Appendix A25.9 – Freshwater Ecology

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1 Introduction

1.1 General Background

1.1.1 This report is one of the appendices supporting Chapter 25 (Ecology and Nature Conservation) of the AWPR Environmental Statement (ES). This report considers the potential impacts associated with the AWPR on watercourses that would be directly and indirectly affected by the Southern Leg section of the proposed scheme in terms of the freshwater ecological communities they support. As such, this report is focused on impacts on overall aquatic ecosystem health, which is measured by macroinvertebrate communities, habitat complexity and freshwater fish.

1.1.2 The six component route sections for the Southern Leg study area of the proposed scheme are as follows:

- Section SL1 ch207200 – 203150 (Charleston to Bishopston);
- Section SL2 ch203150 – 200600 (Bishopston to Burnhead);
- Section SL3 ch200600 – 102870 (Burnhead to the A93);
- Section SL4 ch102870 – 105900 (A93 to Beanshill);
- Section SL5 ch105900 – 108500 (Beanshill to the South Kingswells Junction); and
- Section SL6 ch108500 – 111200 (South Kinswells Junction to Derbeth Overhills).

1.1.3 All tables and figures are structured in this manner.

1.1.4 The Ecological Impact Assessment (EcIA) was undertaken in accordance with the Design Manual for Roads and Bridges (DMRB) Volume 10 and 11 (Highways Agency, 2001) and the Environmental Impact Assessment (Scotland) Regulations 1999. Studies on freshwater ecology were included as part of the EcIA with cognisance of draft Institute of Ecology and Environmental Management (IEEM) guidelines.

1.1.5 These studies included desk-based consultation to collate existing information about freshwater ecology in the area affected by the scheme and field surveys to provide current data about the status of freshwater ecology.

1.1.6 Cumulative impacts are assessed in a separate report combining the predicted impacts for all habitats and species over the proposed route (refer to Part E of the Environmental Statement ES).

Aim

1.1.7 Macroinvertebrate surveys, river habitat assessment and fish habitat assessment of potentially impacted watercourses were conducted to:

- obtain baseline information on macroinvertebrate and fish communities and river habitat condition and infer general aquatic ecosystem conditions and water quality trends;
- identify any rare and/or protected aquatic species or pollution indicator species;
- evaluate the ecological health/status of watercourses potentially affected by the proposed scheme;
- assess the potential impacts that the proposed scheme may have on freshwater habitat and macroinvertebrate communities; and
- identify appropriate mitigation measures to ameliorate these impacts.

1.2 Macroinvertebrate Background

Biology

1.2.1 Macroinvertebrates are commonly used to provide a holistic assessment of the health of watercourses (Wright et al. 1984). Traditional water quality measures such as pH, dissolved oxygen, nutrient levels and toxic substances provide a snapshot of environmental conditions at the moment the samples are taken. However, as water quality conditions are variable, this type of monitoring can fail to detect occasional changes or intermittent pulses of pollution.

1.2.2 In contrast, biological monitoring provides an integrated assessment of ecosystem condition. As macroinvertebrates live at a site for many months and cannot move great distances, the assemblage of animals present at a site reflects the build up of pressures on an aquatic ecosystem over time, (such as the surrounding land use or the effects of pollution). Macroinvertebrate samples, combined with an assessment of the available river habitat (through river habitat surveys) can provide an overall assessment of the ecological health of a watercourse.

Status

1.2.3 The Water Framework Directive[1] (WFD) recognises that the ecosystem health is the most effective way to assess the environmental quality status of a watercourse. It has moved the focus away from chemical water quality targets to the requirement that all[2] watercourses in Europe reach at least 'good' ecological status by 2015. The WFD also requires that the ecological status of watercourses do not deteriorate from their current condition. Given that, under the WFD, the ecological status of watercourses is now the focus of river management and impact assessment, the role of biological surveys has increased in importance.

1.2.4 In addition to the requirements of the WFD for promotion and maintenance of good aquatic ecological health, a number of freshwater species have been identified as scarce in the UK including the stonefly *Brachyptera putata* (Bratton 1990).

1.2.5 The River Dee is designated a Special Area for Conservation (SAC) under the Habitats Directive for the following three qualifying species:

- Atlantic salmon, *Salmo salar*, (also listed in Annex V of the Habitats Directive and Appendix III of the Bern Convention and in the UK Biodiversity Action Plan (BAP) as a Species of Conservation Concern (SoCC));
- Freshwater pearl mussel, *Margaritifera margaritifera*, (also fully protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended), listed in Annex V of the Habitats Directive and Appendix III of the Bern Convention and in the UK BAP as a Priority Species) which is present in the main stem of the River Dee only and is addressed in detail in the confidential Appendix report A25.10 (Freshwater Pearl Mussel Survey Report); and
- Otter, *Lutra lutra*, (also fully protected under Schedules 5 and 6 of the Wildlife and Countryside Act (1981) (as amended), listed in Annex IV of the Habitats Directive 3, Appendix II of the Bern Convention and Appendix I of CITES 4 and in the UK BAP as a Priority Species) which is present throughout the Dee catchment and is addressed in detail in Appendix A40.5 (Otter Survey Report).

[1] European Directive 2000/60/EC
[2] Not including heavily modified or artificial waterways, these must reach 'good' ecological potential
[3] Habitats Directive 92/43/EEC
[4] CITES – Convention on International Trade in Endangered Species of Wild Flora and Fauna 1975

1.2.6 The North East Scotland Local Biodiversity Action Plan (LBAP) Priority Species list includes the UK Priority Species *Brachyptera putata*, a stonefly found in well- oxygenated flowing water. It also includes the following UK SoCC river lamprey *Lampetra fluviatilis* and brook lamprey *Lampetra planeri* (addressed in section 1.3). All the above LBAP species have actions addressed through a relevant Habitat Action Plan (HAP) rather than through a dedicated North East Scotland Species Action Plan (SAP).

1.3 Fish Background

Biology and Distribution

1.3.1 The fish species present in the River Dee catchment, their migratory status and estimates of their relative abundances, derived from the desk based consultation, are given in Table 1. The fish species present within the River Dee catchment are consistent with those species expected for an upland spate river in North East Scotland.

Table 1 – Fish Species, Migratory Status and Likely Relative Abundance in the River Dee Catchment

Common Name	Scientific Name	Migratory s=Status	Relative Abundance	
			Lower River	Tributaries
Atlantic salmon	*Salmo salar*	Anadromous	abundant	abundant
Brown/sea trout	*Salmo trutta*	Potamodromous/anadromous	common	abundant
European eel	*Anguilla anguilla*	Catadromous	present	present
Brook lamprey	*Lampetra planeri*	Potamodromous	present	common
River lamprey	*Lampetra fluviatilis*	Anadromous	present	present
Sea lamprey	*Petromyzon marinus*	Anadromous	rare	rare
Minnow	*Phoxinus phoxinus*	Local	common	common
3-spined stickleback	*Gasterosteus aculeatus*	Local	common	rare
Pike	*Esox lucius*	Potamodromous	rare	rare
Perch	*Perca fluviatilis*	Potamodromous	rare	rare
Flounder	*Platychthys flesus*	Amphidromous	common	present

Atlantic Salmon (*Salmo salar*)

1.3.2 The River Dee supports a significant proportion of the Scottish salmon resource. In recent years, it has contributed 4-5% of all salmon caught in Scotland. Spawning takes place at gravel bedded sites throughout the main stem and in all accessible tributaries from the head of tide up to altitudes of 500m (Webb and McLay, 1996). Consequently, juvenile salmon (parr) are found throughout the system except the uppermost and inaccessible reaches of tributaries.

1.3.3 In most rivers, salmon begin to enter the system in early spring, often as early as February, but the precise timing varies between catchments. These “springers” are often the biggest fish (multi-sea winter) and are the part of the population that has shown the biggest decline in recent years. In the Dee, some salmon are known to enter the river in the November of the year before they spawn, i.e. thirteen months prior to spawning (Adrian Hudson, DDSFB, pers. comm.). These are followed by the 2-sea winter salmon (summer salmon), usually from April onwards with grilse (1-sea winter salmon) appearing in May and June. A study of salmon entry into the Dee estuary showed that up-estuary movements leading to river entry were predominantly nocturnal and tended to occur on the

ebb tide. Penetration into the non-tidal reaches of the river also occurred at night, but was no longer associated with tidal phase (Smith and Smith, 1997).

1.3.4 The upstream progress of salmon within the River Dee system is influenced to some extent by man made obstructions, although the apparent slight delay caused by a Crump weir was considered to be "insignificant in terms of the overall progress of riverine migration" (Smith et al., 1997). The cumulative impact of repeated short delays could potentially be of greater concern.

1.3.5 Atlantic salmon are autumn and winter spawners, but the precise timing of their spawning season varies between and within catchments. In the River Dee, salmon are known to return to the same part of the river where they were born and are considered to represent distinct sub-populations (Youngson et. al., 1994). Furthermore, the fish that spawn in the headwaters do so earlier in the year than those spawning in the lower reaches (Webb and McLay, 1996).

1.3.6 At certain stages of their development, salmonid eggs are very sensitive to mechanical shock. Immediately after fertilisation the eggs are not sensitive, but within a few hours any shock or vibration can result in epiboly or yolk overgrowth. The eggs then remain sensitive for approximately the first third of the incubation period, until they are eyed (Jensen, 1997).

1.3.7 Atlantic salmon alevins hatch and emerge from the gravel during the spring, with the time of emergence being linked to temperature and incubation period. During the first few weeks after hatching, the alevins are poor swimmers and rely on their yolk sac for nutrition. In the next stage, salmon parr generally "drift feed" on aquatic invertebrates which they collect from the water column and water surface.

1.3.8 Juvenile salmon migrate to the sea after one, two, three and, exceptionally, four years in the river as smolts. In the River Dee, the incidence of younger smolts is thought to be increasing (Adrian Hudson, DDSFB, pers. comm.). Downstream migration usually begins in April with fish moving at night, either individually or in small groups. As the season progresses (usually during May), migration occurs both day and night and the fish move in large shoals at the surface.

1.3.9 In the River Dee, there is also a large scale emigration of parr from tributary streams during the autumn. It is not known if these fish continue onto the sea as "autumn smolts", or remain within the main stem of the Dee.

Brown/Sea Trout (*Salmo trutta*)

1.3.10 Brown trout breed in winter, from October to January, in gravelly shallows (Wheeler, 1969). The seagoing form is known as sea trout. This species migrates seawards as smolts slightly earlier than salmon, usually during March and April. Brown trout and sea trout are found throughout the Dee catchment, but brown trout are surprisingly uncommon in the lower River Dee, where salmon predominate (Adrian Hudson, DDSFB, pers. comm.). Juvenile trout feed on aquatic invertebrates and become piscivorous as they get older.

European Eel (*Anguilla anguilla*)

1.3.11 The life cycle of the European eel involves a massive catadromous migration from their spawning grounds in the Sargasso Sea, which takes up to three years to complete. Larval eel arrive in Scottish estuaries during February (Wheeler, 1969) at which stage they are transparent and are referred to as glass eel. As they enter the rivers they become pigmented and are known as elvers. Eel feed almost exclusively on benthic invertebrates, although some individuals become predatory and switch to a fish based diet. They are commonly nocturnally active and are cryptic during the day. Eel spend a considerable period feeding and growing in freshwater (from seven to nineteen years), before turning silver and heading seawards in the autumn. Eel are present throughout the Dee catchment, including the upper river and small tributary streams. Research has shown that eel are relatively insensitive to sound (Turnpenny et al., 1993), but that they do react to lights

(Hadderingh and Smythe, 1997).

Brook Lamprey (*Lampetra planeri*)

1.3.12 Brook lamprey spend their entire lives in freshwater, although they do migrate upstream to spawn and there is thought to be a tendency for the larvae (called ammocoetes) to move downstream during development (Wheeler, 1969). Spawning occurs during early March at partially shaded sites, in excavated depressions in sand and gravel. Where river lamprey and brook lamprey occur together the brook lamprey occupy the headwaters and breed well upstream of the river lampreys (Wheeler, 1969). As both species are found in the River Dee, it is likely that brook lamprey are most prevalent in the upper river and in the tributaries. Brook lamprey metamorphose after six years buried in the sediment feeding on organic matter. Adult brook lamprey do not feed and die after spawning.

River Lamprey (*Lampetra fluviatilis*)

1.3.13 River lamprey breed in freshwater in March and April and inhabit freshwaters throughout their larval stage. Spawning sites commonly have sand and gravel substrata, flowing water and are usually at least partly in the shade (Wheeler, 1969). The male creates a nest by removing pebbles with his sucker disc and excavating sand by shaking his tail. River lamprey are present in the River Dee and may penetrate into some of the larger tributaries. River lamprey larvae live buried in silty habitats where they feed on organic matter for five years. In early autumn, river lamprey ammocoetes metamorphose into the adult form and migrate downstream to the sea. As adults, river lamprey are parasitic, feeding on the blood and tissue of other fish, returning to rivers to spawn when 300-500mm in length.

Sea Lamprey (*Petromyzon marinus*)

1.3.14 Sea lamprey breed in freshwater in May and June and inhabit freshwaters throughout their larval stage. Spawning requires a gravel substratum and clean fast flowing water, but adjacent silty areas are also required for the larvae. Sea lamprey are present in the River Dee but are probably most abundant in the main stem. Sea lamprey larvae are blind and toothless and live buried in silty and sandy substrata for around five years, feeding on organic matter (Wheeler, 1969). In late summer, sea lamprey ammocoetes metamorphose into the adult form, during which phase they are referred to as transformers. After metamorphosis the adult sea lamprey, which now have eyes and teeth, migrate downstream to the sea and become parasitic, feeding on the blood and tissue of other fish. Maturity is reached after one or two years at sea, at which point the adults, approximately 600-800mm in length, return to rivers to spawn.

Minnow (*Phoxinus phoxinus*)

1.3.15 Minnows are found in most rivers and streams and in some stillwaters. They are a shoaling species, rarely larger than 100mm and living for a maximum of six years (Wheeler, 1969). They are likely to be found throughout much of the River Dee catchment, including some of the tributary streams and may be locally abundant where the habitat is suitable.

3-Spined Stickleback (*Gasterosteus aculeatus*)

1.3.16 One of the most widespread of the fishes of northern Europe, the three-spined stickleback is found in virtually all waters except fast flowing hill streams (Wheeler, 1969). In the River Dee, sticklebacks are present in the slower flowing reaches of the main stem and may also be found in the lower sections of slow flowing tributary streams. Three-spined sticklebacks rarely exceed 60mm in length and spawning occurs in April and May. Male sticklebacks build nests, fan the eggs with their pectoral fins and then guard a small brood of offspring.

Pike (*Esox lucius*)

1.3.17 Pike are solitary, ambush predators that prefer still or relatively slow flowing habitats with cover. Spawning occurs in the spring on vegetation in shallow water and often in inundated riparian vegetation in field margins and field drainage ditches. They are found in the lower reaches of the River Dee but are only present in low numbers and are likely to be absent from the upper river and tributaries.

Perch (*Perca fluviatilis*)

1.3.18 Perch are found in stillwaters and slow flowing reaches of rivers and, like the pike, are restricted to the lower reaches of the River Dee where they are present in low numbers. Spawning occurs in April or May on submerged vegetation or branches. Perch live in small shoals and feed mainly on aquatic invertebrates, but they become increasingly piscivorous as they grow.

Flounder (*Pleuronectes flesus*)

1.3.19 Some flounder spend part of their lives in freshwater, but their movements between fresh and saltwater are not directly linked with reproduction. Although most abundant in the lower reaches of rivers and estuaries, some flounder are known to penetrate a long distance into freshwater and may enter the lower reaches of some tributary streams. In the River Dee, flounder are likely to be found in the lower sections of the main stem, where they may be seasonally common. They may also be present in the downstream sections of tributary streams that feed the lower rivers. The timing of entry into freshwater varies with region, but in Eastern Scotland flounder are known to spend the summer at sea (Dando, 1984).

Sensitive Periods for Fish

1.3.20 According to their biology and behaviour each species has one or more sensitive periods during the calendar year, during which time certain activities, in specific parts of their habitat, could have an impact on them. These sensitive periods have been agreed with a representative of the River Dee District Salmon Fisheries Board (DDSFB) and are summarised in Table 2.

