on the existing drinking and bathing water quality, ecology and nature and conservation value of the surrounding area'*.
- 9.5.4 The implications of the WFD have also been taken into account in the formulation of mitigation strategies; mitigation measures for all watercourses aim to achieve and preserve 'good' water quality and ecological status of any watercourse. SEPA requires any construction activities near watercourses or waterbodies to be licensed during the construction phase under the terms of CAR (2005), and road outfalls require a licence for the operational phase (if draining more than 1km of road). The requirements of EC Freshwater Fisheries and the Dangerous Substances Directives have also been taken into consideration when choosing the appropriate level of road run-off treatment.

Approach to Mitigation

- 9.5.5 Mitigation measures typically comprise solutions aimed at the source of the impact. The risk of causing deterioration in status of each watercourse can be reduced by 'designing out' any risk. This has been taken into account during the selection of a preferred route and road alignment, for example to avoid important/sensitive water features where possible.
- 9.5.6 Where potential adverse impacts cannot be prevented (i.e. where there is a need for road run-off to be discharged to local watercourses and drainage ditches) mitigation measures are proposed, and have been developed continually throughout the design process. In particular, major design components such as road drainage, locations of bridges and culverts and watercourse realignment details have been developed through an iterative process involving structural engineers, geomorphologists, hydrologists, ecologists and water quality specialists.
- 9.5.7 Consultation with SEPA and SNH has been undertaken at key design stages to seek guidance on appropriate levels of road drainage, culverting and watercourse realignment from these statutory bodies before the publication of the ES. Relevant fisheries boards have also been contacted. Further information on the consultation process is provided in Chapter 6 (Scoping and Consultation). Mitigation requirements will continue to develop through the CAR application process and ongoing liaison with SEPA.
- 9.5.8 All general and site-specific mitigation measures are summarised in Table 9.10 at the end of this section.

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

- 9.5.9 Prior to construction, most activities within the water environment associated with the proposed scheme will require licensing under the new CAR process (SEPA, 2007). The application will require detailed information on:
- the proposed activity, its design and the reasons for the chosen design;
 - potential impacts on the water environment, including baseline environmental information;
 - mitigation included in the design, aimed at reducing the potential impact; and
 - detailed construction methodology.
- 9.5.10 Preparation of CAR applications for the watercourses that would be affected by the proposed scheme is currently underway in liaison with SEPA. It will be necessary to develop the mitigation measures to the satisfaction of SEPA before the CAR licence is approved, and ongoing design and mitigation refinement is therefore anticipated during this process and the detailed design phase.

General Mitigation Requirements

Road Drainage

- 9.5.11 The drainage system of the proposed scheme has been designed in accordance with '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).
- 9.5.12 Where it has been identified as necessary for road drainage to outfall to receiving watercourses, mitigation has been designed to minimise both the volume of discharge and the risk to water quality. For each outfall a range of SUDS solutions were considered to attenuate the road run-off to pre-development rates (see Appendix A9.1: Surface Water Hydrology) and reduce the polluting load carried within this run-off to acceptable levels.
- 9.5.13 For each outfall a 'treatment train' is proposed which comprises a series of mitigation measures such as filter drains and catchpits, detention basins and treatment ponds (up to three in series which may include wet or dry ponds or a mixture). Different types of treatment were considered within each treatment train (dry/wet ponds) to maximise pollutant removal.

Filter Drains and Catchpits

- 9.5.14 Filter drains usually consist of a perforated pipe laid in a trench backfilled with gravel and usually placed along the road verge. Filter drains can be used to convey highway drainage to the discharge point and also filter out pollutants such as suspended solids, hydrocarbons, and heavy metals. DMRB indicates copper removal efficiency of 20% and zinc removal efficiency of 75%. Where the proposed scheme would be situated in a cutting, there is a greater risk of groundwater contamination and the filter drain must therefore be designed with an impermeable liner to minimise risk of pollution to groundwater.
- 9.5.15 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 run-off and settle out hydrocarbons and metals. Catchpits are located at regular intervals (of no less than 90m) along filter drains and at the junctions of carrier drains.
- 9.5.16 Piped carrier drains may be required at certain locations to transfer surface water beneath the main carriageway, and from the filter drains to designated outfall points. This type of treatment conveys surface water but generally is not designed to attenuate flows.

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- 9.5.17 The carriageway drainage is designed to carry the 50% AEP (1:2 year return period) and is checked for surcharging at the 10% AEP. Above the 10% AEP (1:10 year return period) the water is expected to spill into the pre-earthworks drainage ditches which run alongside the road, at the toe of embankments and at the top of cuttings. These ditches are designed to convey the 1.33% AEP (1:75 year return period) event. Above the 1.33% AEP, flood flow routes would be identified by engineers to ensure flooding is directed either down the carriageway or down the overflowing ditches to the detention features (described below) before outfall into the receiving watercourses.

Detention Basins/Treatment Ponds

- 9.5.18 These are 'end-of-line' treatment systems, providing biological treatment and removal of dissolved contaminants and nutrients. They are constructed to collect road run-off prior to discharge to the receiving environment; detention basins are principally used to attenuate flows, whilst treatment ponds are required to treat the more polluted first flush component of road run-off. All constructed ponds would be located outwith the 0.5% AEP floodplain.
- 9.5.19 The proposed detention basins would mitigate flows up to the 0.5% AEP (1:200 year return period event). The basins would be designed to attenuate the 1% AEP (1:100 year return period) back to pre development run-off rates (Q med Greenfield run-off rate). Then, to account for climate change (as detailed in Section 9.2.31-9.2.33), the freeboard allowance on the basins are checked to ensure that the 0.5% AEP (1:200 year return period event) can be accommodated before the spillway would be activated
- 9.5.20 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 Run-off Using Constructed Wetlands' (Environment Agency, 1998) and 'CIRIA C609' (CIRIA, 2004). This would include consideration of both wet and dry ponds in sequence to maximise pollutant removal by differing methods. Design treatment times on the proposed scheme would be between 24-48 hours depending on the number of ponds and level of treatment required. Pollution removal rates decrease in efficiency as detention time in ponds increases, and studies have shown that a detention time beyond 24 hours does not result in a significant improvement in quality (CIRIA, 2004). All treatment systems along the proposed scheme are designed to hold water within them for between 39 and 192 hours.
- 9.5.21 The required storage volume to treat road drainage (the treatment volume) has been calculated based on the guidance contained in the CIRIA SUDS Design Manual (CIRIA, 2000) and the design guidance given in Treatment of Highway Run-off Using Constructed Wetlands (Environment Agency, 1998). CIRIA guidance states that ponds should be designed with storage volume, V_t (the volume generated by a mean annual flood) or in exceptional circumstances, $4V_t$ (four times the volume generated by a mean annual flood). In agreement, SEPA recommends that ponds draining particularly sensitive catchments be designed for storage volume $4V_t$. In the Northern section of the proposed scheme the outfall into Red Moss Burn, which drains to Corby and Lily Loch SSSI, has been designed to hold $4V_t$. Best design practice for pollutant removal, as detailed in CIRIA C609 (2004) and CIRIA C697 (2007), should be adhered to.

Swales

- 9.5.22 Swales are vegetated surface features that drain water evenly off impermeable areas. The swale channel is broad and shallow, and covered by grass or other suitable vegetation to slow down flows and trap pollutants (CIRIA, 2004). Swales can also be designed for a combination of conveyance, infiltration, detention and treatment of run-off (CIRIA, 2004). They are typically located next to highways but can also be constructed in landscaped areas within car parks and elsewhere.
- 9.5.23 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% AEP (1:2 year) and 10% AEP (1:10 year), they 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

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they are often used in conjunction with other techniques. They are reported to remove 70%-90% total zinc and 50%-70% dissolved copper from the road drainage (DMRB, 1998). For the purposes of this assessment, the removal efficiencies are assumed to be 70% for total zinc and 50% for dissolved copper.

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

Outfall Structures

- 9.5.25 Outfall structures will form part of the detailed design developed through the CAR process. Mitigation incorporated into the design will ensure that outfalls are positioned to limit the potential for scour around the culvert. This involves ensuring that the outfall does not cause a 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 or be located where there is high susceptibility to erosion.

- 9.5.26 The design will also incorporate any scour protection measures necessary at the outfall. Details of best practice are identified in CIRIA 697 (2007).

Maintenance of Road Drainage Network

- 9.5.27 To avoid failure or sub-optimal operation of the road drainage network, maintenance of its components is necessary as follows:

- maintenance of filter drains includes regular inspection and weed control, annual sediment removal and vegetation build up, replace clogged filter material typically once in 10 years or more;
- maintenance of filtration devices includes 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, remove sediment from forebay (the first depression within the basin, usually concrete for easy maintenance) when 50% full and from the pool when volume reduced by 25% (25 years or greater);
- regular maintenance of receiving watercourses and culverts to reduce the risk of blockages and thus increased flood risk;
- if herbicides are used, those recommended by SEPA for use near watercourses to be applied in line with manufacturer's instructions to reduce pollution of watercourses; and,
- provision of scour protection at the drainage discharge outfall to protect the banks and bed of the receiving ditch and to limit erosion.

- 9.5.28 Water quality/sedimentation/ecological monitoring downstream of key outfalls would be undertaken to provide an indication for problems should they arise. A program of monitoring would be agreed with SEPA, in particular this would be undertaken at the drainage outfall on the River Don to monitor any long-term impacts on the watercourse.

Water Crossings (Bridges)

- 9.5.29 As described in Section 9.4 (Potential Impacts), bridges are proposed over the River Don and Goval Burn. Bridging these high sensitivity salmonid watercourses will minimise adverse impacts to water quality, hydrological regime, geomorphological diversity and construction phase risks. The

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river crossing designs have been developed by a team including structural engineers with inputs from hydraulic modellers, environmental scientists and aesthetic advisors. Details of design features are given in Chapter 4 (The Proposed Scheme), with aspects specific to water quality, quantity and geomorphology outlined below.

- 9.5.30 The use of bridges will minimise any impact on the hydrological regime during both construction and operation. Although all structures have been designed to convey at least the 1 in 200 year design period event, bridge structures may accommodate flows of higher return period events. Bridges have been designed to entirely span the watercourse, ensuring minimal impacts to watercourse hydrology during normal flow conditions, however channel conveyance may still be impacted
- 9.5.31 The bridge design is such that no piers will be located in the water column which will avoid the need for in-channel works at any of these crossing points. During construction this significantly reduces the potential for accidental spillage and sediment release within the water channel, and avoids the requirement for river diversion or pumping water away during construction. 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 due to the fact it will entirely span the watercourse.
- 9.5.32 Bridges have also been designed to minimise damage to the surrounding riparian zone, with piers set back from the water's edge and viaduct options being preferred over the construction of large embankments on floodplains. In addition to reducing any risk of increase to flood risk, this should also allow sufficient light through most bridge structures to maintain riparian vegetation, thereby reducing erosion and minimising adverse impacts on water quality.

Watercourse Crossings (Culverts)

- 9.5.33 Culverts have been designed to appropriate return period flows. SEPA requires design to a 0.5% AEP (1 in 200 years). SPP7 (SE, 2004) states that this return period already includes an allowance for climate change (refer to paragraph 9.2.31-33). The proposed culvert design follows SEPA policy and the guidelines set out in 'Culvert Design Manual: Report 168' (CIRIA, 1997). In addition, culvert are designed to facilitate fish passage following guidance from 'River Crossings and Migratory Fish: Design Guidance: A Consultation Paper for the Scottish Executive' (SEERAD, 2000) (refer to Appendix A10.15: Fish Report). Proposed crossings will ensure that there is minimal disruption to the existing flow regime of the affected watercourse. Mammal ledges will also be installed either side of the culvert to provide wildlife access, as described in Chapter 10 (Ecology and Nature Conservation).
- 9.5.34 The decision to install depressed invert culverts at all crossings (with the exception of the River Don and Goval Burn crossings where bridges will be provided), has been made taking into account engineering, economic and environmental constraints. It should be noted that this culvert design will reduce the environmental impacts to some watercourses but not all. For example, morphologically diverse watercourses such as Craibstone Burn will remain significantly impacted since a culvert will reduce the sinuosity and morphological diversity of the watercourse in the long-term.
- 9.5.35 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 river 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 also be formed of locally sourced material of the same size as the dominant particle size in the pre-existing gravel channel (excluding silt accumulations) and no fine sediment will be placed in the new channels.
- 9.5.36 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 can occur within the

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culverts causing loss of bed sediments to downstream depositional areas. Problems associated with stream power are most likely to occur where culverting has involved the straightening of previously sinuous watercourses. In order to minimise the risk of scour, baffles will be installed within the culvert to dissipate flow energy and to stabilise the bed sediments, in particular culverts. The culverts identified as requiring baffles are:

- Gough Burn;
- Craibstone Burn;
- the lower two crossings of Bogenjoss Burn, and
- Middlefield Burn.

9.5.37 All culverts will be designed to ensure that gradients do not differ markedly from existing conditions to avoid excessive siltation or erosion.

9.5.38 Culverts will be designed to minimise potential for blockages to occur (e.g. due to trapped debris). This includes provision of large capacity; smooth transitions into the culverts; and avoidance of steps, obstructions or changes of cross-section within the culverts. Where there is found to be a significant potential risk of blockage due to surrounding land use a suitably designed trash screen could also be considered and should be designed following guidance set out in CIRIA C168 (CIRIA, 1997; NRA, 1993). A regular maintenance regime will also prevent any blockages around culverts and bridge piers that could reduce the capacity of the structure. This may include the removal of debris, vegetation from the channel and banks upstream of the structure. .

9.5.39 A one dimensional model of all the proposed culverts crossing natural watercourses has been constructed and results indicate culverts are suitably designed and pass the 0.5% AEP (200 year) flow with spare capacity.

Watercourse Realignments

9.5.40 Watercourse realignments are generally required to direct watercourses away from the road or to 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.

9.5.41 A list of proposed realignments is provided in Section 9.4 (Potential Impacts), with more detailed information provided in Appendix A9.3 (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;
- realignments were 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
- realignments were designed to maximise morphological diversity through the inclusion of meander bends, secondary channels, riparian zones, backwaters and ox bow lakes where appropriate.

9.5.42 Any realignment of a watercourse will be designed such that it causes minimal disturbance to flow patterns within the watercourse and adverse changes on water quality. Where possible, the

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realignment is required to mirror the original alignment in terms of gradient and planform and during the detailed design stage a geomorphologist will be consulted for input into the design. Additional geomorphological assessments will be provided to SEPA, where required, within the CAR application for each realignment.

Pre-earthworks Drainage Ditches

- 9.5.43 Taking a watercourse into pre-earthworks drainage ditches is the equivalent of realigning a watercourse and allowing it to drain in a different channel. Mitigation for these during the operation phase is aimed at ensuring that flood risk is not increased. The drainage system has been designed in accordance with 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

- 9.5.44 Although river diversions and culverts have been designed to minimise the risk of sedimentation and erosion, a monitoring program will be undertaken to flag any potential problems during the construction phase. This approach is aimed at reducing the risk of dramatic changes to the geomorphological character of watercourses which may lead to adverse impacts on water quality. Details of the monitoring approach are given in Appendix A9.3 (Fluvial Geomorphology) but must include regular inspections after construction to monitor watercourses for any areas of new erosion or deposition. The frequency of monitoring required will be determined in liaison with SEPA during the CAR application process.