Table 2 – Extent of Potentially Sensitive Periods for Fish in the River Dee Catchment

Species / Stage	Jan		Feb		Mar		Apr		May		Jun		July		Aug		Sep		Oct		Nov		Dec	
MSW (spring) salmon																								
2-SW (summer) salmon																								
1-SW salmon (grilse)																								
Salmon spawning																								
Salmon eggs																								
Salmon smolt emigration																								
Autumn 'smolt' emigration																								
Sea trout																								
Sea trout spawning																								
Sea trout eggs																								
Sea trout smolt emigration																								
Brown trout spawning																								
Brown trout eggs																								
Elver immigration																								
Silver eel emigration																								
Brook lamprey spawning																								
Sea lamprey immigration																								
Sea lamprey spawning																								
Sea lamprey ammocoete emigration																								
River lamprey immigration																								
River lamprey spawning																								
River lamprey ammocoetes emigration																								
Minnow spawning																								
Stickleback spawning																								
Pike spawning																								

Species / Stage	Jan		Feb		Mar		Apr		May		Jun		July		Aug		Sep		Oct		Nov		Dec	
Perch spawning																								
Flounder migration																								

Status

1.3.21 Atlantic salmon have declined throughout much of their range and some populations have reached critically low levels. A wide range of factors have been implicated in this decline including reduced survival at sea due to overfishing and reduced production in freshwaters through deterioration of habitats and barriers to migration.

1.3.22 Sea and river lamprey have also declined in abundance in many catchments, with barriers to migration and reduced habitat quality again being implicated.

1.3.23 There is also concern over eel populations, which have declined substantially across much of Western Europe in recent years and stocks are now considered to be outside safe biological limits.

1.3.24 Brown trout, minnow, 3-spined stickleback, pike, perch and flounder are widespread and are not currently considered to be in decline throughout much of their normal range.

1.3.25 Some of the fish species present in the Dee catchment are afforded protection under the law via conservation legislation (Table 3).

1.3.26 The River Dee is designated as a Special Area of Conservation (SAC) with salmon being one of the qualifying features. A full description of the Habitats Regulations, under which SACs are designated in Scotland, is given elsewhere.

1.3.27 Salmon in the River Dee catchment are protected under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. The relevant parts of this Act are that it is an offence:

- "to knowingly take, injure or destroy; any smolt, parr, salmon fry or alevin."
- "to injure or disturb any salmon spawn during the annual close time."
- "to obstruct or impede salmon in their passage to any spawning bed or any bank or shallow in which the spawn of salmon may be."

1.3.28 A local Species Action Plan (SAP) has been prepared for Atlantic salmon by the Northeast Scotland Biodiversity Partnership. Although the SAC measures contribute to the conservation of the Atlantic salmon, additional measures are needed to ensure future conservation within the UK.

1.3.29 As a consequence of declining populations all three lamprey species are now listed in Annexes IIa and Va of the Habitats Directive, Appendix III of the Bern Convention and as Species of Conservation Concern in the UK Biodiversity Action Plan (BAP) (Maitland, 2003). All three species of lamprey are also listed on the North East Scotland Local Biodiversity Action Plan (NESLBAP).

1.3.30 Brown trout, eel, minnow, 3-spined stickleback, pike, perch and flounder are not nationally scarce and are afforded no specific legal protection.

Table 3 – Inclusion of Species in Conservation Legislation

Common name	River Dee SAC	Salmon and Freshwater Fisheries act	Habitats Directive	UK BAP	NESLBAP
Atlantic salmon	✔	✔	×	×	✔
Brown/sea trout	×	✔ (sea)	×	×	×
European eel	×	×	×	×	×
Brook lamprey	×	×	✔	✔	✔
River lamprey	×	×	✔	✔	✔
Sea lamprey	×	×	✔	✔	✔
Minnow	×	×	×	×	×
3-spined stickleback	×	×	×	×	×
Pike	×	×	×	×	×
Perch	×	×	×	×	×
Flounder	×	×	×	×	×

2 Approach and Methods

2.1 Consultation

2.1.1 Consultation was undertaken with statutory and non-statutory organisations including Scottish Natural Heritage (SNH), Scottish Environment Protection Agency (SEPA) North East Scotland Biological Records Centre (NESBReC), City of Aberdeen Council and the Dee District Salmon Fisheries Board (DDSFB) to obtain any existing baseline data on the ecological status of watercourses that may potentially be affected by the scheme. Table 4 lists the watercourses that have existing baseline data and have been classified by SEPA.

2.2 Desk Studies

2.2.1 To assist the interpretation of biological data and to enable the efficient targeting of sampling effort, physical parameters of watercourses potentially affected by the proposed scheme were calculated. Details of methods used in these calculations are given in Chapter 24 (Water Environment). The following parameters (and units) were derived for use in this ecological assessment:

- catchment area upstream of proposed crossing point (km^2);
- Q mean flow (m^3/sec);
- Q95 flow (m^3/sec); and
- mean monthly velocities (m/sec).

2.3 Survey Methods

2.3.1 Sites were sampled for aquatic macroinvertebrates in the summer and autumn of 2006 following standard methods (Wright et al*.,* 1984). At the time of sampling, simple physico-chemical parameters were also measured. In conjunction with the macroinvertebrate sampling sites were also visited for river habitat surveys (RHS) and fish habitat assessments. Table 4 summarises which sampling methods were used and what existing data was available for each watercourse. All sampling points are shown on Figures 25.13 a-h.

Macroinvertebrates

2.3.2 Macroinvertebrate sampling was undertaken by kick/sweep sampling for at least 10 metres (taking 3 minutes) with a 250µm mesh Freshwater Biological Association (FBA) net followed by visual observation to find any further specimens. The net was carefully lifted to the bank then samples were emptied into sample jars and preserved in industrial Methylated Spirit for transport back to the laboratory. Samples were then sorted following procedures recommended by the SEPA Riccarton laboratory (pers. comm. Aug 2005). Samples were washed through 250µm and 500µm mesh sieves, retaining all material. The contents of the sieves were then washed into a white tray for picking, examining the sieve to ensure that no organisms had been missed. These survey methods ('live pick') differ slightly from those for the Northern Leg section of the AWPR as a result of feedback from statutory consultees. It is anticipated that this slight change in methods will not cause significant changes to the results obtained.

2.3.3 Macroinvertebrates collected were identified to species level where possible using a low powered microscope and appropriate taxonomic keys (e.g. Croft 1986, Hynes 1993). All material collected was preserved and will be retained for a period of at least one year.

2.3.4 At the time of macroinvertebrate sampling, simple water quality measurements (dissolved oxygen, electrical conductivity, pH and temperature) were taken *in situ* using field probes. Additionally, as part of the collection of baseline data for the Water Environment Impact Assessment (Chapter 24) total hardness was measured during previous surveys carried out in summer 2004.

River Habitat Survey

2.3.5 River habitat surveys were carried out in June 2006 according to standard methodology (EA, 2003). This consists of recording modifications to channel and banks, vegetation structure, substrate and flow type and adjacent land-use. River habitat surveys comprised a survey of a 500m section of each watercourse and its riparian zone, usually at the proposed AWPR crossing point. Data were recorded on standardised survey forms (EA, 2003). Results from the river habitat surveys were submitted to the central database administered by the EA for quality control and calculation of Habitat Indices (see the evaluation section below for more details).

Fish Habitat Assessment

2.3.6 Fish habitat assessment surveys were carried out on all watercourses within the proposed route corridor, along with HABSCORE assessments of those watercourses that were considered likely to support salmonids (namely salmon and sea trout).

2.3.7 Electric fishing surveys were carried in August and September 2006 by the DDSFB on selected watercourses (Table 4) where the habitat assessment results are uncertain regarding the suitability for fish or where suitable habitat is present upstream and/or downstream of the crossing point (following discussions with SNH). The purpose of the electric fishing surveys was to clarify the status of fish species in that watercourse.

2.4 Sampling Effort

2.4.1 All watercourses falling within the route corridor were visited to assess their suitability for sampling. Those watercourses that were of less than 30cm channel width were scoped out due to their small size and any dry watercourses were noted. Typically, watercourses that were scoped out of this assessment were highly modified or artificial land drainage channels.

2.4.2 Some small tributaries of major watercourses were indirectly assessed using data from the main channel near to their confluences.

2.4.3 Some watercourses were large enough to be sampled for macroinvertebrates and basic water quality. However, as they were essentially highly modified land drainage channels, river habitat surveys were not undertaken.

Table 4 – Sampling Effort for Watercourses

Route Section	Watercourse	Code	Macro-invertebrate and *in situ* WQ Sampling	Grid Reference of Sample Point (Mid-survey)	River Habitat Survey	Habitat Assessment	Electric Fishing	Existing SEPA Data	Existing Discharge Data	Additional Water Quality Sampling	Included in Assessment
SL1 Charleston to Bishopston	Loirston Burn	LOIR1	No	NJ 93498 00527	Yes	No	No	None	Yes	No	No
	Loirston Burn	LOR D	Yes	NJ 96503 00616	No, culverted under existing road	No	No	None	Yes	Yes	Yes
	Loirston Burn	LOIR3	No	NO 92259 99819	Yes	No	No	None	Yes	No	No
	Jameston Ditch	JAM	Yes	NO 90674 99610	No	No	No	None	Yes	Yes	Yes
	Bishopston Ditch	BISHOP	No	NO 90713 99242	Yes	No	No	None	No	No	Yes, based on RHS only
	Tributary of Findon Burn	FIN	No, small field drain	n/a	No	No	No	None	No	No	No, small field drain
	Burn of Ardoe	BOA	Yes (April 2004)	n/a	Yes	No	No	None	Yes	Yes	Yes
	Heathfield Burn	HEATH	No	NO 90506 99019	Yes	No	No	None	No	No	Yes, based on RHS only
SL2 Bishopston to Cleanhill	Cowford Burn	COW	Yes	NO 89399 99309	No	No	No	None	Yes	Yes	No – not crossed by route
	Burnhead Burn	BUR	Yes	NO 87021 98676	Yes	Yes	Yes	None	Yes	Yes	Yes
SL3 Cleanhill to A93	Whitestone Burn	STONE	No – Dry (June)	NO 87843 98384	Yes	No	No	None	No	No	Yes, based on RHS only

Route Section	Watercourse	Code	Macro-invertebrate and *in situ* WQ Sampling	Grid Reference of Sample Point (Mid-survey)	River Habitat Survey	Habitat Assessment	Electric Fishing	Existing SEPA Data	Existing Discharge Data	Additional Water Quality Sampling	Included in Assessment
	Greens of Crynoch	GCRYN	No – small field drain	n/a	No	No	No	None	No	No	No, small field drain
	Wedderhill Burn	WEDDER1	No	NO 86872 97633	Yes	No	No	None	No	No	Yes, based on RHS only
	Craigentath Ditch	CRAI D	No, runs underground	n/a	No	No	No	None	No	No	No, underground at crossing point
	Crynoch Burn	CRYA and CRY B	Yes	NO 86146 99430 NJ 86659 97713	Yes, 1 km from confluence with R. Dee	Yes	No	Yes	Yes	Yes	Yes
	Craigentath Burn	CRAI	No, small and underground at crossing point	n/a	No, Wetland with no obvious channel at proposed crossing point	No	No	None	No	No	No, underground at crossing point
	Blaikiewell Burn	BLA	Yes	NO 86886 98709	Yes	Yes	Yes	None	Yes	Yes	Yes
	Kingcausie Burn	KIN	Yes	NO 86209 99884	Yes	Yes	No	None	Yes	Yes	Yes
	River Dee	DEE	Yes	NJ 86009 00432	Yes, upstream and downstream of proposed crossing point	Yes	No	Yes	Yes	Yes	Yes
SL4 - A93 to end of Beanshill	Milltimber Burn	MILT	Yes	NJ 58688 00985	Yes	No	No	None	Yes	Yes	Yes
	Bellenden Burn	BEL	Yes	NJ 84995 01070	No	Yes	No	None	Yes	Yes	Yes

Route Section	Watercourse	Code	Macro-invertebrate and *in situ* WQ Sampling	Grid Reference of Sample Point (Mid-survey)	River Habitat Survey	Habitat Assessment	Electric Fishing	Existing SEPA Data	Existing Discharge Data	Additional Water Quality Sampling	Included in Assessment
	Culter House Ditch	CULT	No	NJ 84970 01695	Yes	No	No	None	No	No	Yes, based on RHS only
	Alburn Burn	ALB	Yes	NJ 85313 01508	No	No	No	None	Yes	Yes	Yes
	Beans Burn	BEA	No, small field drain	n/a	No	No	No	None	No	No	No, small field drain
SL5 end of Beanshill Burn to A944	Silver Burn	SIL	Yes	NJ 85008 04412 (at road)	No – not crossed	Yes	Yes	None	Yes	Yes	Yes
	Gairn Burn	GAIR	Yes	NJ 84736 04477 (at road)	Yes	Yes	Yes	None	Yes	Yes	Yes
	Moss of Auchlea	AUC	No, moss not suitable for sampling	n/a	No	No	No	None	No	No	No
	Upper Beanshill Burn	UBBO	No	NJ 85555 03756	Yes, surveyed outside of 500 m corridor due to land access issues	No	No	None	No	No	Yes, based on RHS only
SL6 A4944 to Derberth Overhills	Westholme Burn	WHOLM	No, Dry (June 2006)	n/a	No	No	No	None	No	No	No, dry channel
	Borrowstone	BOR	No, Dry (June 2006)	n/a	No	No	No	None	No	No	No, dry channel

2.5 Evaluation of Health and Nature Conservation Value of Watercourses

2.5.1 A simple scheme for the ecological assessment of watercourses using the aquatic macroinvertebrate assemblage was used. The scheme is based on applying scores to different macroinvertebrate species according to their relative pollution tolerance. Adding these scores gives an index of the ecological quality of a watercourse, known as the Biological Monitoring Working Party (BMWP) score (ISO-BMWP 1979[5]) and dividing this score by the number of species sampled gives the Average Score Per Taxon (ASPT) value (Table 5). Additionally, a simple measure of species richness was used together with BMWP and ASPT scores to yield an assessment of ecological status.

Table 5 – River Health Categories

ASPT	River Health Category (SEPA)
>6	Excellent A1
5-6	Good A2
4-5	Fair B
3-4	Poor C
<3	Impoverished D

2.5.2 River habitat survey data were used to calculate a Habitat Modification Score (HMS). The HMS is calculated using information on channel modification from each of the 10 spot checks along the 500m section in combination with records of any artificial features such as weirs. Full details of the methods of calculating this score are given in Appendix 3 of EA (1998). HMSs can be interpreted following the system shown in Table 6.

Table 6 – Habitat Modification Score (HMS) Categories

HMS	Descriptive Category of Channel
0	Pristine
0-2	Semi-Natural
3-8	Predominantly unmodified
9-20	Obviously modified
21-44	Significantly Modified
45 or more	Severely Modified

2.5.3 Assessment of the nature conservation value of each watercourse was largely based on the macroinvertebrate community present (using indices described above), water quality and habitat modification. Additional reference was made to the fish community present at each site (refer to paragraph 3.2.28) and whether it provided food resources for otters (see Appendix A25.5: Otter).

2.5.4 Criteria were based on the Ratcliffe Criteria (Ratcliffe, 1977) used in the selection of biological Sites of Special Scientific Interest (SSSI). Sites and features were classified according to the criteria identified in Table 7, which is considered appropriate when applied to designated sites such as the River Dee SAC. This is an approach supported by the Draft Guidelines for Ecological Impact Assessment (IEEM, July 2006).

[5] Scores have since been slightly revised and refined and the values used in this study are those currently used by SEPA.