Construction

Adherence to Best Practice

- 9.5.45 Avoidance and reduction of construction impacts will be achieved by:
- minimising the duration and spatial extent of works in the vicinity of watercourses and ensure adequate sediment control measures are in place around the works;
 - the presence of an ecological clerk of works (ECoW) on site during construction, to ensure the implementation of appropriate environmental safeguards;
 - progressive rehabilitation of exposed areas throughout the construction period as soon as possible after the work has been completed to minimise sediment release into the channel;
 - installation of temporary treatment ponds where appropriate to ensure minimum water quality standards throughout construction details to 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;
 - formal consent of SEPA will be sought for any abstractions from watercourses and any abstractions from the river will be identified and quantified;
 - 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.
- 9.5.46 Measures to avoid, minimise or control pollution of surface water and groundwater will incorporate SEPA requirements for pollution control, including Pollution Prevention Guidelines (PPGs) detailed below:
- PPG01 General guide to the prevention of water pollution:

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- PPG04 Disposal of sewage where foul sewer 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 run-off; and
- PPG21 Pollution Incident Response Planning.

9.5.47 Key mitigation requirements for works in the vicinity of watercourses (incorporating PPG recommendations) are identified below in Table 9.9.

Table 9.9 – Mitigation Measures to Reduce Impacts during Construction Activities

Source of Impact	Mitigation
Suspended Solids	<p>Run-off and erosion control measures will include perimeter cut-off ditches; ditches at the base of embankments; settlement lagoons; the installation of silt fences on cut slopes, 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>Dust release during blasting activities must be minimised by damping with water. More information can be found in Appendix A9.3 (Fluvial Geomorphology).</p> <p>A method statement will be provided detailing proposed measures to mitigate release of suspended solids during the CAR licensing process.</p>
Oils, Fuels and Chemicals	<p>Bunded areas with impervious walls and floor lining for the storage of fuel, oil and chemicals must be provided. These bunded areas will have a value of at least 110% that of the storage tanks. 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) should be completed away from watercourses, ditches and surface water drains.</p>
Watercourse / Drain Crossings and Diversions	<p>If a watercourse diversion is required, it must be diverted or pumped away from the construction site to minimise potential contamination of the watercourse. Temporary culverts (like permanent ones) must be appropriately sized to ensure adequate passage of water during high flow condition (designed to the 0.5% AEP) and must be designed to ensure fish and mammal passage is facilitated.</p> <p>Minimal disturbance to the banks and beds of watercourses and minimal disturbance to existing land drainage systems must be ensured. If the new road blocks existing drainage, the existing land drainage will be culverted or diverted as appropriate. More information can be found in Appendix A9.3 (Fluvial Geomorphology).</p>
Outfall Construction	<p>Ensure that construction of outfall is not conducted during periods of high flow as the disturbed exposed river banks will be vulnerable to erosion.</p> <p>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 will be undertaken prior to construction and will be undertaken using good engineering practices to ensure spillage risk is minimised. It is likely that statutory bodies may undertake the diversion works under their own access rights.</p> <p>Arrangements for safe storage and disposal of sewage effluent from workers on site will be agreed with SEPA and Building Control in advance of construction in accordance with PPG 4.</p>
Contaminated Land and Sediment	<p>The ground investigation, which will be carried out, will identify any areas of contamination and similar methods to those outlined to reduce suspended solids entering watercourses will be used to ensure disturbed sediment does not enter the watercourses. More information can be found in Appendix A9.3 (Fluvial Geomorphology).</p>

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Watercourse realignments

9.5.48 Further detailed site specific assessments are detailed for each watercourse realignment once the construction methods have been finalised (during the CAR application process), but the approach will be based on the following principles:

- In order to limit the potential for bank erosion, new banks of the realignments should be appropriately graded through discussions with a geomorphologist and ecologist.
- 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 river bank sediments together. This will limit the potential for both 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 will be complete, including the new culverts prior to the rerouting of water and no further in-channel works should be conducted. The new channel should 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 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 riverbed 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 which some sediment release can be expected. The new channel must be monitored regularly and where signs of instability are observed, such as erosion or incision, appropriate remediation measures must be undertaken.
- Site activity in the vicinity of temporary realignment will be carefully managed to avoid the risk of accidental spillage into the watercourse. All pumps will have drip trays to avoid accidents and be set away from the river. Site road crossings will consist of a piped section sufficiently long to pass under the road together with strips of ground either side to provide a barrier between the road and open channel sections.
- Sediment traps, such as sedimats (see <http://www.hy-tex.co.uk>), 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.
- It is recommended that works be carried out in early spring in lower flow conditions and to enable the vegetation to establish over the summer.

Programme of Works

9.5.49 The impact of the proposed scheme can be greatly reduced or avoided through appropriate 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.

9.5.50 Appropriate timing of mitigation measures is also critical to ensure their successful implementation. Treatment ponds included as part of scheme design (Figures 9.4a-g) will be programmed for construction early in the programme to allow settlement and treatment of any pollutants contained in site run-off, and to control the rate of flow before water is discharged into the receiving watercourses. Additional temporary settlement ponds may also be required during construction, particularly in the vicinity of sensitive watercourses such as the River Don.

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Monitoring

- 9.5.51 The Employer's Requirements will require the Contractor 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.

Site Specific Mitigation

- 9.5.52 Mitigation specified above is appropriate for watercourses considered in Section 9.4 (Potential Impacts). In addition to these measures, there are specific measures that must be applied to salmonid burns and rivers or small sub-catchments affected by the proposed works: these are outlined below.

Gough/Craibstone/Green Catchment

- 9.5.53 Gough and Craibstone Burns are high sensitivity watercourses that would be culverted and realigned as part of the proposed scheme. These watercourses have excellent water quality and exhibit good morphological diversity and sinuosity. The third burn in the subcatchment, Green Burn is more modified and is considered to be of medium sensitivity. It is proposed to be crossed three times, receive approximately 12ha of road drainage and be subject to an extensive realignment.
- 9.5.54 To reduce the potential impact to water quality, different options for drainage outfalls were considered for this subcatchment. Due to the size of the receiving watercourses, in particular Craibstone Burn, and the potential requirement for additional treatment it was considered that routing all drainage for outfall to the Green Burn was the preferred environmental option. Green Burn is the largest and most modified of all three tributaries with the greatest dilution potential. Hence the mitigation and design has ensured that there will only be an outfall to the Green Burn within this subcatchment.

Bogenjoss Burn

- 9.5.55 Bogenjoss Burn flows through a plantation conifer woodland, and would be extensively realigned at the upstream sites with around 1188m of river length realigned and straightened in total and 2 extensive culvert structures at the mainline crossings downstream. Due to sedimentation and erosion risk it was not considered practical to include meanders in this realignment. However, morphological diversity and the natural sinuosity of the channel would be maintained from the downstream end of the second mainline crossing as the realigned watercourse will be directed back into its original bed from this point downstream.
- 9.5.56 Detailed geomorphological mitigation measures are set out in Appendix A9.3 (Fluvial Geomorphology) and recommend the installation of baffles within some of the culverts (in particular the lower two) to minimise erosion. The size of the bed sediment and precise nature of the bed morphology within the culverts and realignment will be determined by further, more detailed, geomorphological analysis undertaken as part of the CAR application process.

River Don

- 9.5.57 During the construction of the River Don crossing the following specific mitigation measures will be required:
- only one mainline approach road (north or south) will be constructed at any one time to minimise the risk of sediment release and oil and chemical spillage (see Appendix A9.5; Annex 29 for more information);
 - sediment fencing will be constructed as a perimeter to the construction footprint to reduce the sediment release;

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- temporary treatment ponds will be constructed to reduce the run-off pollution from the approach road construction. Often the permanent ponds are constructed first to allow these to be utilised during the construction period providing they are subsequently cleaned out;
- use of plastic sleeve and double falsework/shuttering when working over the watercourse to ensure minimal concrete spillage;
- enclosed spraying when waterproofing preventing chemicals from entering the watercourse;
- no in-channel works to be conducted between 14 October and 31 May that may affect migratory and spawning salmon (refer to Chapter 10); and
- long-term water quality/ecological monitoring before, during and after construction (to be agreed with SEPA prior to work commencement).