Table 7 – Evaluation of Ecological Receptors

Ecological Importance	Attributes of Ecological Receptor
International (European)	Habitats An internationally designated site or candidate site i.e. Special Protection Area (SPA), provisional SPA (pSPA), Special Areas of Conservation (SAC), candidate SAC (cSAC), Ramsar site, Biogenetic/Biosphere Reserve, World Heritage Site or an area which meets the published selection criteria for such designation. A viable area of a habitat type listed in Annex I of the Habitats Directive, or smaller areas of such habitat that are essential to maintain the viability of a larger whole. Any river classified as Excellent A1 and likely to support a substantial salmonid population. Any river with a Habitat Modification Score indicating that it is Pristine or Semi-Natural or Predominately Modified. Species Any regularly occurring population of an internationally important species, which is threatened or rare in the UK, i.e. a UK Red Data Book species or listed as occurring in 15 or fewer 10km squares in the UK (categories 1 and 2 in the UK BAP) or of uncertain conservation status or of global conservation concern in the UK BAP. A regularly occurring, nationally significant population/number of any internationally important species.
National (Scottish)	Habitats A nationally designated site (SSSI, ASSI, NNR, Marine Nature Reserve) or a discrete area, which meets the published selection criteria for national designation (e.g. SSSI selection guidelines) irrespective of whether or not it has yet been notified A viable area of a priority habitat identified in the UK BAP, or of smaller areas of such habitat which are essential to maintain the viability of a larger whole. Any river classified as Excellent A1 and likely to support a substantial salmonid population. Any river with a Habitat Modification Score indicating that it is Pristine or Semi-Natural or Predominantly Unmodified. Species A regularly occurring, regionally or county significant population/number of an internationally/nationally important species. Any regularly occurring population of a nationally important species which is threatened or rare in the region or county (see local BAP). A feature identified as of critical importance in the UK BAP.
Regional (North East Scotland)	Habitats Sites which exceed the county-level designations but fall short of SSSI selection guidelines, where these occur Viable areas of key habitat identified in the Regional BAP or smaller areas of such habitat which are essential to maintain the viability of a larger whole Viable areas of key habitat identified as being of regional value in the appropriate SNH Natural Heritage Future area profile. Any river classified as Excellent A1 or Good A2 and capable of supporting salmonid population. Any river with a Habitat Modification Score indicating that it is Obviously Modified or above. Species Any regularly occurring, locally significant population of a species listed as being nationally scarce which occurs in 16-100 10km squares in the UK or in a Regional BAP or relevant SNH Natural Heritage Future area on account of its regional rarity or localisation. A regularly occurring, locally significant population/number of a regionally important species. Sites maintaining populations of internationally/nationally important species that are not threatened or rare in the region or county.
Authority Area (e.g. County or District) (Aberdeenshire/City of Aberdeen)	Habitats Sites that are recognised by local authorities e.g. Sites of Interest for Nature Conservation (SINS) and District Wildlife Sites (DWS). County/District sites that the designating authority has determined meet the published ecological selection criteria for designation, including Local Nature Reserves (LNR). A viable area of habitat identified in County/District BAP or in the relevant SNH Natural Heritage Future area profile. A diverse and/or ecologically valuable hedgerow network. Semi-natural ancient woodland greater than 0.25 ha. Any river classified as Good A2 or Fair B and likely to support coarse fishery. Any river with a Habitat Modification Score indicating that it is Significantly Modified or above. Species Any regularly occurring, locally significant population of a species that is listed in a County/District BAP on account of its regional rarity or localisation. A regularly occurring, locally

Ecological Importance	Attributes of Ecological Receptor
	significant population of a county/district important species (particularly during a critical phase of its life cycle). Sites supporting populations of internationally/nationally/regionally important species that are not threatened or rare in the region or county, and are not integral to maintaining those populations. Sites/features that are scarce within the county/district or which appreciably enrich the county/ district habitat resource.
Local (Immediate local area of village importance)	Habitats Areas of habitat considered to appreciably enrich the habitat resource, e.g. species-rich hedgerows, ponds etc. Sites that retain other elements of semi-natural vegetation that due to their size, quality or the wide distribution of such habitats within the local area are not considered for the above classifications. Semi-natural ancient woodland smaller than 0.25ha. Any river classified as Fair B or Poor C and unlikely to support coarse fishery. Rivers with a Habitat Modification Score indicating that it is Severely Modified or above. Species Populations/assemblages of species that appreciable enrich the biodiversity resource within the local context. Sites supporting populations of county/district important species that are not threatened or rare in the region or county, and are not integral to maintaining those populations.
Less than Local (Limited ecological importance)	Sites that retain habitats and/or species that are of limited ecological importance due to their size, species composition or other factors. Any river classified as Impoverished D and/or and with a Habitat Modification Score indicating that it is Severely Modified.

2.6 Impact Assessment

2.6.1 In the assessment of significance of impact, consideration has been given both to the magnitude of impact and to the sensitivity of the receiving environment or species. The sensitivity of a feature was determined with reference to its level of importance although other elements have been taken into account where appropriate. Methods of impact prediction used indirect measurements, correlations, expert opinion, and information from previous developments. Impacts include those that are predicted to be direct, indirect, temporary, permanent, cumulative, reversible or irreversible.

Impact Magnitude

2.6.2 The magnitude of an impact has been assessed for each element of the development. A definition of the magnitude impacts is presented in Table 8 and includes positive impact criteria in accordance with IEEM guidance (2002). The magnitude of each impact was assessed independently of its value or statutory status.

Table 8 – Impact Magnitude

Impact Magnitude	Criteria
High negative	The change is likely to permanently, adversely affect the integrity of an ecological receptor, in terms of the coherence of its ecological structure and function, across its whole area that enables it to sustain the habitat, complex of habitats and/or the population levels of species of interest.
Medium negative	The change is not likely to permanently, adversely affect the integrity of an ecological receptor, but the effect is likely to be substantial in terms of its ecological structure and function and may be significant in terms of its ecological objectives. Likely to result in changes in the localised or temporary distribution of species assemblage or populations but not affect the population status at a regional scale or permanently.
Low negative	The change may adversely affect the ecological receptor, but there will probably be no permanent effect on its integrity and/or key attributes and is unlikely to be significant in terms of its ecological objectives. Impacts are unlikely to result in changes to the species assemblage or populations, but core species more vulnerable to future impacts
Negligible	The change may slightly adversely affect the receptor but will have no permanent effect on the integrity of the receptor or its key attributes. There are no predicted measurable changes to the species assemblage or population and the effect is unlikely to result in an increased vulnerability of the receptor to future impacts.
Positive	The change is likely to benefit the ecological receptor, and/or enhance the biodiversity resource of the receptor.
High positive	The change is likely to restore an ecological receptor to favourable conservation status, contribute to meeting BAP objectives (local and national) and/or create a feature that is of recognisable value for biodiversity.

Impact Significance

2.6.3 The significance of an impact was determined according to the matrix of importance and magnitude as illustrated in Table 9.

Table 9 – Impact Significance

Magnitude / Importance	High Negative	Medium Negative	Low Negative	Negligible	Positive	High Positive
International	Major	Major	Moderate	Negligible	Moderate	Major
National	Major	Major	Moderate	Negligible	Moderate	Major
Regional	Major	Moderate	Minor	Negligible	Minor	Moderate
County	Moderate	Moderate	Minor	Negligible	Minor	Moderate
Local	Minor	Minor	Minor	Negligible	Minor	Minor
Less than Local	Minor	Negligible	Negligible	Negligible	Negligible	Negligible

2.6.4 The level of significance of impacts predicted on ecological receptors is an important factor in influencing the decision-making process and determining the necessity and/or extent of mitigation measures. Impacts can be beneficial or adverse, either improving or decreasing the ecological status health or viability of a species, population or habitat. In general, an impact significance greater than or equal to Moderate would require specific mitigation to be undertaken to ameliorate the impact significance to acceptable levels.

2.7 Limitations to Assessment

2.7.1 The use of water quality spot measurement data must be approached with caution as these can only provide a snapshot of conditions. As such water quality measures were used to aid interpretation of biological data rather than vice versa.

2.7.2 Due to time constraints only one macroinvertebrate sample was taken in summer 2006. Repeat autumn sampling was carried out in September 2006.

3 Baseline

3.1 Consultation Information

3.1.1 SEPA monitors a number of the watercourses in Table 4 for water quality and biological measures and has recent river classifications for two relevant watercourses along the route. These data have been used in the impact assessment both in terms of aquatic ecosystem health and water quality. A summary of SEPA's biological data is given below (Table 10). Chapter 24 (Water Environment) contains further details.

Table 10 – Summary of SEPA Biological Data

Route Section	Watercourse	Year	Classification
SL3	Crynoch Burn	2005	A1
SL3	River Dee	2005	A2

3.1.2 The LBAP species *Brachyptera putata* was recorded by SEPA as part of their routine monitoring of the River Dee between 1981 and 2004.

3.1.3 In addition to baseline information obtained from SEPA, physical parameters were also calculated for each watercourse and are shown in Table 11.

Table 11 – Physical Parameters of Watercourses

Route Section	Watercourse	Area upstream (km^2)	Qmean flow (m^3/sec)	Q95 Flow (m^3/sec)	Standard Deviation of Mean Monthly Velocities (m/s)
SL1	Loirston Burn	0.66	0.01	0.001	0.097
	Jameston Ditch	0.24	0.003	0.001	0.025
	Burn of Ardoe	2.92	0.039	0.009	0.055
SL2	Cowford Burn	0.13	0.002	0	0.082
	Burnhead Burn	4.23	0.054	0.013	0.081
SL3	Crynoch Burn A	22.16	0.285	0.067	0.66
	Crynoch Burn B	28.82	0.371	0.087	0.157
	Blaikiewell Burn	4.51	0.056	0.012	0.079
	Kingcausie	1.56	0.021	0.004	0.107
	River Dee	2045	46.11	9.94	0.133
SL4	Milltimber Burn	0.59	0.008	0.001	0.099
	Alburn Burn	0.70	0.003	0.001	0.032
	Bellenden Burn	0.08	0.002	0.000	0.055
SL5	Silver Burn	0.20	0.003	0.001	0.071
	Gairn Burn	0.82	0.011	0.002	0.089

3.1.4 Each of these four parameters provides information on the general nature of the watercourse. The first measure indicates the general size of the watercourse by providing an estimated catchment area upstream of where the watercourse would be crossed by the proposed scheme. There are two watercourses of significant in size in the area, the River Dee and Crynoch Burn.

3.1.5 The second and third parameters give an indication of the volume of water flowing down the channel during mean and low flow periods. The most significant discharge throughout the scheme if from the River Dee with a Qmean flow of 46.11m^3 s^{-1}. A large proportion of the watercourses within the southern leg have very low mean flows and therefore indicate that they may dry out during certain periods of the year, particularly Cowford Burn, Milltimber Burn, Bellenden Burn and Jameston Ditch.

3.1.6 The fourth parameter is a simple measure of the variation in mean monthly velocities for each watercourse. This parameter shows that the most 'flashy' watercourses (i.e. those with a highly variable flow) are the River Dee, Crynoch Burn (downstream) and Kingcausie Burn.

3.2 Survey Results

Macroinvertebrate Survey

3.2.1 Macroinvertebrate surveys were undertaken in June 2006, with a second season sampling occurring in September 2006. Sampling points are shown in Figures 25.13a-h and the species identified from each of the burns is provided in Table 12.

3.2.2 Loirston Burn is significantly modified throughout the reach that was assessed. A macroinvertebrate sample was taken downstream of the culvert underneath the A90, as the upstream sections were considered too small and polluted. The assemblages present were limited with only pollution tolerant individuals such as the freshwater shrimp and true fly (Diptera) larvae being observed. An ASPT score of 2.7 led to a classification of impoverished biological status, which is typical of heavily modified channels.

3.2.3 The Burn of Ardoe was not accessible for macroinvertebrate sampling, therefore data from previous surveys were used to inform the assessment. Previous sampling was taken upstream of the proposed scheme crossing point and indicated good biological status with a macroinvertebrate fauna comprising mainly common, but often pollution sensitive species (ASPT 5.54).

3.2.4 Jameston Ditch is a field drain flowing into the Burn of Ardoe. Despite being a field drain, the channel was substantial with a good cover of aquatic macrophyte. The ditch was found to support a varied macroinvertebrate assemblage with individuals showing a range of pollution tolerances (ASPT 4.4). A number of water beetles were identified, as were dipteran larvae, freshwater snails, caddis flies and freshwater hog louse. These species have no specific flow requirements and are generally representative of slow flowing or standing waters (Extence et al, 1999).

3.2.5 Cowford Burn is a straightened channel flowing along field boundaries that is culverted under existing access roads and forms part of a complex of field drains. The macroinvertebrate assemblage was found to be varied with pollution-intolerant species present and an ASPT of 5.3, leading to a classification of good biological status. A number of caddis fly larvae were identified, as were stoneflies, pea mussels, dipterans and beetles. The species identified are generally found in slow flowing or standing waters, with the exception of the caddis fly *Plectrocnemia conspersa* and *Chaetopteryx villosa* which require a moderate flow (Extence et al., 1999).

3.2.6 Burnhead Burn flows through semi-improved grasslands as a straightened channel along the edge of an access road before flowing into Blaikiewell Burn. Burnhead Burn was sampled along the straightened section upstream of its confluence with Blaikiewell. The macroinvertebrate assemblage was varied, supporting a number of pollution-intolerant species such as the stonefly *Siphonoperla torrentium*. A total of 12 families were identified with an ASPT of 5.3, leading to a classification of good biological status. A number of species that were identified have more specific flow requirements typically greater than 20 cm s^{-1} (Extence et al., 1999).

3.2.7 Blaikiewell Burn was found to be fast flowing as it passed between semi-improved grassland on the left bank and broad-leaved mixed woodland to the right (orientated downstream). The macroinvertebrate assemblage was varied with a total of 12 species identified, showing a range of pollution tolerances. The major groups that were identified such as species of mayflies, caddis flies, stoneflies and beetles require moderate to fast flows. The burn was classified as possessing excellent biological status based on the diverse assemblage present and the ASPT of 6.2.

3.2.8 Crynoch Burn was sampled in two separate locations, in its upstream reaches and downstream towards its confluence with the River Dee. Both of these sampling locations fall within the boundary of the River Dee SAC. The upstream and downstream sections supported the largest number of species with ASPT scores of 6.9 and 6.3 indicating excellent biological status. SEPA's 2005 classification put Crynoch Burn at excellent biological status, matching that of the current survey. Although slightly different in physical cross-section, both the upstream and downstream sites supported flow-dependent species of stonefly, mayfly, caddis fly and beetles.

3.2.9 The macroinvertebrate assemblage identified in Kingcausie Burn was slightly limited with only six species being identified. One species in particular, the weevil *Litodactylus leucogaster* was abundant within the stretch of the watercourse that passes through woodland stretch and is a Notable b Species (does not fall within red data book categories but is uncommon in the UK). Kingcausie Burn was classified as being of fair biological status based on the macroinvertebrate assemblage (though was approaching good status).

3.2.10 The River Dee was the largest watercourse sampled in the study area and supported a diverse macroinvertebrate assemblage with a total of 11 species being identified. The ASPT score indicated that the River Dee is of good biological status, which matches the 2005 classification made by SEPA. The River Dee supported a number of flow dependent species including stoneflies, mayflies and beetles.

3.2.11 Milltimber Burn is a species poor, straightened field drain with only seven individuals being identified. The burn was relatively small with a high level of suspended sediment in the water column and was found to only support freshwater snails, dipterans, worms and the freshwater shrimp. The ASPT score for this burn indicated that it is of fair biological status.

3.2.12 Alburn Burn, at the sample point, flowed around the perimeter of a school sports ground and was heavily choked with vegetation. A total of 11 species were identified within the burn with only seven of being scoring families. The ASPT score for the burn indicated that it is in a good biological status. The burn supported species of caddis fly, blackfly and beetles, which all require moderate to fast flow.

3.2.13 Bellenden Burn, in its upper catchment, follows natural meanders of moderately fast flow over cobbles and boulders, with organic debris from the woodland present. The burn was found to support ten species, with caddis flies and mayflies being the dominant groups. This burn also supported the notable weevil species *Litodactylus leucogaster*. The ASPT score for this burn indicated that it possesses good biological status.

3.2.14 Silver Burn is a naturally meandering burn, though is modified in sections where culverts are currently present. The burn was found to support a total of 11 species with the ASPT score indicating a classification of excellent biological status. The dominant groups identified were caddis flies and stoneflies, which made up six of the 11 species identified.

3.2.15 Access to Gairn Burn during macroinvertebrate sampling was restricted and for this reason, the burn was assessed from an existing road bridge. A total of 11 species were identified from the sample, with the majority being relatively pollution tolerant species. This led to an ASPT score indicating fair biological status (though approaching good). The dominant groups identified were dipterans and mayflies.