Goval Burn

9.5.58 The following special mitigation measures are proposed to ensure effective sediment management, less erosion and reduce the adverse impact on the morphological diversity of the watercourse:

- mitigation to minimise the risk of sediment release and oil and concrete spillage during construction, e.g. sediment fencing, concrete mixing and batching outside the flood plain, double falsework/shuttering if the bridge deck is to be constructed in situ (similar to the mitigation used during the construction of the River Don bridge);
- temporary treatment ponds will be constructed to reduce the run-off pollution. Often the permanent ponds are constructed first to allow these to be utilised during the construction period providing they are subsequently cleaned out; and
- no in-channel bridging works to be conducted between 14 October and 31 May to avoid impacts to migratory and spawning salmon (refer to Chapter 10).

Corby/Lily Lochs and Red Moss Burn

9.5.59 The treatment ponds with an outfall to Red Moss Burn during operation would be designed to hold 4Vt (refer to paragraph 9.5.21) due to the sensitivity of the location. Additionally, provision of the Red Moss Burn culvert ensures the severed catchment from the Corby Loch is maintained.

9.5.60 Geomorphological investigations indicate that the depressed invert culvert should be filled with a mix of coarse gravel and cobbles (equal to, or greater than, 60 mm) to ensure the bed of the culvert remains stable under all flow conditions. Further information can be found in Appendix A9.3 (Fluvial Geomorphology).

9.5.61 To mitigate catchment severance for the Lily Loch, the provision of a network culvert to transfer pre-earthworks (clean) drainage from the north side of the scheme into Lily Loch Inflow Channel would be included as part of the scheme. This would ensure that connectivity is maintained between the upper sections of the Lily Loch surface water catchment and the Lily Loch inflow channel. The upper sections of the Lily Loch catchment would have otherwise been severed by the AWPR. The Lily Loch culvert will be designed to discharge into the Lily Loch inflow channel just downstream of the point where the inflow channel is culverted and would be designed to carry the 1.33% AEP flow (1:75 year flow) as it is considered to be part of the drainage network.

9.5.62 During the construction phase extra care must be taken when working near the Red Moss Burn. Any impacts on the water quality of this burn, either through pollutant or sediment release, have the potential to impact on the SSSI downstream. The following special mitigation measures will be required to ensure effective sediment management, minimise erosion and reduce the adverse impact on the watercourse:

- installation of sediment fencing around the footprint of active working areas located within the floodplain; and

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- temporary treatment ponds will be constructed to reduce the run-off pollution. Often the permanent ponds are constructed first to allow these to be utilised during the construction period providing they are subsequently cleaned out.

9.5.63 A detailed construction methodology will be developed as part of the CAR process.

Groundwater

9.5.64 The local impacts on groundwater levels associated with a number of proposed road cuttings within the Northern Leg can be reduced slightly by optimising the drainage design. However, intercepting groundwater that would otherwise flood the road necessitates the reduction of the immediate groundwater level to the level of the road. Groundwater mitigation is provided in Chapter 8.

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Table 9.10 – Summary of Mitigation Measures for each Watercourse

Watercourse	Potential Impact	Mitigation Measures
Kepplehill Burn	Road Drainage	n/a
	Crossing	1 Depressed invert box culvert designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure.
	Realignment	With regards to realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities. Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Development of detailed method statement for agreement with SEPA.
Gough Burn	Road Drainage	n/a
	Crossing	2 Depressed invert box culverts designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Detailed geomorphological mitigation set out in Appendix A9.3 Fluvial Geomorphology, regarding baffle installation and erosion control.
	Realignment	With regards to major realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied and refer to specific requirements detailed in the text.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Refer to specific proposals set out in text. Development of detailed method statement for agreement with SEPA.
Parkhead Burn and Parkhead field ditch	Road Drainage	No mitigation proposed
	Crossing	No mitigation proposed
	Realignment	No mitigation proposed
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Development of detailed method statement for agreement with SEPA.
Craibstone Burn	Road Drainage	n/a
	Crossing	Depressed invert box culvert designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Detailed geomorphological mitigation set out in Appendix A9.3 (Fluvial Geomorphology) , regarding baffle installation and erosion control.
	Realignment	With regards to major realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied and refer to specific requirements detailed in the text.

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Watercourse	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Refer to specific proposals set out in text. . Development of detailed method statement for agreement with SEPA.
Green Burn	Road Drainage	Filter Drain, Detention Basin, 3 x Treatment ponds at two locations
	Crossing	3 depressed invert box culverts designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Detailed geomorphological mitigation set out in Appendix A9.3 Fluvial Geomorphology, regarding sedimentation control.
	Realignment	With regards to major realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied and refer to specific requirements detailed in the text.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Refer to specific proposals set out in text. Development of detailed method statement for agreement with SEPA.
Walton Field Ditch	Road Drainage	No specific mitigation proposed – follow generic mitigation measures where appropriate.
	Crossing	No specific mitigation proposed – follow generic mitigation measures where appropriate.
	Realignment	No specific mitigation proposed – follow generic mitigation measures where appropriate.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51.
Howemoss Burn/Springs	Road Drainage	No specific mitigation proposed – follow generic mitigation measures where appropriate.
	Crossing	Ensure that construction of embankment does not impede spring upwelling.
	Realignment	No specific mitigation proposed – follow generic mitigation measures where appropriate.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities. Development of detailed method statement for agreement with SEPA.
Bogenjoss Burn	Road Drainage	Filter Drain, Detention Basin, Treatment Pond, 30m Swale.
	Crossing	6 depressed invert box culverts designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Detailed geomorphological mitigation set out in Appendix A9.3 Fluvial Geomorphology, regarding baffle installation and erosion control.
	Realignment	Detailed geomorphological mitigation set out in Appendix A9.3 Fluvial Geomorphology. With regards to realignment, localised geomorphological features must be reproduced and hydraulic gradient must be maintained. Sensitive realignment design reintroducing local effects such as 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. Adherence to general principles set out in text must be applied and refer to specific requirements detailed in the text.

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Watercourse	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Refer to specific proposals set out in text. . Development of detailed method statement for agreement with SEPA.
River Don	Road Drainage	Filter Drain, Detention Basin, 2 x Treatment ponds.
	Crossing	Bridge with no piers in the river spanning the watercourse, and an exclusion zone on either bank, back spans of the structure will span the floodplain. Please refer to discussion in text.
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Cut-off ditches and sediment fencing around the footprint of the works and; treatment ponds to reduce sediment release. These ponds may be the same as those used for operational phase since they are likely to be constructed first; however care should be taken to clean ponds before operational phase. Generic mitigation measures in combination with specific mitigation – please refer to text. . Development of detailed method statement for agreement with SEPA.
Goval Burn	Road Drainage	Filter Drain, Detention Basin, Treatment pond.
	Crossing	Bridging structures for all 3 crossings, spanning the watercourse, maintaining morphological diversity and allowing lateral movement
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Construction of bridges reduces risk of sediment/pollutant release. Refer to specific proposals set out in text. Development of detailed method statement for agreement with SEPA.
Mill Lade	Road Drainage	n/a
	Crossing	Bridging structure for crossing, spanning the watercourse, maintaining the historical feature. Overhead aqueduct crossing - replacement of existing structure with extension. Overall gradient of existing structure should be replicated in the new design.
	Realignment	n/a
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Temporary realignment and water storage during the construction of the aqueduct – any temporary realignment should maintain current channel capacity.
Corsehill Burn	Road Drainage	Filter Drain, Detention Basin, Treatment pond.
	Crossing	3 Depressed invert box culverts designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Detailed geomorphological mitigation set out in Appendix A9.3 Fluvial Geomorphology, regarding sedimentation control.
	Realignment	With regards to realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied.

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Watercourse	Potential Impact	Mitigation Measures
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. . Development of detailed method statement for agreement with SEPA.
Red Moss Burn (Corby Loch)	Road Drainage	Filter Drain, Detention Basin, Treatment pond Drainage system to be designed to maintain water quantity arriving at Corby Loch, outfall from pre-earthworks into Red Moss to ensure surface water catchment is maintained.
	Crossing	Depressed invert box culvert for smaller crossings designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Geomorphological investigations summarised in the draft CAR Application for this watercourse indicate that the depressed invert culvert should be filled with a mix of coarse gravel and cobbles, equal to, or greater than, 60 mm to ensure the bed of the culvert remains stable under all flow conditions. The uneven surface of the coarse bed will also trap some of the finer sediment and provide a bed morphology similar to the existing channel.
	Realignment	With regards to realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied and refer to specific requirements detailed in the text.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Refer also to specific proposals provided in the text. Development of detailed method statement for agreement with SEPA.
Corby and Lily Lochs	Road Drainage	Lily Loch: The severed surface water catchment on the upstream side of the proposed scheme will be caught in pre-earthworks ditches and transferred under the road into Lily Loch Inflow Channel. This will maintain the existing hydrological catchment. The design of the embankment through the area would also facilitate groundwater movement towards the lochs. Refer also to specific proposals provided in the text. Corby Loch: See above for Red Moss Burn drainage details. Refer also to specific proposals provided in the text.
	Crossing	Lily Loch: See above for road drainage – network culvert maintains hydrological catchment (sized to pass 1.33% AEP, 1:75yr flow). Refer also to specific proposals provided in the text. Corby Loch: See above Red Moss Burn crossing structure – maintains hydrological catchment. Refer also to specific proposals provided in the text.
	Realignment	Lily Loch: n/a Corby Loch: See above for Red Moss Burn realignment details.

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Watercourse	Potential Impact	Mitigation Measures
	Construction	Lily and Corby Loch: Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Refer also to specific proposals provided in the text. . Development of detailed method statement for agreement with SEPA.
Blackdog Burn	Road Drainage	Filter Drain, 2 x Detention Basin, 2 x Treatment pond (One at each of two locations)
	Crossing	2 depressed invert box culverts for smaller crossings designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure.
	Realignment	With regards to realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities. Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. . Development of detailed method statement for agreement with SEPA.
Blackdog Ditch	Road Drainage	n/a
	Crossing	1 Depressed invert box culvert for smaller crossings designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure.
	Realignment	With regards to realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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. Adherence to general principles set out in text must be applied.
	Construction	Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51. Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls. Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; settlement lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. . Development of detailed method statement for agreement with SEPA..
Middlefield Burn	Road Drainage	Filter Drain, 2xDetention Basin, 2xTreatment pond (One at each of two locations)
	Crossing	3 Depressed invert box culverts for smaller crossings designed to carry a 0.5% AEP (1:200 year flow) with mammal ledge. Maintains bed continuity through the structure. Detailed geomorphological mitigation set out in Appendix A9.3 Fluvial Geomorphology, regarding baffle installation and erosion control.

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Watercourse	Potential Impact	Mitigation Measures
	Realignment	<p>With regards to realignment, geomorphological features must be reproduced and hydraulic gradient and length must be maintained. Sensitive realignment design reintroducing 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.</p> <p>Adherence to general principles set out in text must be applied.</p>
	Construction	<p>Adherence to best practice. Generic mitigation measures apply – paragraph 9.5.45 – 9.5.51.</p> <p>Treatment ponds may be used to mitigate suspended solid runoff reaching watercourses during the construction phase; however they must be cleaned out before use in the operation phase.</p> <p>Batching and mixing off site, using quick setting cement mixes; bunded areas with impervious walls.</p> <p>Cut-off ditches; sediment fencing; to minimise sediment release from earthwork activities</p> <p>Diversion or pumping away during construction of culvert/realignments; Geotextile lining at the temporary realignment to reduce erosion and sedimentation; lagoons to reduce sediment release. Use of similarly sized material to cover the bottom of the culvert. Development of detailed method statement for agreement with SEPA.</p>

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9.6 Residual Impacts

9.6.1 Following successful implementation of all mitigation outlined above, the potential impacts on the water environment will be reduced. Residual impacts taking into account proposed mitigation are detailed below for construction and operation. Supporting information is provided in the technical appendices, and summarised in Table 9.11.

Impact Assessment

9.6.2 The methodology adopted for assigning this residual impact adopts a precautionary approach. Consequently, the overall residual impact significance was assigned based on the highest residual impact magnitude for each of the technical disciplines following the adoption of the mitigation measures detailed in Section 9.5, taking account of the sensitivity categories assigned in the baseline assessment. Indirect residual impacts on the associated habitats are presented in Chapter 10.

Residual Operational Impacts

Kepplehill Burn and field ditch

9.6.3 With proposed mitigation, the long-term residual impact of the installation of culverts and associated realignment on the hydrology and water quality of the watercourse are considered to be of negligible magnitude. Providing a depressed invert culvert in this location and a sensitive realignment is considered to reduce the impact on the geomorphology of this watercourse to a negligible magnitude.

9.6.4 Overall, the residual impact on Kepplehill Burn and field ditch is therefore of Negligible significance.

Gough Burn

9.6.5 With proposed mitigation, the long-term residual impact of the installation of two culverts and associated realignment on the hydrology and water quality of the watercourse are considered to be of negligible magnitude.

9.6.6 With the provision of two depressed invert culverts and sensitive realignment the impact to the geomorphology of the watercourse is not considered to be reduced. The watercourse is currently very sinuous with good morphological diversity and the installation of culverts will significantly impact the naturalness of the watercourse. The impact on the geomorphology will remain high.

9.6.7 Overall, the residual impact on Gough Burn is considered to be of Substantial significance, due to the geomorphological change of the watercourse.

Parkhead Burn and field ditch

9.6.8 The pre-earthworks drainage design ensures that there is sufficient capacity to convey flows, and the residual impact on hydrology and flood risk are considered to be of negligible magnitude.

9.6.9 Overall, the residual impact on Parkhead Burn and field ditch considered to be of Negligible significance.

Craibstone Burn

9.6.10 With proposed mitigation, the long-term residual impact of the installation of culvert and associated realignment on the hydrology and water quality of the burns are considered to be of negligible magnitude

9.6.11 With the provision of a depressed invert culvert and despite sensitive realignment, the impact to the geomorphology of the watercourse is not considered to be reduced and therefore remains high.

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The watercourse is currently very sinuous with good morphological diversity and the installation of a culvert will significantly impact the naturalness of the watercourse.

- 9.6.12 Overall, the residual impact on Craibstone Burn is therefore of Substantial significance due to geomorphological change.

Green Burn

- 9.6.13 With proposed mitigation, the long-term residual impact of the installation of culverts and associated realignment on the hydrology of the watercourse are considered to be of negligible magnitude.

- 9.6.14 The provision of three depressed invert culverts and a sensitive realignment may provide an improvement to the morphological diversity at some locations along this watercourse. Consequently, the impact to the geomorphology of the watercourse is considered to reduce to a low magnitude.

- 9.6.15 The provision of three treatment ponds before outfall will reduce the impact of the polluted runoff before it reaches the watercourse. This reduction is considered to reduce the impact magnitude from high to low.

- 9.6.16 Overall, the residual impact on Green Burn is considered to be of Slight significance.

Walton field ditch

- 9.6.17 The pre-earthworks drainage design ensures that there is sufficient capacity to convey flows, and the residual magnitude of impact on hydrology and flood risk is considered to be negligible.

- 9.6.18 Overall, the residual impact on Walton field ditch is therefore considered to be of Negligible significance.

Howemoss Spings

- 9.6.19 The pre-earthworks drainage will be designed to incorporate the flows from this spring, and the magnitude of impact to the surface water hydrology is therefore considered to be of negligible magnitude.

- 9.6.20 Overall, the residual impact on Howemoss Springs is therefore considered to be of Negligible significance.

Howemoss Burn

- 9.6.21 With appropriate mitigation, hydrological impacts on the burn are reduced to negligible magnitude

- 9.6.22 Overall, the residual impact on Howemoss Burn is therefore considered to be of Negligible significance.

Bogenjoss Burn

- 9.6.23 With proposed mitigation, the long-term residual impacts of the installation of 6 culverts, extensive realignment and drainage outfall on the hydrology of the watercourse are considered to be of negligible magnitude. However, the magnitude of impact on the geomorphology will remain high as the watercourse is currently very sinuous with good morphological diversity, and the culverts will significantly impact the naturalness of the watercourse. Similarly, the extensive realignment will shorten the watercourse leading to an increased potential for erosion.