Table 12 – Macroinvertebrate Taxa Identified (Abbreviations as for Table 4)

Invertebrate taxa	LOR D	JAM	BOA	COW	BUR	BLA	CRY A	CRY B	KIN	DEE	MILT	ALB	BEL	SIL	GAIR
Oligochaeta	2		2							2	2				
Hydracarina			1												
Gammaridae Gammarus pulex		1	1	41	1	5	130	4	90	8	7	66	79		7
Asellidae Asellus aquaticus															1
Hirudinae															
Erpobdellidae															
Erpobdella octoculata										1					
Erpobdella sp.										2					
Trichoptera															
unindentifiable							2								
Limnephilidae									1						
Limnephilus lunatus		5		1										1	
Chaetopteryx villosa				4	2				4		1	3	3		
Halesus sp.															
Potamophylax rotundipennis												1			1
Rhyacophilidae															
Rhyacophila dorsalis			2				1	4						1	
Hydropsychidae															
pupa								2						1	

Invertebrate taxa	LOR D	JAM	BOA	COW	BUR	BLA	CRY A	CRY B	KIN	DEE	MILT	ALB	BEL	SIL	GAIR
Hydropsyche siltalia						1									
Hydropsyche sp.			2												
Glossosomatidae															
Agapetus fuscipes					1										
Agapetus bifidus			1												
Polycentropodidae			1												
Plectrocnemia conspersa				3								1	2	1	2
Polycentropus kingi										5					
Plecoptera (Stoneflies)															
Leuctridae															
Leuctra inermis										40					
Leuctra geniculata							1			8					
Leuctra moselyi														12	
Leuctra sp.						2	4	2							
Nemouridae															
Nemurella picteti				8											6
Nemoura spp.			5												
Amphinemoura sulcicollis			20												
Perlodidae														2	
Isoperla grammatica			1												
Chloroperlidae															

Invertebrate taxa	LOR D	JAM	BOA	COW	BUR	BLA	CRY A	CRY B	KIN	DEE	MILT	ALB	BEL	SIL	GAIR
Siphonoperla torrentium					1	1	1								
Mollusca															
Lymnaeidae															
Lymnaea peregra											12				
Lymnaea truncatula		1													
Potamopyrgus jenkinsi											2		6		
Ancylidae															
Ancylus fluviatilis			1								4				
Sphaeridae															
Pisidium sp.		1		3	1						33		3		2
Ephemeroptera (Mayflies)															
Caenidae															
Caenis horaria								3							
Caenis sp.							1								
Caenis rivulorum							3								
Ephemerellidae															
Ephemerella ignita						1	19	99		6			20	1	
Baetidae															
Baetis spp.					1	4	126	16	8					20	5
Baetis fuscatus										3					
Baetis rhodani			12												

Invertebrate taxa	LOR D	JAM	BOA	COW	BUR	BLA	CRY A	CRY B	KIN	DEE	MILT	ALB	BEL	SIL	GAIR
Heptageniidae															
Heptagenia sp.							1								
Ecdyonurus sp.							3	2		17					
Diptera (True flies)															
Unientified larvae				1		1	9					2	1	14	4
Unientified pupa	1	1			6	5									
Chironominae (Chironomidae)	3	1		1	5					16		19	4		40
Orthocladiinae (Chironomidae)	8	2	27	12	140	54	8	5	1			19	1	1	56
Tanypodinae (Chironomidae)				12	34	20	3	12		5	2	9	7	1	8
Chironomidae pupa			1		3			2							
Tipulidae			1		1										
Simulidae Larvae					11	20		3				14			3
Coleoptera (Beetles)															
Unidentified larvae															
Curculionidae (A)	1														
Litodactylus leucogaster									22				3		
Pelenomus sp.															
Dytiscidae															
Unidentified larvae							1								
Potamonectes depressus elegans (A)										1					
Ilybius fuliginosus (A)				1											

Invertebrate taxa	LOR D	JAM	BOA	COW	BUR	BLA	CRY A	CRY B	KIN	DEE	MILT	ALB	BEL	SIL	GAIR
Stictotarsus duodecimpustulatus (A)					1										
Hydroporus sp. (A)		1													
Oreodytes sanmarkii (A)						1	1	1							
Hydroporinae larvae						1				1					
Hydraenidae															
Hydraena gracilis (A)							2	1							
Scirtidae															
Scirtes sp. (L)					1										
Hydrophilidae															
Anacaena globulus (A)		3										1			
Helophorus aequalis (A)		4													
Helochares sp. (A)		1													
Helophorus brevipalpis (A)															
Elmidae						1									
Limnius volckmari (L)							8	4		1					
Limnius volckmari (A)					1		1								1
Elmis aenea (L)					2		11	8				3			
Elodes sp. (L)									1					2	
Hempitera (True Bugs)															
Velidae															
Microvelia sp.													2		

Invertebrate taxa	LOR D	JAM	BOA	COW	BUR	BLA	CRY A	CRY B	KIN	DEE	MILT	ALB	BEL	SIL	GAIR
BMWP Score	8	31	72	37	64	62	76	76	29	63	28	37	43	67	49
Number of scoring families	3	7	13	7	12	10	11	12	6	11	7	7	8	9	10
ASPT	2.7	4.4	5.54	5.3	5.3	6.2	6.9	6.3	4.8	5.7	4.0	5.3	5.4	7.4	4.9
Number of species	4	8	15	8	13	12	14	13	6	11	7	11	10	11	11

Water Quality

3.2.16 Water quality samples were taken during summer 2006 and are presented in Table 13 with sampling points shown on Figures 25.13a-h. This sampling is intended to give a broad indication of water quality only. Most watercourses were found to have high dissolved oxygen levels, placing them indicatively in the excellent category for this parameter. A number of watercourses were identified as being in the good category for this parameter with less than 70% saturation. These included the River Dee, Crynoch Burn (upstream), Alburn Burn and Cowford Burn. Three watercourses were found to have dissolved oxygen levels of less than 60% saturation. These watercourses were small slow flowing drains that had a high level of suspended sediments and vegetation.

3.2.17 Electrical conductivity readings for all watercourses were in a typical range for freshwaters (50-500µS/cm) with the exception of Loirston Burn, which had a conductivity of 1102µS/cm.

3.2.18 For all watercourses, pH values were within the excellent category according to SEPA's river classification scheme, with all being close to neutral. The total hardness values for most of the burns tested put them into the moderately hard category, with a few exceptions. The River Dee, Gairn Burn, Cowford Burn, the Burn of Ardoe and Burnhead Burn were within the soft water category. One anomaly was identified with Loirston Burn recording a total hardness of 520mg/L, which is also reflected in the high conductivity at this site.

Table 13 – Water Quality Spot Measurements

Watercourse	DO (% sat)	Electrical Conductivity (µS/cm)	Temp (°C)	pH	Total Hardness (mg/L)
CRY A	76	195.5	13	7.9	83
BLA	86.2	238	14.5	7.1	63
KIN	84	200	10.8	6.3	77
CRY A	76	196	13	7.9	83
CRY B	113.2	192	15.1	7.7	78
DEE	74.4	66.7	13.6	7.1	26
MILT	22.6	338	12.5	7.4	93
ALB	75.7	238	9.7	7.5	97
BEL	110.8	233	11.1	6.6	100
SIL	113.5	182.1	11.7	7.1	78
GAIR	85.9	141.7	9.6	6.9	52
LOR D	63.1	1102	11.9	7.6	520
JAM	51	272	13.5	6.9	66
BOA	94	340	13.7	7.5	49
COW	73.7	177	11.5	6.5	51
BUR	82.6	149.4	13.7	7.4	59

River Habitat Surveys

3.2.19 River habitat surveys were conducted along 500m sections to describe the physical parameters of each watercourse in the study area that would be crossed by the proposed scheme. Locations of river habitat surveys are shown in Figures 25.13a-h and site descriptions and Habitat Modification Scores are presented in Table 14.

3.2.20 The reach of Loirston Burn (downstream) that was surveyed was the section closest to Loirston Loch and is extensively realigned and over-deepened, passing through a long culvert. Both banks were found to be extensively re-sectioned with whole bank reinforcement being present along both banks. Poaching by cattle and embanking were present on the left bank. Loirston Burn was classed as severely modified.

3.2.21 The surveyed reach of Loirston Burn (upstream) was the section furthest from Loirston Loch and was classed as obviously modified. It was found to be extensively realigned and over-deepened with both banks being extensively re-sectioned.

3.2.22 Bishopston Ditch is extensively realigned, over-deepened and passes through one culvert. This watercourse flows into Hare Moss where the channel disappears. Bishopston Ditch was classed as significantly modified.

3.2.23 Heathfield Burn is a drainage ditch that was classed as significantly modified. It is realigned and over-deepened and passes through two culverts. Both banks are extensively re-sectioned with the right bank being reinforced and embanked in places.

3.2.24 The Burn of Ardoe was assessed as severely modified as it has been extensively re-sectioned and reinforced with the upstream section straightened.

3.2.25 Burnhead Burn was classed as significantly modified. It is extensively realigned and over-deepened in places. Both banks are re-profiled and toe only reinforcement is extensive.

3.2.26 Whitestone Burn is a field drain that was classed as significantly modified due to being extensively realigned and over-deepened. Both banks are extensively re-sectioned and reinforced, while the left bank was found to be embanked in places.

3.2.27 Wedderhill Burn is a field drain that was classed as severely modified due to being extensively realigned and over-deepened. Both banks are extensively re-sectioned, reinforced and embanked in places.

3.2.28 Crynoch Burn, upstream of the proposed crossing point, was classed as significantly modified. It is sinuous, but partly impounded by a weir. The banks along this reach are extensively reinforced at the toe. Several unvegetated point bars were recorded which indicated that the burn was actively transporting materials. The surveyed reach is within the boundary of the River Dee SAC.

3.2.29 Crynoch Burn, downstream of the proposed crossing point, was classed as obviously modified. The burn flows through a gorge into the River Dee and toe only bank reinforcement is present along half of the reach. A section of the reach was found to be impounded by two weirs. Two unvegetated point bars were recorded which indicated that the burn was actively transporting materials. The surveyed reach is within the boundary of the River Dee SAC.

3.2.30 Blaikiewell Burn is a relatively small burn that has been realigned, but appears to be becoming more naturalised with several riffles, pools and point bars recorded. Both banks have been extensively re-sectioned however, no artificial features were recorded. Blaikiewell Burn was classed as obviously modified.

3.2.31 Kingcausie Burn is a small burn flowing into Crynoch Burn via a waterfall. Upstream of the surveyed reach it is heavily modified with a fully reinforced left bank and bed. The surveyed reach is sinuous and flows through plantation woodland and improved grassland. It was classed as obviously modified.

3.2.32 The River Dee downstream of the proposed crossing point was classed as semi-natural. A set-back embankment along the left bank was the only modification recorded. Side bars were recorded along this reach of active river.

3.2.33 River Dee upstream of the proposed crossing point was classed as obviously modified. A major bridge spans the river with the B979. Embankment is present along both banks. One riffle, one vegetated point bar and side bars were recorded along this reach of active river.

3.2.34 Milltimber Burn is a field drain that has been extensively realigned and over-deepened. It drains runoff from urban development to the River Dee. It was classed as significantly modified due to the presence of a culvert, extensively re-sectioned banks, poaching, reinforcements and embanking.

3.2.35 Culter House Ditch is classed as severely modified. The left bank is fully reinforced (stone wall). The ditch is extensively realigned and over-deepened. One culvert was recorded. Both banks are extensively re-sectioned and embanked in places.

3.2.36 Gairn Burn was classed as significantly modified. The survey was carried out downstream of the proposed crossing point as dense vegetation prevented access to the burn upstream of this. The burn has been extensively realigned and over-deepened. One culvert, one intermediate bridge and five minor bridges were recorded. The surveyed reach flowed from conifer plantation under a road and through a garden.

3.2.37 Access to Upper Beanshill Burn at the point where the scheme would cross could not be gained. Therefore, this watercourse was surveyed outside of the study area, which allowed the character of the watercourse to be assessed. This reach was classed as significantly modified and is extensively realigned and over-deepened. Two culverts were recorded. The watercourse appears to have been excavated to drain conifer plantations along the upstream section of the reach. Further downstream, the burn flows into online ponds within ornamental gardens.

Table 14 – River Habitat Survey Southern Leg

Watercourse Code and Habitat Modification Score	Valley Form, Channel Dimensions, Bank Profile/Modification and Artificial Features	Substrate, Channel Form and Flow	Vegetation	Surrounding Land-use
Loirston Burn LOR downstream 48 (severely modified)	No obvious valley sides. Bankfull width 5m. Water width 4m. Depth 0.04m. Bank height 1 – 1.7m. Both banks have been extensively re-sectioned. Whole bank reinforcement present on both banks. Top reinforcement only present on right. Poaching and embanking present on left. Artificial features: 1 culvert.	Substrate comprised 20% gravel/pebble, 10% sand, 10% earth and 60% not visible. No riffles, pools or point bars were recorded. Flow types were 20% rippled, 40% not perceptible and 40% not visible.	Riparian vegetation structure was predominantly simple along both banks. Trees were absent from both banks. Channel vegetation comprised liverworts/mosses/lichens, emergent broad-leaved, herbs, emergent reeds/sedges/grasses/horsetails, amphibious and filamentous algae.	Improved/semi-improved grassland extensive on both banks. Scrub and shrubs present on both. Suburban/urban development present on both banks, particularly extensive on left bank. Tall herb/rank vegetation present on right. Tilled land present on left bank.
Loirston Burn LOR upstream 20 (obviously modified)	No obvious valley sides. Bankfull width 3.5m. Water width 0.5m. Depth 0.05m. Bank height 1.5 - 2m. Both banks have been entirely re-sectioned. No artificial features were recorded within the survey reach.	Substrate comprised 60% gravel/pebble, 10% sand, 10% silt, 10% cobble and 10% not visible. No riffles, pools or point bars were recorded. Flow types were 10% smooth and 90% not perceptible.	Riparian vegetation structure was predominantly uniform/ simple along the left and simple/complex along the right. Occasional clumps of trees were present on both banks. Channel vegetation comprised extensive reeds/sedges/grasses/horsetails with liverworts/mosses/lichens, emergent broad-leaved herbs, floating-leaved (rooted) and amphibious also present.	Coniferous plantation was extensive on both banks. Broad-leaved/mixed plantation, rough/unimproved grassland/pasture and tall herb/rank vegetation present on both banks. Moorland/heath and improved/semi-improved grassland present on right bank.
Bishopston Ditch BISHOP 24 (significantly modified)	No obvious valley sides. Bankfull width 3m. Water width 0.4m. Depth 0.1. m. Bank height 1 – 1.5m. Both banks have been extensively re-sectioned. Embanking was present on right. Artificial features: 1 major weir/sluice.	Substrate comprised 10% earth and 90% not visible. No riffles, pools or point bars were recorded. Flow types were 100% not visible.	Riparian vegetation structure was simple along both banks. Trees were absent from both banks. Channel vegetation comprised extensive emergent broad-leaved herbs and emergent reeds/sedges/grasses/horsetails with amphibious also present.	Improved/semi-improved grassland extensive on left. Tall herb/rank vegetation present on both banks. Wetland extensive. Scrub, shrubs and moorland/heath present on right bank.

Watercourse Code and Habitat Modification Score	Valley Form, Channel Dimensions, Bank Profile/Modification and Artificial Features	Substrate, Channel Form and Flow	Vegetation	Surrounding Land-use
Heathfield Burn HEATH 32 (significantly modified)	No obvious valley sides. Bankfull width 2.5m. Water width 1m. Depth 0.2m. Bank height 1 – 1.75m. Both banks have been extensively re-sectioned. Reinforcement (top only) present on right. Embanking was present on right. Artificial features: 2 culverts.	Substrate comprised 30% earth and 70% not visible. No riffles, pools or point bars were recorded. Flow types included 10% smooth, 30% not perceptible and 60% not visible.	Riparian vegetation structure was simple along both banks. Trees were absent from both banks. Channel vegetation comprised extensive emergent reeds/sedges/grasses/horsetails and amphibious with liverworts/mosses/lichens and emergent broad-leaved herbs also present.	Improved/semi-improved grassland extensive on both banks. Tall herb/rank vegetation present on both banks. Suburban/urban development extensive on right. Tilled land extensive on left bank.
Burn of Ardoe BOA 60 (severely modified)	Valley forms concave/bowl shape with channel bank full width an average 2m. Water width of 1.5m and a depth of 15cm. Banks were on average 1.25m high with a gently sloping bank profile along both banks. The upstream area of the burn has been extensively re-sectioned and reinforced (some areas whole and/or toe only) while maintaining more natural meanders in the central, wooded section of the reach. The burn returns to an extensively modified profile at the downstream end of the survey reach. Artificial features present in the survey reach: 1 culvert, 1 minor bridge, 1 intermediate and 2 minor outfalls/intakes.	Substrate comprised loose unconsolidated bed material composed of 80% boulder; 10% cobble; 10% not visible and small amounts of gravel/pebble and silt. Throughout the reach, 15 riffles, 6 pools and 1 unvegetated point bar were recorded. Flow types comprised: 70% rippled, 20% smooth and 10% unbroken standing waves.	Riparian vegetation along both banks was largely simple with some areas of complex habitat along the wooded section, particularly on the right bank. Occasional clumps of trees are present on both banks, particularly the central wooded section of the reach where trees are approximately continuous for around 100m. Moderate areas of channel shading are present with occasional overhanging boughs, exposed bankside roots, underwater tree roots and large woody debris. In-channel vegetation dominated by extensive areas of liverworts/mosses/lichens and filamentous algae.	Along the left bank, landuse is dominated by rough/unimproved pasture with extensive areas also present along the right bank. In smaller sections, broad-leaved/mixed plantation dominates along the right bank with scrub/shrubs and tall herb/rank vegetation present along both banks.
Burnhead Burn BUR D/S 42 (significantly modified)	No obvious valley sides. Bankfull width 3m. Water width 2m. Depth 0.2m. Bank height 3 – 3.5m. Both banks have been extensively re-sectioned and reinforced (toe only). Steep bank present on the left. Artificial features: 1 culvert.	Substrate comprised 40% gravel/pebble, 40% silt, 10% cobble and 10% not visible. No riffles, pools or point bars were recorded. Flow types were 60% smooth and 40% rippled.	Riparian vegetation structure was simple/complex along the left. Vegetation along the right bank-face was simple to complex and the right banktop was predominantly bare. Occasional clumps of trees were present on the left bank only. Channel vegetation comprised extensive reeds/sedges/grasses/horsetails with liverworts/mosses/lichens, emergent broad-leaved herbs and floating-leaved (rooted) also present.	Improved/semi-improved grassland extensive on both banks. Scrub, shrubs and tilled land present on both banks. Broad-leaved/mixed woodland present on the left bank and suburban/urban development present on the right bank.

Watercourse Code and Habitat Modification Score	Valley Form, Channel Dimensions, Bank Profile/Modification and Artificial Features	Substrate, Channel Form and Flow	Vegetation	Surrounding Land-use
Whitestone Burn STONE 44 (significantly modified)	No obvious valley sides. Bankfull width 2.5m. Water width 0.5m. Depth 0.02m. Bank height 1.25 – 1.75m. Both banks have been extensively re-sectioned. Reinforcement (whole bank) present on left and extensive on right. Embanking was present on left bank. No artificial features were recorded within the survey reach.	Substrate comprised 40% silt, 50% artificial and 10% gravel/pebble. No riffles, pools or point bars were recorded. Flow types included 40% smooth, 40% not perceptible, 10% rippled and 10% not visible.	Bank-face vegetation structure was simple along both banks. Banktop vegetation structure was simple on the left bank and complex on the right bank. Trees were semi-continuous along the right bank only. Channel vegetation comprised extensive emergent broad-leaved herbs with emergent reeds/sedges/grasses/horsetails and amphibious also present.	Improved/semi-improved grassland extensive on both banks.
Wedderhill Burn WEDDER 65 (severely modified)	No obvious valley sides. Bankfull width 2.5m. Water width 0.4m. Depth 0.02m. Bank height 1 – 1.5m. Both banks have been extensively re-sectioned. Reinforcement (top only) present on both banks. Embanking was present on left and extensive on right. Artificial features: 3 culverts.	Substrate comprised 50% silt, 40% gravel/pebble and 10% sand. No riffles, pools or point bars were recorded. Flow types included 80% smooth, 10% rippled and 10% not perceptible.	Riparian vegetation structure was predominantly simple along both banks. Trees were absent from both banks. Channel vegetation comprised extensive emergent reeds/sedges/grasses/horsetails with emergent broad-leaved herbs, floating-leaved (rooted) and amphibious also present.	Improved/semi-improved grassland extensive on both banks.
Crynoch Burn CRYB U/S 25 (significantly modified)	Asymetrical valley form. Bankfull width 8m. Water width 2.5m. Depth 0.2m. Bank height 1.5 – 2m. Left bank steep and composite profiles. Right bank vertical/undercut and steep profiles. Reinforced (toe only) extensive on both banks. Whole bank reinforcement present on both banks. Artificial features: 1 intermediate and 1 minor weir/sluice and 3 minor bridges.	Substrate comprised 50% gravel/pebble, 30% sand, 10% artificial and 10% bedrock. 3 pools were recorded. No riffles or point bars were present. Flow types were 70% cobble, 20% gravel/pebble, 10% boulder with small areas of bedrock.	Riparian vegetation structure was predominantly simple/complex along both banks. Trees were continuous on both banks, providing channel shading. Overhanging boughs, exposed bankside roots, fallen trees and large woody debris present. Channel vegetation comprised extensive liverworts/mosses/lichens with emergent broad-leaved herbs also present.	Scrub, shrubs, artificial open water along left bank with suburban development and extensive parkland/gardens. Broad-leaved/mixed woodland, broad-leaved/mixed plantation, scrub, shrubs and extensive parkland/gardens along the right bank.

Watercourse Code and Habitat Modification Score	Valley Form, Channel Dimensions, Bank Profile/Modification and Artificial Features	Substrate, Channel Form and Flow	Vegetation	Surrounding Land-use
Crynoch Burn CRYB D/S 19 (obviously modified)	Gorge valley. Bankfull width 5m. Water width 5m. Depth 0.2 m. Bank height 2-4m. Both banks had vertical/undercut, composite and extensive steep profiles. Vertical with toe and gentle profiles present on left bank. Whole bank and toe only reinforcement present on both banks. Artificial features: 2 intermediate weirs/sluices and 1 minor bridge.	Substrate comprised 60% cobble, 20% gravel/pebble and 20% boulder with some areas of bedrock also present. 3 pools and 2 unvegetated point bars were recorded. Flow types were 40% rippled, 20% smooth, 20% broken standing waves and 20% unbroken standing waves.	Riparian vegetation structure was predominantly complex along the left and simple/complex along the right bank. Trees were continuous on both banks, providing extensive channel shading. Overhanging boughs, exposed bankside roots, underwater tree roots, fallen trees and large woody debris present. Channel vegetation comprised extensive liverworts/mosses/lichens.	Both banks had Broad-leaved/mixed plantation, suburban/urban development and extensive broad-leaved/mixed woodland and coniferous plantation. A rock bluff was present on the left bank. Scrub and shrubs present on the right bank.
Blaikiewell Burn BLA 20 (obviously modified)	Shallow v-shaped valley form. Bankfull width 2m. Water width 1m. Depth 0.03m. Bank height 0.8m. Both banks had extensive vertical/undercut and steep banks. Vertical with toe present on both banks. Both banks extensively re-sectioned. No artificial features were recorded within the survey reach.	Substrate comprised 80% gravel/pebble, 10% cobble and 10% bedrock. 10 riffles, 6 pools, 1 unvegetated and 2 vegetated point bars were recorded. Flow types were 40% smooth, 30% rippled and 30% unbroken standing waves.	Riparian vegetation structure was uniform/simple along both banks. Trees were absent from both banks. Channel vegetation comprised liverworts/mosses/lichens, emergent broad-leaved herbs, emergent reeds/sedges/grasses/horsetails and filamentous algae.	Right bank had extensive Broad-leaved/mixed woodland, scrub and shrubs, rough/unimproved grassland/pasture and suburban/urban development (road). Tall herb/rank vegetation also present. Left bank had extensive improved/semi-improved grassland, scrub and shrubs also present.
Kincausie Burn KIN 20 (obviously modified)	No obvious valley sides. Bankfull width 3m. Water width 2 m. Depth 0.05 m. Bank height 0.6 – 0.75m. Both banks had extensive vertical/undercut and steep profiles with gentle and composite profiles also present. Left bank was extensively re-sectioned and reinforced (whole bank). Toe only reinforcement present on both banks. Poaching present on the right. Artificial features: 1 culvert and 2 minor bridges.	Substrate comprised 50% gravel/pebble, 30% sand, 10% artificial and 10% bedrock. 3 pools were recorded. No riffles or point bars. Flow types were 50% smooth, 30% rippled, 10% broken standing waves and 10% not perceptible.	Riparian vegetation structure was predominantly simple/complex along the left and uniform/simple along the right. Trees were continuous on the left and semi-continuous on the right, providing extensive channel shading. Overhanging boughs, exposed bankside roots, fallen trees and large woody debris present. Limited channel vegetation comprised liverworts/mosses/lichens and amphibious.	Broad-leaved/mixed woodland extensive on both banks. Coniferous plantation extensive on the left and present on the right. Improved/semi-improved grassland extensive on the right bank.

Watercourse Code and Habitat Modification Score	Valley Form, Channel Dimensions, Bank Profile/Modification and Artificial Features	Substrate, Channel Form and Flow	Vegetation	Surrounding Land-use
River Dee DEE D/S 1 (semi-natural)	U-shaped valley. Bankfull width 90 m. Water width 60m. Depth 0.7m. Bank height 2m. Both banks had vertical/undercut, composite and extensive steep profiles. Vertical with toe and gentle profiles present on left bank. Whole bank and toe only reinforcement present on both banks. Artificial features: 2 intermediate weirs/sluices and 1 minor bridge.	Substrate comprised 80% gravel/pebble and 20% cobble. No riffles, pools or point bars were recorded. Flow types were 90% rippled and 10% unbroken standing waves.	Riparian vegetation structure was predominantly simple along the left and complex along the right. Trees were continuous on the right bank only. Channel shading was absent. Limited channel vegetation comprised emergent reeds/sedges/rushes/grasses/horsetails, amphibious and filamentous algae.	Left bank: scrub and shrubs and extensive improved/semi-improved grassland and tiled land. Right bank: Broad-leaved/mixed plantation, improved/semi-improved grassland and extensive suburban/urban development (road).
River Dee DEE U/S 12 (obviously modified)	U-shaped valley. Bankfull width 90m. Water width 60m. Depth 0.7m. Bank height 2m. Steep profiles present on both banks. Vertical/undercut and vertical with toe present on the right. Gentle profile present on left bank. Left bank embanked in places. Set-back embankment present on the right and extensive on the left. Artificial features: 1 major bridge and 1 minor outfall.	Substrate comprised 40% gravel/pebble, 20% cobble and 40% not visible. 1 riffle and 1 vegetated point bar were recorded. Flow types were 40% rippled, 30% smooth and 30% unbroken standing waves.	Riparian vegetation structure was predominantly simple/complex along both banks. Trees were semi-continuous on the left bank and in occasional clumps on the right. Channel shading, overhanging boughs, exposed bankside roots and large woody debris were present. Channel vegetation comprised extensive emergent reeds/sedges/rushes/grasses/horsetails with emergent broad-leaved herbs and amphibious also present.	Both banks had broad-leaved/mixed woodland, scrub and shrubs, rough/unimproved grassland/pasture and extensive tilled land. Coniferous woodland, improved/semi-improved grassland and tall herb/rank vegetation were present on the left and coniferous plantation and extensive parkland/gardens were present on the right.
Milltimber Burn MILT 41 (significantly modified)	No obvious valley sides. Bankfull width 2m. Water width 0.75m. Depth 0.2m. Bank height 0.75 - 1m. Both banks extensively re-sectioned. Top only reinforcement present on the right. Poaching extensive on the left. Embankment present on the left and extensive on the right Artificial features : 1 culvert.	Substrate comprised 50% silt, 30% earth, 10% sand and 10% not visible. Gravel/pebble was also present. No riffles, pools or point bars were recorded. Flow types were 40% smooth, 40% rippled, 10% not perceptible and 10% not visible.	Riparian vegetation structure was predominantly uniform/simple along the left and simple/complex along the right. Isolated/scattered trees were present on the right bank only providing some channel shading. Channel vegetation comprised extensive emergent broad-leaved herbs, emergent reeds/sedges/rushes/grasses/horsetails and amphibious.	Both banks had scrub and shrubs, tall herb/rank vegetation and extensive improved/semi-improved grassland and suburban/urban development.

Watercourse Code and Habitat Modification Score	Valley Form, Channel Dimensions, Bank Profile/Modification and Artificial Features	Substrate, Channel Form and Flow	Vegetation	Surrounding Land-use
Culter House Ditch CULT 45 (severely modified)	No obvious valley sides. Bankfull width 1.75m. Water width 0.3m. Depth 0.02m. Bank height 1 – 1.75m. Both banks extensively re-sectioned. Whole bank reinforcement extensive on the left and present on the right. Toe only reinforcement present on the right. Embankment extensive on the left and present on the right. Artificial features: 1 culvert.	Substrate comprised 10% earth, 10% sand and 10% gravel/pebble. Flow type was not visible at 70% of spot checks due to overgrown channel vegetation. No riffles, pools or point bars were recorded. Flow types were 20% rippled, 10% not perceptible and 70% not visible.	Riparian vegetation structure was predominantly simple/complex along the left and simple along the right. Trees were semi-continuous on the left bank only providing some channel shading. Overhanging boughs were present. Channel vegetation comprised extensive amphibious with liverworts/mosses/lichens, emergent broad-leaved herbs and emergent reeds/sedges/rushes/grasses/horsetails also present.	Left bank land-use was dominated by extensive coniferous plantation (recently felled) and broad-leaved/mixed woodland with parkland/gardens also present. Right bank was extensive improved/semi-improved grassland. Suburban/urban development was present on both banks (road).
Gairn Burn GAIRN 35 (significantly modified)	No obvious valley sides. Bankfull width 3m. Water width 0.5m. Depth 0.03m. Bank height 1.5m. Both banks extensively re-sectioned. Whole bank and toe only reinforcement present on both banks. Poaching and embankment present on both banks. Artificial features: 1 culvert, 1 intermediate bridge and 5 minor bridges.	Substrate comprised 100% gravel/pebble with areas of artificial (laid stone) also present No riffles, pools or point bars were recorded. Flow types were 70% rippled, 20% smooth and 10% not visible.	Bank face vegetation structure was predominantly simple along both banks. Banktop vegetation structure was predominantly uniform. Isolated/scattered trees were present along both banks. Channel shading was present. Channel vegetation comprised mosses/liverworts/lichens, emergent broad-leaved herbs, emergent reeds/ sedges/rushes/grasses/ horsetails, floating-leaved (rooted) and amphibious.	Both banks: improved/semi-improved grassland (extensive) and suburban/urban development. Coniferous plantation and parkland/gardens present on left bank. Rough/unimproved grassland/pasture present on right bank.
Upper Beanshill Burn UBBO 33 (significantly modified)	Concave/bowl shaped valley with a distinct flat valley bottom. Bankfull width 2m. Water width 1m. Depth 0.3m. Bank height 0.5m. Both banks have been extensively re-sectioned. Artificial features: 2 culverts and 1 minor bridge.	Substrate comprised 90% earth and 10% not visible. No riffles, pools or point bars were recorded. Flow type was 20% rippled, 10% not visible and 70% not perceptible.	Riparian vegetation was simple/bare on both banks. Trees were semi-continuous along both banks providing extensive channel shading. Fallen trees and large woody debris were present. Channel vegetation comprised extensive emergent reeds/sedges/rushes/grasses/horsetails and floating-leaved (rooted). Liverworts/mosses/lichens, emergent broad-leaved herbs, free-floating and amphibious were also present.	Coniferous plantation was extensive along both banks. Broad-leaved/mixed woodland, scrub and shrubs, wetland and suburban/urban development were present along both banks. Parkland/gardens and artificial open water were present on the left bank.

Freshwater Fish

3.2.38 Not all of the burns within the study area were suitable for HABSCORE and electric fishing assessments as they were either deemed too small to support salmonids or were ephemeral in nature. Those watercourses that were suitable for HABSCORE are listed in Table 15, along with results showing possible salmon and trout age classes present. In addition, the electric fishing surveys results are show the presence or absence of salmon and trout.

3.2.39 The reach of Burnhead Burn that was subject to assessment forms part of a straightened channel. Flow is moderate with a stoney substrate with in-stream vegetation providing refuge for small fish, a few of which were observed during the survey (brown trout juveniles). Assessments of the site deemed it suitable for small trout (namely brown trout), though was not considered suitable for salmon or sea trout. The HABSCORE output for the burn indicated that trout fry (0+) and juveniles (<20cm) are likely to be present, with a possibility of adults (>20cm). The electric fishing surveys within Burnhead Burn yielded no fish (Table 15) although suitable habitat was identified for lamprey and sticklebacks. It cannot be assumed that lamprey and stickleback are absent from the burn based on the electric fishing results. The electric fishing surveys were designed with salmon in mind and as such other species may have evaded capture.