- 9.6.24 The provision of a treatment pond and a swale before outfall is considered to reduce the potential pollution and accidental spillage risk to the watercourse. The resulting residual impact magnitude to the water quality is considered to be negligible.

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9.6.25 Overall, the residual impact on Bogenjoss Burn remains of Substantial significance. This is principally driven by the residual impact to the geomorphology of the watercourse.

River Don

9.6.26 The proposed bridge and outfall design would result in a negligible magnitude of impact on the flood risk and hydrological regime. During low flows there is unlikely to be an impact to the watercourse since no piers are proposed in the channel. During periods of flooding the hydrodynamic modelling has indicated that the design of the bridge is unlikely to make a significant impact on water levels in the vicinity of the watercourse.

9.6.27 The design of the bridge, with no piers in the channel is considered to have a negligible impact on the geomorphology of the River Don. Similarly the provision of two treatment ponds before outfall is considered to reduce the potential impact of pollution or accidental spillage to negligible magnitude.

9.6.28 Overall, the residual impact on the River Don is considered to be of Slight/Negligible significance.

Goval Burn

9.6.29 With proposed mitigation, the long-term residual impact of the three proposed bridges and the drainage outfall on the hydrology of the watercourse is considered to be of negligible magnitude. The provision bridges across the watercourse at this location are considered to reduce the impact to the long-term geomorphology to a negligible magnitude impact since no piers are proposed in the channel. The provision of one treatment pond before direct outfall to the Goval Burn is assessed to reduce the potential impact to the water quality to a negligible magnitude.

9.6.30 Overall, the residual impact on Goval Burn is of Slight/Negligible significance.

Mill Lade

9.6.31 It is proposed to retain the slope and channel capacity of this feature, and the residual magnitude of impact on the hydrological functioning of the feature is therefore considered to be negligible. The Mill Lade is an artificial channel with limited geomorphological processes, consequently with appropriate mitigation a negligible magnitude impact on geomorphology is expected.

9.6.32 Overall, the residual impact on the Mill Lade is of Negligible significance.

Corsehill Burn

9.6.33 With proposed mitigation, the long-term residual impact of the installation of three culverts, realignment and drainage outfall on the hydrology of the watercourse are considered to be of negligible magnitude.

9.6.34 As this watercourse is already heavily modified the proposed realignment and provision of culverts is considered to have a negligible magnitude impact on the geomorphology.

9.6.35 The provision of a treatment pond before outfall is considered to reduce the impact on water quality to a low magnitude.

9.6.36 Overall, the residual impact on Corseshill Burn is considered to be of Slight significance.

Red Moss Burn

9.6.37 With proposed mitigation, the long-term residual impact of the installation of the culvert, realignment and outfall on the hydrology of the burns is considered to be of negligible magnitude. Similarly the residual impact on the geomorphology of the watercourse is considered to be reduced to a negligible magnitude. The provision of a treatment pond before outfall is considered to reduce the magnitude of impact on the receiving water quality to low.

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9.6.38 Overall, the residual impact on Red Moss Burn is of Slight significance.

Corby and Lily Lochs

9.6.39 Maintaining the hydrological connectivity through Red Moss Burn is considered to reduce the hydrological impact on Corby Loch to a negligible magnitude.

9.6.40 The provision of a network culvert to transfer the pre-earthworks drainage from the north of the road to the south and outfall into the Lily Loch inflow channel is considered to maintain the hydrological catchment and prevent catchment severance. This, therefore, reduces the impact on Lily Loch to negligible magnitude.

9.6.41 Since the hydrology assessment dictates the overall impact on these features the residual impact on the water environment of both lochs is considered to be of Slight/Negligible significance.

Blackdog Burn

9.6.42 With proposed mitigation, the long-term residual impact of the installation of two culverts, realignment and drainage outfall on the water quality of the watercourse are considered to be of low magnitude. The provision of depressed invert culverts will allow sediment transfer and continuity through the culvert and a sensitive realignment. The residual impact on the geomorphology of the watercourse is considered to be reduced to a negligible magnitude. Similarly, the sizing of these culverts results in hydrological impacts of negligible magnitude.

9.6.43 Overall, the residual impact on the water environment is of Slight significance.

Blackdog Ditch

9.6.44 With proposed mitigation, the long-term residual impact of the installation of the culvert and associated realignment on the hydrology, geomorphology and water quality of the watercourse are considered to be of negligible magnitude.

9.6.45 Overall, the residual impact on Blackdog Ditch is of Negligible significance.

Middlefield Burn

9.6.46 With proposed mitigation, the long-term residual impact of the installation of three culverts, realignment and drainage outfall on the hydrology of the watercourse are considered to be of negligible magnitude. Providing depressed invert culverts will allow sediment transfer and continuity through the culvert, and the sensitive realignment will reduce the long-term impacts to geomorphology to a negligible magnitude. The provision of a treatment pond before outfall reduces the impact on the water quality from accidental spillage or ongoing pollution to negligible magnitude.

9.6.47 Overall, the residual impact on Middlefield Burn is of Negligible significance.

Residual Catchment Impacts

Gough/Green/Craibstone Subcatchment (including smaller watercourses)

9.6.48 Extensive realignment and culverting of watercourses within this subcatchment is considered to result in an overall residual impact of Substantial significance. Principally this impact is driven by changes to the geomorphology of the watercourses.

9.6.49 As noted in Section 9.4 (Potential Impacts), operational impacts on the River Don catchment are discussed in Part E (Cumulative Assessment) of this ES.

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Residual Construction Impacts

Kepplehill Burn and field ditch

- 9.6.50 The residual impacts on hydrology, geomorphology and water quality during construction are considered to be reduced to negligible magnitude and therefore overall, the residual impact on Kepplehill Burn and field ditch is of Negligible significance.

Gough Burn

- 9.6.51 Hydrological and water quality residual impacts are considered to be reduced to negligible magnitude. However, impacts on geomorphology are only predicted to reduce to low magnitude (from high), as disturbance is expected during culvert and realignment construction, and the temporary diversion of the watercourse may result in suspended solid release and short-term impacts on erosion and deposition downstream.

- 9.6.52 Overall, the residual impact on Gough Burn during construction is of Moderate significance due to the sensitivity of the watercourse.

Parkhead Burn and field ditch

- 9.6.53 Mitigation measures are assessed to result in a negligible magnitude impact on the hydrology of this watercourse. Consequently overall, the residual impact on Parkhead Burn and field ditch during construction is of Negligible significance.

Craibstone Burn

- 9.6.54 Hydrological and water quality residual impacts are considered to be reduced to negligible magnitude. However, impacts on geomorphology only predicted to reduce to low magnitude (from high), as disturbance is expected during culvert construction, realignment, and the temporary diversion of the watercourse. These may result in suspended solid release and short-term impacts on erosion and deposition downstream.

- 9.6.55 Overall, the residual impact on Craibstone Burn during construction is of Moderate significance which is a reflection of the sensitivity of the watercourse.

Green Burn

- 9.6.56 The residual impacts during construction on hydrology, water quality and geomorphology are considered to be reduced to negligible magnitude by proposed mitigation.

- 9.6.57 Overall the residual impact on Green Burn during construction is of Negligible significance.

Walton field ditch

- 9.6.58 Mitigation measures are assessed to result in a negligible impact on the hydrology of this watercourse. Consequently the overall residual impact on Walton field is of Negligible significance.

Howemoss Spings

- 9.6.59 Mitigation measures are assessed to result in a negligible impact on the hydrology of this water feature. Consequently, the overall residual impact on Howemoss Springs is of Negligible significance.

Howemoss Burn

- 9.6.60 The residual impacts during construction on hydrology, water quality and geomorphology are considered to be of negligible magnitude.

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9.6.61 Overall, the residual impact on Howemoss Burn during the construction phase is of Negligible significance.

Bogenjoss Burn

9.6.62 With proposed mitigation, the long-term residual impact of the installation of six culverts, extensive realignment and drainage outfall on the hydrology and water quality of the watercourse are considered to be of low and negligible magnitude, respectively.