3.2.40 Blaikiewell Burn is a more natural channel with evidence of previous realignment. The burn flows directly into Crynoch Burn through a shallow cascade and as such is open to migratory species. The burn offers excellent bank cover for fish and offers suitable habitat for stickleback and minnows. The presence of a waterfall at the confluence with Crynoch Burn indicates that the watercourse is inaccessible for lamprey. During the habitat assessment, juvenile brown trout were identified. The HABSCORE output for the burn indicated that it was unlikely for salmon to be present, though is possible for all life stages of trout to utilise the burn. Electric fishing results confirmed the presence of trout within the burn with fry (0+) and parr (1+ and 2+) being caught. No other fish species were identified within the burn however, it should be assumed that stickleback and minnow are present.

3.2.41 Crynoch Burn was assessed at two locations, upstream of the Blaikiewell Burn confluence and upstream of the Kingcausie Burn confluence. The upstream site (CRYA) was found to be likely to support salmon parr (>0+) and trout juveniles (<20cm) although it is unlikely to support fry of either species. The downstream site, however, is considered likely to support salmon parr and fry, trout fry and possibly trout juveniles and adults. No electric fishing surveys were completed within Crynoch Burn as it is part of the River Dee SAC designated *inter alia* for Atlantic salmon. Therefore, their presence is pre-supposed in areas connected to the River Dee without physical barriers to their movement.

3.2.42 Kingcausie Burn flows through a woodland and forms a natural meandering channel at the survey reach. Upstream, the burn is extensively straightened. The burn provides a number refuges for fish through overhanging branches and instream debris. Kingcausie Burn flows into Crynoch Burn through a steep waterfall, indicating that the burn is not accessible for migratory fish. This is reflected in the HABSCORE output, which indicated that salmon are unlikely to be found. Juvenile trout are likely to be present with a possibility of juveniles and adults. No electric fishing surveys were considered necessary for Kingcausie Burn due to the presence of the waterfall.

3.2.43 The River Dee is a large slow flowing river providing a range of habitats for a large number of fish species. HABSCORE assessments indicated that the River Dee is likely to support salmon fry and parr, trout fry and possibly juvenile and adult trout. No electric fishing surveys were carried out within the River Dee SAC, which is designated *inter alia* for Atlantic salmon. Therefore, their presence and that of other qualifying species is pre-supposed.

3.2.44 Bellenden Burn, where it flows through woodland along a natural meandering channel, contains fish refuges in the form of fallen vegetation. The HABSCORE assessment indicated that the burn was unlikely to support salmon, although it may support adult and juvenile trout. No electric fishing surveys were carried out within Bellenden Burn.

3.2.45 The reach of Silver Burn that was assessed had a moderate flow with cobble and gravel substrate making it suitable for fish species. However, the presence of a dam approximately 8.5km downstream of the crossing point makes the burn inaccessible to migratory salmonids. The HABSCORE output indicated that the burn was unlikely to support salmon, but it possibly supports trout fry, juveniles and adults. Electric fishing surveys of the burn confirmed the presence of trout with fry (0+) being identified. No other species were found, though suitable habitat was present for lamprey, minnows and stickleback.

3.2.46 The reach of Gairn Burn that was assessed was found to have moderate flow with a cobble and pebble substrate providing fish refuges. The HABSCORE output indicated that the burn was unlikely to support salmon or trout fry, though it was likely to support trout juveniles and adults. Electric fishing surveys of the burn confirmed the presence of trout with fry (0+) being identified. No other species were found, though suitable habitat for lamprey, minnows and stickleback was present.

Table 15 – Likelihood of the Presence of Salmon and Trout Age Classes Based on HABSCORE and Electric Fishing Results. Key: 0+ = fry, >0+ , 1+ and 2+ = parr, >3+ adult.

Section	Watercourse	Code	Salmon				Trout			
			Likely	Possibly	Unlikely	EF Results	Likely	Possibly	Unlikely	EF Results
SL2	Burnhead Burn	BUR	-	-	✓	No fish	0+ <2+	>3+	-	No fish
SL3	Blaikiewell Burn	BLA	-	-	✓	None	0+ <2+ >3+		-	0+ 1+ 2+
SL3	Crynoch Burn (US)	CRYA	>0+	-	0+	Not sampled	<2+	>3+	0+	Not sampled
SL3	Crynoch Burn (DS)	CRYB	0+ >0+	-	-	Not sampled	0+	<2+ >3+	-	Not sampled
SL3	Kingcausie	KIN	-	-	✓	Not sampled	0+	<2+ >3+	-	Not sampled
SL3	River Dee	DEE	0+ >0+		-	Not sampled	0+	<2+ >3+	-	Not sampled
SL4	Bellenden Burn	BEL	-	-	✓	Not sampled	<2+ >3+		0+	Not sampled
SL5	Silver Burn	SIL	-	-	✓	None	-	0+ <2+ >3+	-	0+
SL5	Gairn Burn	GAIR	-	-	✓	None	<2+ >3+		0+	0+

4 Evaluation

4.1.1 In order to form evaluations of the ecological value of freshwater habitats in the study area, individual burns within each section that may potentially be affected by the scheme referred to as freshwater habitat areas. Each freshwater habitat area has been assessed for its ecological value to the receptor, with a final assessment of the ecological value of the section being made.

4.1.2 Overall, the watercourses surveyed within the study area ranged in ecological importance from international to local, with biological status ranging from excellent to impoverished. A summary of the evaluation of the watercourses in the study area is provided in Table 16.

4.2 Section SL1

4.2.1 Loirston Burn was assessed for habitat modification at two separate locations and was identified as severely and obviously modified. The burn was sampled for macroinvertebrates at one location and was classified as impoverished. The impoverished nature of the watercourse and the degree of modification has led to an evaluation of local value.

4.2.2 Bishopston Ditch was only assessed for river habitat survey, as it was not suitable for macroinvertebrate sampling. The ditch was identified as significantly modified straightened field drain, although it flows into Hare Moss and as such has been evaluated as county value.

4.2.3 Heathfield Burn was identified as too small for macroinvertebrate sampling and as such was only assessed for habitat modification. The burn was identified as significantly modified as it forms a straightened field drain. Heathfield Burn has been evaluated as being of local value.

4.2.4 Jameston Ditch was only assessed for macroinvertebrates, as it would not be crossed by the proposed scheme. This highly modified watercourse was assessed as possessing fair biological status and has been evaluated as being of local value.

4.2.5 The Burn of Ardoe was evaluated as being of county value. Although it is heavily modified, it was found to support healthy macroinvertebrate communities and provides habitat for otters and fish.

4.3 Section SL2

4.3.1 Cowford Burn was only assessed for macroinvertebrates, as it would not be directly crossed by the proposed scheme. This watercourse was assessed as being in good biological status. However, due to its small size and highly modified status, it was evaluated as being of local value.

4.3.2 Burnhead Burn was assessed for habitat modification at two locations and was found to be significantly and severely modified on both reaches. The burn was sampled for macroinvertebrates near its confluence with Blaikiewell Burn and was found to possess good biological status. The burn was also assessed using HABSCORE and was found to possibly support trout fry and parr, but not salmon. No fish were caught during electric fishing surveys. Despite the modified nature of this watercourse, the good biological conditions and possible presence of salmonids led to an evaluation of county value.

4.4 Section SL3

4.4.1 Whitestone Burn was only assessed for river habitat survey, as it was not considered suitable for macroinvertebrate sampling. This watercourse is a significantly modified straightened field drain and has been evaluated as local value.

4.4.2 Wedderhill Burn was not assessed for macroinvertebrates during 2006 as it was considered too small for sampling. Habitat modification surveys were undertaken which identified this watercourse as being severely modified. As such, the burn has been evaluated of less than local value.

4.4.3 Crynoch Burn was sampled for macroinvertebrates at two locations within the study area. The site furthest upstream was not assessed for habitat modification. Therefore, evaluations are based on the biological status of the watercourse and the presence/absence of salmonids. The burn was found to be in excellent status and likely to support salmon and trout. Crynoch Burn was evaluated as being of international value, as it falls within the River Dee SAC boundary. Further downstream, the burn was assessed using river habitat survey, macroinvertebrates and fish. The burn was identified as both significantly and obviously modified throughout the survey reach. This reach of Crynoch Burn was found to be in excellent biological status and likely to support salmon and trout. Despite the degree of modification, the burn has been evaluated as international value due to the excellent biological status, the presence of salmon and trout and the fact that the burn falls within the River Dee SAC.

4.4.4 Blaikiewell Burn was assessed as being obviously modified due to evidence of realignment. The burn was also identified as possessing excellent biological status and supports trout fry and parr. Therefore, Blaikiewell Burn was evaluated as being of regional value.

4.4.5 Kingcausie Burn was assessed as obviously modified as the upstream reaches are straightened field drains, although the watercourse returns to a more natural course downstream. The biological status of the burn was assessed as being fair, though it was found to support the notable weevil species *Litodactylus leucogaster*. The burn is considered likely to support all age classes of resident trout, but not salmon. Subsequently, the burn has been evaluated as being of regional value.

4.4.6 The River Dee was assessed as being both semi-natural and obviously modified within the river habitat survey reach. Macroinvertebrate sampling indicated that the river was of good biological status, supporting a diverse invertebrate assemblage. The River Dee supports all age classes of both salmon and trout. The river has been designated as a special area of conservation and as such has been evaluated as being of international value.

4.5 Section SL4

4.5.1 Milltimber Burn is significantly modified and was assessed as possessing fair biological status. The modified nature and biological status led to an evaluation of local value.

4.5.2 Alburn Burn was not assessed for habitat modification, as it would not be crossed by the proposed scheme. Therefore, the evaluation is based on the macroinvertebrate assemblage. The burn was found to be in good biological status and has been evaluated as being of county importance.

4.5.3 Bellenden Burn was found to possess good biological status and was also found to support the notable weevil *L. leucogaster*. The burn is also considered likely to support juvenile and adult trout, but no fry or salmon. The burn has been evaluated as being of county value.

4.5.4 Culter House Ditch was only assessed for habitat modification as the ditch was dry at the time of sampling. The ditch is severely modified with extensive re-sectioning and realignment and was evaluated as being of less than local importance.

4.6 Section SL5

4.6.1 Silver Burn was assessed for macroinvertebrates and fish and was identified as being of excellent biological status. The burn supports trout fry, though it is unlikely that it supports salmon due to barriers to migration. River habitat survey was not completed for this burn as it is not crossed by the proposed route. The evaluation is based on macroinvertebrates and fish and as such is evaluated as being of regional value.

4.6.2 Gairn Burn is a straightened land drain that was assessed for macroinvertebrates and identified as being of fair biological status. The burn supports trout fry, but it is unlikely to support salmon due to barriers to fish migration. Gairn Burn has been evaluated as being of county value.

4.6.3 Upper Beanshill Burn was only assessed for habitat modification as flow levels were too low to allow macroinvertebrate sampling. The burn is significantly modified and has been is evaluated as being of local value.

4.7 Section SL6

4.7.1 Westholme Burn and Borrowstone burn are located within the study area of this section but were not sampled due to the lack of suitable habitat. They are considered to be of local value only.

Table 16 – Watercourse Evaluation

Route Section	Watercourse	Ecological Habitat Area	Code	Size (km^2)	ASPT	Biological Classification	HMS	Habitat Classification	HABSCORE Salmon/Trout Presence	Electric Fishing Presence	Evaluation	Comment
Section SL1	Loirston Burn	S2, S4, S5, S6	LOR DS	0.66			48	Severely modified	n/a	n/a	Local	Straightened and dredged through plantation woodland.
			LOR		2.7	Impoverished			n/a	n/a		
			LOR US				20	Obviously modified	n/a	n/a		
	Bishopston Ditch	S13	BISHOP	n/a	n/a	n/a	24	Significantly modified	n/a	n/a	County	Although significantly modified, it flows into Hare Moss
	Heathfield Burn	S13	HEATH	n/a	n/a	n/a	32	Significantly modified	n/a	n/a	Local	Straightened field drain.
	Jameston Ditch	S10, S13	JAM	0.24	4.4	Fair	n/a	n/a	n/a	n/a	Local	None
	Burn of Ardoe	S10, S13	BOA	2.92	5.54	Good	60	Severely modified	n/a	n/a	County	Although severely modified this burn is still of County value as it is only a discrete section that is modified. The burn provides connectivity between the River Dee and Hare Moss, which is particularly valuable for otters.
Section SL2	Cowford Burn	S12, S13	COW	0.13	5.3	Good	n/a	n/a	n/a	n/a	Local	None
	Burnhead Burn	F26, S19	BURN	4.23	5.3	Good	42	Downstream: Significantly modified	Salmon – unlikely Trout - likely	No fish caught	County	None
							45	Upstream: Severely modified	n/a	n/a		None

Route Section	Watercourse	Ecological Habitat Area	Code	Size (km^2)	ASPT	Biological Classification	HMS	Habitat Classification	HABSCORE Salmon/Trout Presence	Electric Fishing Presence	Evaluation	Comment
Section SL3	Whitestone Burn	S19	STONE	n/a	n/a	n/a	44	Significantly modified	n/a	n/a	Local	None
	Crynoch Burn	F27, S18, S22	CRY A	22.16	6.9	Excellent	n/a	n/a	Salmon – parr likely Trout - likely	n/a	International	Part of the River Dee SAC and of excellent water quality.
			CRY B	28.82	6.3	Excellent	25	Upstream: Significantly modified	Salmon –likely Trout - likely	n/a	International	Part of River Dee SAC. Largely natural burn.
							19	Downstream: Obviously modified				
	Blaikiewell Burn	S22	BLA	4.51	6.3	Excellent	20	Obviously modified	Salmon – unlikely Trout - likely	Trout 0+, 1+, 2+	Regional	Realigned burn now returning to a more natural state.
	Kingcausie Burn	S20, S22, S24	KIN	1.56	4.8	Fair	20	Obviously modified	Salmon – unlikely Trout - likely	n/a	Regional	Despite the low biological classification the burn retains predominantly semi-natural features, with realignment in places. Also supports the notable b weevil *Litodactylus leucogaster*.
	River Dee	S28	DEE	20.45	5.7	Good	1	Upstream: Semi-natural	Salmon –likely Trout - likely	n/a	International	Part of River Dee SAC.
							12	Downstream: Obviously modified				
Section SL4	Milltimber Burn	S29	MILT	0.59	4.0	Fair	41	Significantly modified	n/a	n/a	Local	None
	Alburn Burn	S32	ALB	0.70	5.3	Good	n/a	n/a	n/a	n/a	County	None

Route Section	Watercourse	Ecological Habitat Area	Code	Size (km^2)	ASPT	Biological Classification	HMS	Habitat Classification	HABSCORE Salmon/Trout Presence	Electric Fishing Presence	Evaluation	Comment
	Bellenden Burn	S32, S33, S35, S36	BEL	0.08	5.4	Good	n/a	n/a	Salmon – unlikely Trout - likely	n/a	County	Supports the notable b weevil species *L. leucoagster*.
	Culter House Ditch (not shown on plans)	S32, S35, S36	CULT	n/a	n/a	n/a	45	Severely modified	n/a	n/a	Less than local	None
Section SL5	Silver Burn	S40, S41, S42, S44	SIL	0.20	7.4	Excellent		n/a	Salmon – unlikely Trout - possible	Trout 0+	Regional	On basis of excellent biological status
	Gairn Burn	S40, S42, S44	GAIR	0.82	4.9	Fair-Good		Significantly modified	Salmon – unlikely Trout - possible	Trout 0+	County	On basis of biological status
	Upper Beanshill Burn	S40, S42, S43	UBBO	n/a	n/a	n/a	33	Significantly modified	n/a	n/a	Local	None
Section SL6	Westholme Burn	S46	WHOLM	n/a	n/a	n/a		n/a	n/a	n/a	Local	None
	Borrowstone Burn	N1	Bor	n/a	n/a	n/a		n/a	n/a	n/a	Local	None

5 Potential Impacts

5.1 Introduction

5.1.1 This section describes the types of potential impacts that may affect freshwater communities. A summary of potential impacts that would result from the proposed scheme, in the absence of appropriate mitigation, is also provided.

5.1.2 Potential impacts on aquatic ecosystem health from construction and operation of the scheme may include:

- point source and/or diffuse organic/inorganic pollution;
- increased sediment loading and changes to sediment transport;
- introduction of suspended solids (also referred to as finely divided solids) into the water column;
- decrease in stream and bankside habitat complexity;
- habitat fragmentation;
- substantial changes to discharge regime;
- direct mortality; and
- disturbance.

5.1.3 Other impacts such as dust deposition, spread of alien species, changes to groundwater flow are addressed in the Terrestrial Habitats Report (Appendix A25.1) and Water Environment (Chapter 24).

5.1.4 It should be noted that the impacts associated with the operational phase of the scheme are considered to be permanent, whereas temporary impacts, which are only apparent while the road is being built, are discussed in association with the construction phase.

5.1.5 In general, direct impacts are where the impacts of the proposed scheme would result in a direct change to the status of an ecological receptor, during construction or operation. Indirect effects of the proposed scheme generally relate to secondary effects.

5.2 General

Point Source and/or Diffuse Organic/Inorganic Pollution

5.2.1 During construction of the proposed scheme, there is potential for accidental pollution release to adjacent waterways including oil and fuel from plant, liquid concrete, uncontrolled sewage release and fine sediment release. The effect of any given pollutant is likely to have greater impacts in smaller watercourses that have lower dilution.

5.2.2 Oils, fuels and chemicals can enter watercourses via accidental spillage from storage tanks or leakage from mobile or stationary plant. Oils can form a film on the water surface resulting in an adverse effect on water quality. These oils can interfere with the gills of invertebrates and fish and inorganic pollutants may have a lethal effect on aquatic flora and fauna.

5.2.3 Concrete, cement and admixtures could be released to watercourses through accidental spills or from the washings of plant and machinery. Concrete and cement are highly alkaline and may adversely affect aquatic organisms if the pH is elevated to or maintained above 8.5.

5.2.4 Accidental/uncontrolled release of sewage could result from damage to pipelines during service diversion. Release of sewage to watercourses would result in organic loading and could lead to increased biological oxygen demand and decreases in dissolved oxygen.

5.2.5 Without mitigation in place, operation of the proposed scheme could potentially impact adjacent watercourses through polluted road runoff (inorganic) and accidental spills (inorganic and organic).

5.2.6 Road runoff and some accidental spills from traffic using the new road are likely to raise levels of inorganic pollution entering the watercourses and lead to decreased macroinvertebrate species richness. As stated above inorganic point source pollution leads to the loss of pollution sensitive/rare species and ultimately leads to fish kills if toxicity reaches lethal levels.

5.2.7 Accidental spills of organic pollution (e.g. from a milk tanker crash) are likely to lead to decreased macroinvertebrate species richness and the increased abundance and dominance of a few pollution-tolerant species in the short term. For localised events impacts are less likely to permanently affect the faunal assemblage as macroinvertebrates are able to drift away from pollution hotspots. Increased organic pollution can also lead to nuisance plant growth and increased biological activity as organic material is broken down. Increased biological activity causes increased biological demand and results in decreased dissolved oxygen, which can potentially lead to fish kills.

5.2.8 The European Inland Fisheries Advisory Commission (EIFAC) conducted a series of reviews on the effects of water pollutants on fish and established standards and guidelines that have been adopted by the European Commission. These refer to two levels of water quality, one (more stringent) pertaining to waters containing salmonid fisheries, the other to waters containing only cyprinid fisheries.

5.2.9 Water quality standards for salmonids, based on the EIFAC water quality criteria, are covered under the Surface Waters (Fishlife) (Classification) (Scotland) Regulations 1997 (Table 17). These Regulations, however, make no mention of total suspended solids and therefore there are no universal regulatory standards for total suspended solids in Scotland.

Table 17 – Summary of Surface Waters (Fishlife) (Classification) (Scotland) Regulations 1997

Parameter	Requirements for Salmonid Waters	Methods of Analysis	Minimum Sampling Frequency	Observations
Temperature (°C)	21.5 for 98% of the time	Thermometry	Weekly	Over-sudden variations in temperature must be avoided
pH	6 to 9	Electrometry calibration using two known standards	Monthly	N/A
Dissolved oxygen (mg/l O_2)	50% ≥ 9	Winkler's method or specific electrodes	Monthly	Twice per day where major daily variations are expected

Increased Sediment Loading and Changes to Sediment Transport

5.2.10 During construction increased sediment loading to adjacent watercourses could occur in the absence of suitable mitigation. Suspended solids can result from excavations, runoff from stockpiles, plant and wheel washing, runoff from site roads, runoff during embankment construction, earthworks and landscaping. The risk of release of suspended solids into watercourses or drainage ditches is greatest at road crossings where earthworks will be involved in the construction of culverts, bridges and river diversions. Changes in water velocities resulting

from temporary stream diversions during construction are also predicted to affect sediment transport.

5.2.11 Sediments can cause damage to aquatic invertebrates and fish through deposition resulting in a smothering effect, reducing microhabitat availability or by interference with feeding and respiratory apparatus. This is of critical importance for freshwater pearl mussels in the River Dee. This species is reported to have a specific suspended solids tolerance of around 25 mg/L (Cosgrove et al, 2000) that cannot be exceeded for long periods without deleterious effects on the mussels. Similarly, salmonids, on which the freshwater pearl mussels rely for their dispersal, also have a suspended solids tolerance of around 30mg/L. Alabaster and Lloyd (1982) summarise that long-term levels of suspended sediment below 25mg/L will have no harmful effects on fish. Levels of 25-80mg/L^{-1} are acceptable as a rule of thumb, levels of 80-400mg/L are unlikely to support good fisheries and levels over 400mg/L generally will not support substantial fish populations (refer to Table 18).

5.2.12 Suspended solids may also contain contaminants that can result in pollution of the receiving watercourse. Sediment smothering can also reduce light availability for aquatic plants which can lead to die back and in turn increase organic loading and its associated impacts including lowered levels of dissolved oxygen. Increased turbidity can hamper predatory macroinvertebrates' search for prey. Additionally, increased turbidity as sediment is entrained in the water column and can lead to decreased dissolved oxygen (DO) levels.

5.2.13 During operation increased sediment loading could result from road runoff, particularly during and following heavy rain when road drainage systems may not function optimally. In addition, the proposed scheme may result in a substantial change to the discharge regime (see below) and this could permanently alter the sediment transport and geomorphological character of some of the watercourses (see Fluvial Geomorphology Appendix A24.3). This could indirectly impact on aquatic organisms specifically adapted to microhabitats that may be lost through changes in sediment dynamics. For example increased scour may adversely affect a caddis fly species which relies on fine sand to build its case or an area may become unsuitable for salmon egg laying.

Suspended Solids

5.2.14 Alabaster and Lloyd (1982) list four ways in which excessive levels of sediment (also referred to as Finely Divided Solids) can be harmful to fish:

- act directly on the fish and either killing them, reducing their growth or resistance to disease;
- prevent the successful development of fish eggs and larvae;
- modify natural movements and migrations of fish; and
- reduce the abundance of food available to the fish.

5.2.15 Fish show varying tolerances to suspended solids according to species. Although exposure to several thousand mg/l may not kill fish during hours or days of exposure (Alabaster and Lloyd, 1982), exposure to a very high suspended solids load for extended periods can be fatal.

5.2.16 Alabaster and Lloyd (1982) summarise that levels of total suspended solids below 25mg l^{-1} will have no harmful effects on fish. Levels of 25-80mg l^{-1} are acceptable as a rule of thumb, 80-400mg l^{-1} are unlikely to support good fisheries and levels over 400mg l^{-1} generally will not support substantial fish populations (see Table 18).

Table 18 – Summary of Effects of Finely Divided Solids (Total Suspended Solids) on Fish and their Habitat (Alabaster and Lloyd, 1982)

FDS (Mg/l)	Risk to Fish and their Habitat
0	No risk
<25	No harmful effects
25-80	Generally acceptable
80--400	Unlikely to support good fisheries
>400	Not compatible with substantial fish populations

5.2.17 Sediment released during the construction phase could settle over river bed gravels, killing invertebrates, fish eggs and alevins. Accumulations of fine sediments could also make habitats unsuitable for fish spawning. This could represent a high adverse impact on the population at sites downstream of the works.

5.2.18 The impact of accidental spillages during the construction phase will depend on a wide range of variables including the nature and volume of the chemical and the volume of the receiving water (the dilution factor). Consequently, the magnitude of impact on sites downstream of the works could vary from low to high adverse but is likely to decline with increasing distance from source. It is likely to be the smallest tributaries that could be impacted most heavily. Large volume drains with a high pollutant load adjoining small burns could have a high adverse impact on the burn downstream of the inflow. Chemical spillages during the key fish migration period could prevent or delay migration beyond that point, potentially having a high adverse impact on the population. This could also constitute an offence under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003.

5.2.19 As lamprey ammocoetes spend a period of five or more years buried in river bed sediments feeding on detritus, they could be particularly sensitive to an accumulation of pollutants during the operation phase, which could have a high adverse impact at localised sites downstream of the crossing points.

5.2.20 During operation, a major accident (fuel tanker, milk tanker, etc.) close to one of the water crossings could result in a large scale runoff of toxic chemicals into the waterway. Depending on the nature of the release, the dilution factor and the timing of the event this could constitute a high adverse impact on all species exposed.

Decrease in Stream and Bank Side Habitat Complexity

5.2.21 Construction of the proposed scheme would involve over 40 watercourse crossings and at each of these crossing points there would be a degree of habitat simplification/modification. This would occur as a result of activities associated with the installation of road crossings such as culverting, channel straightening, bank reinforcement or reprofiling, realignment, over deepening and clearing of riparian zone. These activities have the potential to reduce habitat and food availability for aquatic species, in turn leading to decreases in species richness and mortality.

5.2.22 As the road is likely to be at least 30m wide (wider in the embanked sections), each watercourse that requires the installation of a culvert must be straightened across at least the length of the culvert, which would result in the loss of riparian habitat, reduced channel sinuosity and decreased flow heterogeneity. The realignment of watercourses during this construction phase would also result in reaches being straightened and loss of riparian habitat. Realignments can also reduce the total channel length leading to changes in discharge regime and sediment transport (see below), which may in turn simplify in-stream and marginal habitat characteristics and lead to increased erosion and flooding.

5.2.23 Operation of the proposed scheme includes maintenance of the road and verges that could potentially impact on riparian zone habitat complexity through bank mowing. Also, the spread of exotic species such as Japanese Knotweed could result in simplification of riparian habitat.

Habitat Fragmentation

5.2.24 Habitat fragmentation in watercourses usually involves some kind of physical barrier, which can stop free movement of fauna. Culverts under duel carriageway roads typically constitute long straightened reaches of smooth substrate with no in-stream or bankside habitat complexity and associated food resources and may also result in changes in slope and faster flow conditions. Without appropriate design, these structures could pose a barrier to fish, otter and invertebrate movement.

5.2.25 In addition to culverts, the creation of new realigned channels can also cause habitat fragmentation by reducing channel sinuosity and potentially changing the discharge regime. This may stop or hamper the movement of fauna that require specific flow conditions to migrate up or down watercourses. Temporary diversion channels that would be created as an alternative route while the stream is being realigned and culvert constructed would result in temporary fragmentation of habitat.

5.2.26 Habitat fragmentation is particularly relevant to salmonid fish (i.e. salmon and trout), which need to migrate upstream to breed. The migration of fish may be hindered or prevented through the formation of a physical barrier, a psychological barrier or by significantly increasing water velocities or reducing water depth. In the case of the River Dee and its tributaries this is of critical importance to Freshwater Pearl Mussels, which rely on salmonids during their parasitic life stage when immature mussels (glochidia) attach to the gills to disperse to suitable habitats for recruitment.

5.2.27 Operation of the proposed scheme is unlikely to result in any additional habitat fragmentation impacts other than the chance that culverts may become blocked if not properly maintained, particularly following periods of heavy rain, which may result in severance between upstream and downstream habitat.

Substantial Changes to Discharge Regime

5.2.28 The proposed construction works will alter the slope of the surrounding land and slightly increase the local amount of impermeable surface through the construction of the road pavement, which is estimated as being approximately 1.5 km^2 across the whole scheme including junctions but not including embankments and road drainage infrastructure (total area of 4.2 km^2). This has the potential to increase the total discharge via runoff to the watercourses, possibly constituting an adverse impact on the aquatic ecosystem. The installation of culverts and the realignment of watercourses can also substantially alter the discharge regime through changes in slope and channel sinuosity, affecting water velocities and discharge volumes. The detention ponds that would collect road drainage will be designed to avoid changes to the natural discharge regime of watercourses.

5.2.29 Changes to the discharge regimes of watercourses have the potential to lead to substantial changes in local habitat, food availability and water quality. Substantial reductions in flow levels can severely affect flow-reliant species and those sensitive to decreases in dissolved oxygen. Increased flows to watercourses has the potential to adversely affect species reliant on slow flow areas such as pools and marginal dead water for feeding and resting (i.e. migratory fish). There is potential for microhabitat simplification due to scouring and increased flood frequency which can also reduce the number of species able to survive in a variable discharge environment.

Direct Mortality

5.2.30 The installation of culverts at proposed road crossing points would require the dewatering and mechanical excavation of sections of watercourses. These activities have the potential to result in local mortalities, which would be an impact during construction and operation if the fish are not moved to the temporary diversion channel beforehand. Were salmon or sea trout to be present at a given crossing point, impacts on these species could constitute an offence under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Fish eggs cannot easily be moved and could be lost from the dewatered area, resulting in a high adverse impact locally. It is possible that noise and vibration from construction works during the sensitive stages of salmonid egg incubation could result in damage to eggs close to the source of the vibration. This would have a high adverse impact locally but only a low adverse impact on the population as a whole. Unless appropriately managed, these activities could also constitute an offence under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003.

Disturbance

5.2.31 Fish are sensitive to a number of disturbances including sound pressure, vibration and light, with the degree of sensitivity varying between species and lifestage. The potential for disturbance to some species and lifestages during the construction phase is high. Resident fish, some of which are territorial, are likely to leave the area adjacent to the works and will need to find new territories, resulting in increased competition elsewhere. Without appropriate mitigation, this disturbance would represent a high adverse impact on resident fish within the affected area.

5.3 Specific Impacts

5.3.1 This section assesses the potential site specific impacts that would be likely to affect the freshwater environment during both construction and operation of the proposed scheme. The impacts are summarised in Table 19. The general impacts discussed above will apply to all relevant watercourses during construction.

5.3.2 In section SL1, the creation of two new culverts along Loirston Burn and the expansion of two existing culverts would increase the existing habitat fragmentation and decrease the currently restricted habitat complexity of the burn. The burn would receive water from detention ponds that are designed to trap the majority of particulate pollutants from road runoff. These two factors combined mean that the ecological quality of the Loirston Burn and the aquatic habitat it offers would be reduced.

5.3.3 No culverting of the Jameston Ditch is proposed, however, road runoff would be discharged to the ditch via an outfall from the detention basins. This may have localised impacts upon water quality and flow, may also result in a positive change in terms of the diversity of species assemblages that the watercourse can support as flow is currently very slow in the ditch. However, beneficial impacts would only occur if the road runoff was treated prior to being discharged to the ditch.

5.3.4 The culverting of Bishopston Ditch, Heathfield Burn and the Burn of Ardoe would lead to localised reductions in habitat complexity and therefore changes to localised species distributions, but these effects are likely to be restricted to the lengths of the culverts. No realignment of these burns is proposed and none of these watercourses is expected to receive road drainage.

5.3.5 In SL2, Burnhead Burn would be adversely affected by the proposed culvert, which would result in habitat loss and simplification. This has the potential to affect macroinvertebrate and fish species in the burn as well as downstream in Blaikiewell and Crynoch Burns. Any potential risk to Crynoch Burn is of particular concern as it is part of the River Dee SAC. Increased sediment levels may adversely affect egg and juvenile stages of the Atlantic salmon life cycle, one of the qualifying

species of the SAC. The discharge of road runoff would also have the potential to affect water quality in the burn.

5.3.6 In SL3, the construction of a buried structure over Blaikiewell Burn has the potential to release sediment and other pollutants into the burn. As Crynoch Burn is located downstream, it may be indirectly affected. Once constructed, the shaded reach underneath the structure has the potential to reduce aquatic and riparian habitat complexity, altering the species distributions in the burn.