9.6.63 However, impacts on geomorphology are only predicted to reduce to medium magnitude from high, as widespread disturbance is expected as a result of the installation of six culverts, outfall construction, and extensive realignment. The temporary diversion of the watercourse may result in suspended solid release and short-term impacts on erosion and deposition downstream.

9.6.64 Overall the residual impact on Bogenjoss Burn during construction is of Moderate/Substantial significance which is a reflection of the watercourse sensitivity.

River Don

9.6.65 Construction mitigation and avoidance of any works on the active floodplains will result in a negligible magnitude of impact on the hydrological regime (including the flood risk). Provision of temporary runoff and suspended solid removal before outfall to the river is assessed to reduce the magnitude of impact to the geomorphology and water quality of the watercourse to a negligible magnitude.

9.6.66 Overall, the residual impact on the River Don during construction is of Slight/Negligible significance.

Goval Burn

9.6.67 Adherence to general mitigation measures for the construction phase is likely to reduce the impact on the hydrology, water quality and geomorphology of this watercourse to a negligible magnitude.

9.6.68 Overall, the residual impact on Goval Burn during construction is of Slight/Negligible significance.

Mill Lade

9.6.69 With temporary water management solutions which allow the passage of flow during the construction phase, impacts to the hydrology and flood risk of this artificial channel are reduced to low magnitude. Impacts on the geomorphology and water quality are reduced to a negligible magnitude.

9.6.70 Overall, the residual impact on the Mill Lade during construction is of Negligible significance.

Corsehill Burn

9.6.71 Hydrological, geomorphology, and water quality impacts are considered to be reduced to negligible magnitude as a result of the mitigation proposed.

9.6.72 Overall, the residual impact on Corsehill Burn during construction is of Negligible significance.

Red Moss Burn

9.6.73 Hydrological, geomorphology, and water quality impacts are considered to be reduced to negligible magnitude as a result of the mitigation proposed.

9.6.74 Overall, the residual impact on Red Moss Burn during construction is of Negligible significance.

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Corby and Lily Lochs

- 9.6.75 The magnitude of impacts on the lochs are considered to be reduced to a negligible magnitude. When considered in combination with Red Moss Burn, the overall residual impact on the lochs during construction is reduced to Slight/Negligible significance.

Blackdog Burn and small tributary

- 9.6.76 The magnitude of impacts on the hydrology, water quality and geomorphology of the watercourse are considered to be reduced to negligible magnitude.

- 9.6.77 Overall, the residual impact on Blackdog Burn and the small tributary during construction is of Negligible significance.

Blackdog Ditch

- 9.6.78 The impacts on the hydrology, water quality and geomorphology of the watercourse are considered to be reduced to negligible magnitude.

- 9.6.79 Overall, the residual impact on Blackdog Ditch during construction is of Negligible significance.

Middlefield Burn

- 9.6.80 The impacts on the hydrology, water quality and geomorphology of the watercourse are considered to be reduced to negligible magnitude.

- 9.6.81 Overall, the residual impact on Middlefield Burn during construction is of Negligible significance.

Residual Catchment Impacts

Gough/Green/Craibstone Subcatchment (including smaller watercourses)

- 9.6.82 Extensive realignment and culverting within this subcatchment is considered to give a combined impact on the subcatchment of Moderate significance during construction. Principally, this impact is driven by the impact to the geomorphology of the watercourses.

- 9.6.83 As noted in Section 9.4 (Potential Impacts), construction impacts on the River Don catchment are discussed in Part E (Cumulative Assessment) of this ES.

Groundwater

- 9.6.84 The details of the groundwater residual impact assessment are provided in Chapter 8 (Geology, Contaminated Land and Groundwater). As the groundwater assessment is linked to this assessment, the salient points are summarised here for ease of understanding.

- 9.6.85 It is anticipated that after further characterisation of the local groundwater conditions and supply details, any potential impacts on private groundwater supplies would be mitigated by improving or replacing the affected supplies, resulting in residual impacts of Negligible significance.

- 9.6.86 Potential impacts on local groundwater quality are mitigated by the same management procedures as proposed for protection of surface waters, and are predicted to ensure that any pollution releases will result in Negligible significance if they reach groundwater.

- 9.6.87 Due to limitations in the current understanding of the groundwater contribution to Corby and Lily Lochs, residual impacts are considered to be Slight to Moderate significance following a precautionary approach.

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Table 9.12 – Residual Impact on key watercourses in the Northern Leg (residual impact of pollutant release included in overall assessment)

Feature	Overall Sensitivity	Potential Impact Significance (unmitigated)	Residual Impact Description Summary	Overall Residual Impact	
				Magnitude	Significance
Kepplehill Burn	Low	Slight	<u>Construction</u> : 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
		Slight	<u>Operation</u> : 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 realignment offset where possible by pool and riffle sequences. Change to discharge and flood regime minimised through careful design of realignment and culvert. Capacity for 0.5%AEP (1:200 year flow). Hydrology, Geomorphology, and Water Quality: Negligible	Negligible	Negligible
Gough Burn	High	Substantial	<u>Construction</u> : Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology and Water Quality: Negligible Geomorphology: Low	Low	Moderate
		Substantial	<u>Operation</u> : 2 Depressed invert culverts allow natural substrate through the culverts. Long-term changes to morphology of the watercourse and sinuosity lost permanently. Capacity for 0.5%AEP (1:200 year flow). Hydrology and Water Quality: Negligible Geomorphology: High	High	Substantial
Parkhead Burn & Field Ditch	Low	Negligible	<u>Construction</u> : Best practice mitigation adhered to for working close to watercourses. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
		Negligible	<u>Operation</u> : Impact remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
Craibstone Burn	High	Substantial	<u>Construction</u> : Risk of sediment release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology and Water Quality: Negligible Geomorphology: Low	Low	Moderate
		Substantial	<u>Operation</u> : Design of depressed invert culvert allows natural substrate through the culvert. Long-term changes to morphology of the watercourse and sinuosity lost permanently. Capacity for 0.5%AEP (1:200 year flow). Hydrology and Water Quality: Negligible Geomorphology: High	High	Substantial
Green Burn	Medium	Moderate/ Substantial	<u>Construction</u> : 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

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Feature	Overall Sensitivity	Potential Impact Significance (unmitigated)	Residual Impact Description Summary	Overall Residual Impact	
				Magnitude	Significance
Green Burn [cont'd]	see above	Moderate/ Substantial	<u>Operation:</u> Morphological diversity lost but burn is already heavily modified. Where possible this is offset by the introduction of pool and riffle sequences. Road drainage attenuated to pre-development rates. Road drainage system ensures that road run-off entering burn complies with Environmental Quality Standards (EQS) and is within acceptable risk limits for accidental spillage. Capacity for 0.5%AEP (1:200 year flow). Hydrology: Negligible Geomorphology and Water Quality: Low	Low	Slight
Walton Field Ditch	Low	Negligible	<u>Construction:</u> Best practice mitigation adhered to for working close to watercourses to ensure impact is minimised. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
		Negligible	<u>Operation:</u> Impact remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
Howemoss Springs	Medium	Slight	<u>Construction:</u> Risk of sediment and pollutant release minimised through best practice. Ongoing monitoring during the construction phase will identify any impacts at an early stage. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
		Slight	<u>Operation:</u> Sensitive location of embankment will ensure that the spring remains unchanged. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
Howemoss Burn	Low	Slight	<u>Construction:</u> Risk of sediment and pollutant release minimised through best practice. Ongoing monitoring during the construction phase will identify any impacts at an early stage. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Negligible
		Slight	<u>Operation:</u> Lost of short section of watercourse downstream. Hydrology: Low Geomorphology and Water Quality: scoped out of assessment	Low	Negligible
Bogenjoss Burn	High	Substantial	<u>Construction:</u> Risk of sediment and pollutant release minimised through best practice but residual impact remains high due to the length and extent of the works. Construction phase monitoring will identify accidental pollution at an early stage. Hydrology: Low Geomorphology: Medium Water Quality: Negligible	Medium	Moderate/ Substantial

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Feature	Overall Sensitivity	Potential Impact Significance (unmitigated)	Residual Impact Description Summary	Overall Residual Impact	
				Magnitude	Significance
			<p><u>Operation:</u> Long-term decrease to morphological diversity as a result of extensive culverting and realignment - offset, where possible, with the introduction of pools and riffle sequences, however sinuosity lost permanently. Road drainage attenuated to pre-development rates. Road drainage system ensures that road run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Capacity for 0.5%AEP (1:200 year flow).</p> <p>Hydrology and Water Quality: Negligible Geomorphology: High</p>	High	Substantial
River Don	High	Substantial	<p><u>Construction:</u> Mitigation reduces any impact from potential sediment release during the construction of mainline approach roads to an acceptable level.</p> <p>Hydrology, Geomorphology, and Water Quality: Negligible</p>	Negligible	Slight/Negligible
		Substantial	<p><u>Operation:</u> Morphological diversity maintained as a result of the installation of a bridge spanning the watercourse and the floodplains with no in-channel supports. Bridge designed to have minimal impact on current 0.5% AEP (1:200 year flows) and levels. Road drainage attenuated to pre-development rates. Road drainage system ensures that run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage.</p> <p>Hydrology, Hydrodynamic Modelling, Geomorphology, and Water Quality: Negligible</p>	Negligible	Slight/Negligible
Goval Burn	High	Moderate/ Substantial	<p><u>Construction:</u> 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	Slight/Negligible
		Substantial	<p><u>Operation:</u> Morphological diversity maintained as a result of the installation of bridges spanning the watercourse and the floodplains with no in channel supports. Bridge will be designed to have minimal impact on current 0.5% AEP (1:200 year flows) and levels. Road drainage attenuated to pre-development rates. Road drainage system ensures that run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage.</p> <p>Hydrology, Geomorphology, and Water Quality: Negligible</p>	Negligible	Slight/Negligible
Mill Lade	Low	Moderate	<p><u>Construction:</u> Risk of sediment and pollutant release minimised through best practice. Construction phase monitoring will identify accidental pollution at an early stage. Risk of flood risk during aqueduct construction minimised by temporary storage facility.</p> <p>Hydrology: Low Geomorphology and Water Quality: Negligible</p>	Low	Negligible
		Slight	<p><u>Operation:</u> Bridging of watercourse ensures minimal impact to flow and sediment regime.</p> <p>Hydrology and Geomorphology: Negligible Water Quality: Scoped out of assessment</p>	Negligible	Negligible
Corsehill Burn	Medium	Moderate	<p><u>Construction:</u> 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

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Feature	Overall Sensitivity	Potential Impact Significance (unmitigated)	Residual Impact Description Summary	Overall Residual Impact	
				Magnitude	Significance
		Moderate/ Substantial	<u>Operation:</u> Long-term decrease to morphological diversity as a result of culverting and realignment offset, where possible, with the introduction of pools and riffle sequences. Capacity for 0.5%AEP (1:200 year flow).Road drainage system ensures that road run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Road drainage attenuated to pre-development rates. Hydrology and Geomorphology: Negligible Water Quality: Low	Low	Slight
Red Moss Burn	Medium	Moderate/ Substantial	<u>Construction:</u> Risk of sediment and pollutant release will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact on the water column at an early stage. Hydrology, Geomorphology, and Water Quality: Negligible	Negligible	Negligible
	see above	Moderate/ Substantial	<u>Operation:</u> Long-term decreased morphological diversity due to culverting and realignment offset with introduction of pools and riffle sequences where possible and sensitive sediment introduction. Capacity for 0.5%AEP (1:200 year flow).Road drainage system ensures that road run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Road drainage attenuated to pre-development rates. Hydrology and Geomorphology: Negligible Water Quality: Low	Low	Slight
Corby and Lily Lochs)	High	Moderate/ Substantial	<u>Construction:</u> Risk of sediment and pollutant release will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact on the water column at an early stage. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Slight/Negligible
		Moderate	<u>Operation:</u> Outfall of pre-earthworks ditches to Red Moss Burn and Lily Loch Outfall Channel ensures minimal changes to water quantity reaching the lochs. Overall size of current catchment to the lochs maintained by drainage and culvert design. Hydrology: Negligible Geomorphology and Water Quality: scoped out of assessment	Negligible	Slight/Negligible
Blackdog Burn	Medium	Moderate	<u>Construction:</u> Risk of sediment and pollutant release will be minimised through best practice. Ongoing monitoring during the construction phase will identify any impact on the water column at an early stage. Hydrology, Geomorphology, and Water Quality: Negligible	Negligible	Negligible
		Moderate	<u>Operation:</u> Long-term decreased morphological diversity due to culverting and realignment offset with introduction of pools and riffle sequences where possible.. Capacity for 0.5%AEP (1:200 year flow).Road drainage system ensures that road run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Road drainage attenuated to pre-development rates. Hydrology and Geomorphology: Negligible Water Quality: Low	Low	Slight
Blackdog ditch	Medium	Moderate	<u>Construction:</u> Risk of sediment and pollutant release minimised through best practice. Ongoing monitoring during the construction phase will identify any impacts at an early stage. Hydrology, Geomorphology, and Water Quality: Negligible	Negligible	Negligible

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Feature	Overall Sensitivity	Potential Impact Significance (unmitigated)	Residual Impact Description Summary	Overall Residual Impact	
				Magnitude	Significance
		Slight	<u>Operation:</u> Morphological diversity lost but burn is already heavily modified.. Capacity for 0.5%AEP (1:200 year flow). Road drainage system ensures that road run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Hydrology, Geomorphology, and Water Quality: Negligible	Negligible	Negligible
Middlefield Burn	Low	Slight	<u>Construction:</u> 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
Middlefield Burn [cont'd]		Moderate	<u>Operation:</u> Long-term decreased morphological diversity due to culverting and realignment offset with introduction of pools and riffle sequences where possible.. Capacity for 0.5%AEP (1:200 year flow).Road drainage system ensures that road run-off entering burn complies with EQS and is within acceptable risk limits for accidental spillage. Road drainage attenuated to pre-development rates. Hydrology, Geomorphology, and Water Quality: Negligible	Negligible	Negligible

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Summary of Residual Impacts

- 9.6.88 Table 9.11 illustrates that the operational residual significance of impacts on the following watercourses remains unchanged from the potential impacts:
- Gough Burn;
 - Craibstone Burn; and,
 - Bogenjoss Burn.
- 9.6.89 Potential operation impacts (i.e. pre-mitigation) on the above watercourses were of Substantial significance, and although certain aspects of mitigation will reduce impacts (such as adherence to best practice during construction), the overall significance of residual impacts remains Substantial.
- 9.6.90 Gough Burn, Craibstone Burn and Bogenjoss Burn are currently in good condition at the proposed crossing points. The proposed scheme requires extensive realignment and culverting, which will result in the permanent loss of sinuosity and a reduction to morphological diversity. This will impact on the current hydrological regime, with direct impacts on fluvial geomorphology, and consequently indirect impacts on water quality and freshwater ecology.
- 9.6.91 During construction the impacts upon the geomorphology of Gough Burn and Craibstone Burn are considered to reduce from high to low as a result of mitigation. However, due to their sensitivity this results in an overall residual impact of Moderate significance during the construction phase. Due to the extent of work proposed for Bogenjoss Burn construction impacts are considered to reduce from high to medium as a result of mitigation. Therefore, the significance of impact reduces to Moderate/Substantial for this burn, which is a reflection of the sensitivity of this watercourse.
- 9.6.92 Impacts on the River Don in the absence of mitigation were assessed as of Substantial significance, but proposed mitigation (including road design) has reduced this to Slight/Negligible residual impact significance. All remaining impacts on assessed watercourses are reduced to Negligible, Slight/Negligible or Slight significance.
- 9.6.93 It should be noted that the assessment has adopted a precautionary approach throughout and overall sensitivities, potential impacts and residual impacts have been reported by defaulting to the highest assessment determined by either of the disciplines (Hydrology, Fluvial Geomorphology, Water Quality and Hydrodynamic Modelling where appropriate).

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