5.3.7 The realignment of Kingcausie Burn would result in extensive habitat loss and simplification of habitat in the newly-created channel, with the loss of resident macroinvertebrate (including the notable weevil species *Litodactylus leucogaster*) and fish populations. The proposed activities have the potential to alter the sediment and discharge regime of Kingcausie Burn as a whole, which could result in increased sediment loads, adversely affecting habitat suitability for macroinvertebrates and fish. The effective implementation of appropriate mitigation and monitoring would be required to ensure that sediment is not transported downstream. These impacts may also indirectly affect Crynoch Burn, which is downstream.

5.3.8 Noise and vibration associated with the activities required to construct the proposed crossing over the River Dee may pose a small risk to salmonid eggs and the migratory adults although the sensitive scheduling of works will minimise potential impacts on salmon movements along the River Dee during construction of the proposed bridge. The potential risk of sediment release associated with the construction of the bridge crossing over the River Dee has been modelled and the results are provided in Appendix A24.6.

5.3.9 In SL4, the culvert that would be constructed on Milltimber Burn would reduce habitat complexity and alter the distribution of macroinvertebrate and fish species in the burn on a local scale. The release of sediment and other pollutants during construction may also have a temporary impact upon downstream habitats and species. This is of particular concern due to the proximity of the River Dee SAC.

5.3.10 Impacts on Gairn Burn, in SL5, would occur as a result of the creation of two relatively short culverts, associated realignments and the receipt of road drainage. Culverting of this burn would lead to a reduction in habitat complexity for the extent of the culverts, although this is not expected to lead to fragmentation of populations. Realignment of the burn has the potential to release quantities of sediment and other pollutants into the burn, leading to reduced habitat suitability in at least the short-term.

5.3.11 No watercourses in SL6 would be affected by the scheme.

Table 19 Potential Impacts on Watercourses

Section and Ecological Value	Water-course	Watercourse Ecological Value	Crossing	Realignment	To Receive Road Discharge	Habitat Area Lost square metres	Impact Description	Magnitude	Impact Significance
SL 1	Loirston Burn LOIR	Local	Four culverts; one of 34m at ch205580, , one of 16m at ch340, one of 47m at ch790, and one of 45m at ch207030	No realignment of burn	Yes		Construction: Amendments to two existing culverts and the creation of two new culverts in the existing straightened channel would involve earthworks. This would result in sediment and/or other pollution release and short-medium term slight decrease in bankside and in-stream habitat complexity. Operation: Long-term slightly decreased habitat complexity for culverted section which may lead to habitat fragmentation for any mobile species and localised changes to species distributions. Discharge of road runoff may adversely affect water quality in the burn.	Low negative	Minor
SL 1	Bishopston Ditch BISHOP	County	55m long culvert at ch203900	No realignment of burn	n/a		Construction: Culverting of existing channel would involve some earthworks, resulting in sediment and/or other pollution release. A short-term localised decrease in bankside and in-stream habitat complexity would also occur. Operation: There would be a slight localised impact upon habitat complexity within the 55m length of culvert. This may also lead to localised changes in species distribution.	Negligible	Negligible
SL 1	Heathfield Burn HEATH	Local	46m long culvert at ch203650	No realignment of burn	n/a		Construction: Culverting of existing channel would involve some earthworks, possibly resulting in sediment and/or other pollution release. A short-term localised decrease in bankside and in-stream habitat complexity would also occur.	Negligible	Negligible

Section and Ecological Value	Water-course	Watercourse Ecological Value	Crossing	Realignment	To Receive Road Discharge	Habitat Area Lost square metres	Impact Description	Magnitude	Impact Significance
							Operation: There would be a slight localised impact upon habitat complexity within the length of culvert, which may also lead to localised changes in species distribution.		
SL 1	Jameston Ditch JAM	Local	n/a	n/a	Yes		Construction: n/a Operation: There would be change to water quality and flow as a result of receiving road runoff. The additional flow may positively alter the species assemblages and habitat complexity.	Positive	Minor (positive)
SL 1	Burn of Ardoe BOA	County	59m long culvert at ch204020	No realignment of burn	N/a		Construction: Culverting of existing channel would involve earthworks, resulting in sediment and/or other pollution release. A short-term localised decrease in bankside and in-stream habitat complexity would also occur. Operation: There would be a slight localised impact upon habitat complexity within the length of culvert, which may also lead to localised changes in species distribution.	Negligible	Negligible
SL 2	Burnhead Burn BURN	County	65m long culvert at ch200100	No realignment of burn	Yes		Construction: Culverting of existing channel would involve some earthworks, resulting in sediment and/or other pollution release. This is a particular concern due to its proximity to Blaikiewell Burn (and further downstream, Crynoch Burn). A short-term localised decrease in bankside and in-stream habitat complexity would also occur.	Medium negative	Moderate

Section and Ecological Value	Water-course	Watercourse Ecological Value	Crossing	Realignment	To Receive Road Discharge	Habitat Area Lost square metres	Impact Description	Magnitude	Impact Significance
							Operation: There would be a slight localised impact upon habitat complexity within the length of culvert, which may also lead to localised changes in species distribution. Discharged road runoff has the potential to alter the water quality within the burn with subsequent impacts upon species assemblages		
SL 2	Whitestone Burn STONE	Local	51m long culvert at ch200990	No realignment of burn	n/a		Construction: This is an ephemeral channel and as such culvert construction impacts would be restricted to periods of water flow within the watercourse. Potential impacts include sediment and/or other pollution release. There would be a short-term decrease in bankside and in-stream habitat complexity.	Negligible	Negligible
							Operation: There would be a slight localised impact upon habitat complexity within the length of culvert, which may also lead to localised changes in species distribution.		
SL3	Blaikiewell Burn BLA	Regional	Buried structure of 45m at ch100150	No realignment	n/a		Construction: Bridging of existing channel would involve earthworks, resulting in sediment and/or other pollution release. This is of particular concern due to its proximity to Crynoch Burn. A short-term localised decrease in bankside and in-stream habitat complexity would also occur.	Medium negative	Moderate
							Operation: There would be a slight localised impact on habitat complexity and species distribution under the buried structure as a result of shading,		

Section and Ecological Value	Water-course	Watercourse Ecological Value	Crossing	Realignment	To Receive Road Discharge	Habitat Area Lost square metres	Impact Description	Magnitude	Impact Significance
SL3	Kingcausie KIN	Regional	47m long culvert at ch 101470	Realigned length of 404m resulting in shortening of the burn by 37m	n/a		Construction: Culverting and realignment of existing semi-natural channel would involve earthworks, resulting in sediment and/or other pollution release. This is a particular concern due to its proximity to Crynoch Burn. Permanent loss of bankside and in-stream habitat would occur. This is of particular note for the population of notable weevil species, *Litodactylus leucogaster*.	High negative	Major
							Operation: Permanent loss of habitat and species assemblages from 404m of realigned section and significant habitat fragmentation. There would be a localised impact upon habitat complexity within the length of culvert, which would lead to localised changes in species distribution.		
SL3	River Dee DEE	International	3 span viaduct bridge of 120m at ch102000	n/a	Yes		Construction: Bridge construction and installation of outfall would involve earthworks that would result in sediment and other pollution release into the River Dee, without mitigation. Sediment release has the potential to directly affect salmonid spawning areas through the smothering of eggs in the river gravels. There may also be the potential for noise and vibration issues associated with piling activities which may affect migratory fish such as salmon.	Medium negative	Major
							Operation: Night-time lighting of the bridge may result in behavioural changes of migratory salmonids. The road bridge may result in shading of the river resulting in small localised changes in species distributions. Discharged road runoff would have a localised impact on water quality, without mitigation.		

Section and Ecological Value	Water-course	Watercourse Ecological Value	Crossing	Realignment	To Receive Road Discharge	Habitat Area Lost square metres	Impact Description	Magnitude	Impact Significance
SL4	Milltimber Burn MILT	Local	77m long culvert at ch102670	n/a	n/a		Construction: Culverting of existing channel would involve earthworks, resulting in sediment and/or other pollution release as well as short-term decrease in bankside and in-stream habitat complexity. This is of particular note due to its proximity to the River Dee SAC.	Medium negative	Minor
							Operation: There would be a slight localised impact upon habitat complexity within the length of culvert, which may also lead to localised changes in species distribution.		
SL 4	Culter House Ditch CULT	Less than local	n/a	All pre-earthworks	n/a		Construction: The upper section of the existing watercourse would be permanently lost during construction. There is the potential for sediment release during construction.	Negligible	Negligible
							Operation: The habitat that would be available in the remainder of the channel would be similar to current conditions as an ephemeral drainage ditch.		
SL 5	Gairn Burn GAIR	County	Two culverts, one of 12m at ch163 and one of 8m on pond access road	Realigned length of 163m resulting in shortening of burn by 13m	Yes		Construction: Culverting and realignment of existing channel would involve earthworks, resulting in sediment and/or other pollution release. This would decrease bankside and in-stream habitat complexity in the short-term and reduce habitat suitability in the short-term for some resident species.	Low negative	Minor
							Operation: There would be a slight localised impact upon habitat complexity within the length of culvert, which may also lead to localised changes in species distribution. Some localised impact on water quality may arise from the receiving road runoff.		

Section and Ecological Value	Water-course	Watercourse Ecological Value	Crossing	Realignment	To Receive Road Discharge	Habitat Area Lost square metres	Impact Description	Magnitude	Impact Significance
	Upper Beanshill Burn UBBO	Local	Taken into pre-earthworks	n/a	n/a		Construction: Some sediment or pollution release may occur during the construction of the underbridge. Temporary decreases to the suitability of habitat would occurt.	Negligible	Negligible
	Westholme Burn	Local	n/a	n/a	Yes		Construction: n/a Operation: Road runoff would decrease the water quality of the burn but the small increase in flow may enhance the habitat available within the watercourse.	Positive	Minor (positive)

6 Mitigation

6.1 Introduction

6.1.1 This section describes the mitigation proposed to address the potential impacts that have been identified in Section 5. Generic mitigation measures will be implemented throughout the areas affected by the proposed scheme. Additional site specific mitigation measures are proposed where impacts of Moderate or above magnitude are predicted.

6.1.2 As outlined in the EIA (Scotland) Regulations 1999, mitigation measures are intended "to prevent, reduce or where possible, offset any significant adverse impacts on the existing ecology and nature and conservation value of the surrounding area." The Nature Conservation (Scotland) Act 2004 has added the requirement for the Scottish Executive to enhance biodiversity as part of any development by having regard to the Rio Convention and the Scottish Biodiversity strategy.

6.1.3 The Water Framework Directive has also been taken into account in the formulation of mitigation strategies. In particular its aim for all watercourses to gain 'good' ecological status and its requirement that there must be no deterioration in ecological status of any watercourse. It should also be noted that mitigation details will be further developed in consultation with SEPA during the licensing process under the terms of the Controlled Activities Regulations (CAR) 2005.

6.2 Mitigation and Scheme Design

6.2.1 The development of mitigation to avoid or reduce impacts on aquatic communities has been a continuous process during scheme design. In particular, the development of major design components such as road drainage, locations of bridges and culverts, as well as watercourse realignment details, have been though an iterative design process involving structural engineers, geomorphologists, ecologists and water quality specialists.

6.2.2 Consultation with SEPA and SNH to seek guidance on appropriate levels of road drainage, culverting and watercourse realignment has been ongoing throughout the design and EIA process.

Road Drainage

6.2.3 The main mitigation strategy for protection of the aquatic environment during operation of the scheme is the provision of the road drainage system, which is designed to substantially reduce polluted road runoff entering local watercourses. The road drainage system will also minimise the risk of accidental spills, in most cases avoiding this potential impact entirely. Road drainage is designed in accordance with the principles contained in the Sustainable Urban Drainage Systems (SUDS): Design Manual for Scotland and Northern Ireland (CIRIA C521 and CIRIA C609). Details of the proposed road drainage are provided in Chapter 24 (Water Environment). SUDS techniques to be implemented to avoid and reduce potential impacts during normal road operation include the following:

- filter drains and catchpits along the entire road;
- attenuation basins and treatment ponds to treat all road runoff;
- swales; and
- the provision of scour protection at the drainage discharge outfall.

6.2.4 The removal efficiencies of the various treatment systems are given in Appendix A24.4 (Water Quality). For common road runoff contaminants zinc, copper, iron, lead, suspended solids and hydrocarbons removal efficiencies are generally around 70-90%. In addition, the proposed road drainage is predicted to reduce the risk of spillage causing pollution by 65% (DMRB, 1998; CIRIA

C609, 2004).

Bridges and Culverts

6.2.5 The buried structure proposed for Blaikiewell Burn and the bridge crossing for the River Dee have been designed to entirely span the watercourse at the crossing point. No piers will be located in the channel and there will be no need for in-channel works as part of construction of the crossing structures. The structures will reduce damage to the surrounding riparian zone, with abutements set back from the edge of the water. Viaduct options are generally preferred over the construction of large embankments on floodplains.

6.2.6 Specific activities (such as piling) resulting in particular disturbances (such as noise and vibration) will be avoided during sensitive periods for fish (e.g. the first third of salmonid egg incubation – see Table 2). This will apply to all watercourses where salmonids may be present (see Tables 15 and 16). Any works that have the potential to generate high levels of noise (e.g. piling) will be initiated using a soft start approach, allowing sensitive animals to move away from the sound source prior to the noise reaching peak volumes. Night working will be avoided, allowing a quiet period for migratory fish to pass the construction site. Lights on the construction sites will be directed away from the water.

Culvert Design

6.2.7 Culverts have been designed following guidance from Scottish Executive on culverts and migratory fish (SEERAD, 2000) to prevent habitat fragmentation and reduce the loss of habitat complexity. This will reduce impacts in watercourses with notable species such as the notable weevil species *Litodactylus leucogaster*, found within Kingcausie Burn and Bellenden Burn. Depressed invert culverts will be installed with the base of the structure set below bed level to allow natural substrate to be used within the culvert, thus providing in-stream habitat diversity. Initially, substrate in the culvert will comprise imported material of a similar size to that of the original channel, which will be specified to ensure that the sediment does not wash out at times of high flow or silt up in times of low flow. More information is provided in Appendix A24.3 (Fluvial Geomorphology Report). During the operation of the road, natural substrate is also likely to accumulate in the culvert. Depressed invert culverts will be installed to convey the majority of the watercourses that would be crossed by the road under the scheme.

6.2.8 All culverts have been designed to accommodate a 1:200 year flood and to allow 30mm additional headroom for out-of-water mammal passage. Gradients will not differ markedly from existing conditions to avoid excessive siltation or erosion. Guidelines in SEERAD (2000) have been followed to ensure that flow conditions allow for the passage of migratory fish.

Watercourse Realignments

6.2.9 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. Details of realignment requirements are given in Chapter 24 (Water Environment). The following broad principles have been applied during the design of watercourse realignments:

- reduce crossing (culvert) lengths and associated long term habitat loss and fragmentation by allowing the watercourse to cross the mainline AWPR at 90 degrees;
- 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; and

- maximise habitat creation potential through the inclusion of meander bends, secondary channels, riparian zones, backwaters and oxbow lakes where appropriate.

6.3 Construction Mitigation

Adherence to Best Practice near watercourses

6.3.1 Avoidance and reduction of construction impacts on watercourses throughout the scheme will be achieved by:

- minimising the duration and spatial extent of works in the vicinity of watercourses;
- the presence of an appropriately qualified Ecological Clerk of Works 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;
- where appropriate the installation of temporary treatment ponds to ensure minimum water quality standards throughout construction;
- inspection and maintenance of all erosion controls weekly and after heavy rainfall events;
- any abstractions from watercourses will be identified and quantified. Formal consent from SEPA will be sought for any abstractions from watercourses;
- location of site compounds away from watercourses and floodplains; and
- regulation of the storage of any materials on the floodplain or near tributaries to reduce risk of pollutants/fine sediment entering watercourses.

6.3.2 One of the key mitigation strategies during construction is avoiding pollution release to watercourses and reducing the resulting impacts if this occurs. The chief mechanism for this will be through best practice at site and adherence to the following Pollution Prevention Guidelines (PPG) published by SEPA:

- PPG01 General Guide to the Prevention of Water Pollution;
- PPG04 Disposal of Sewage Where No Mains Drainage is Available;
- PPG05 Works In, Near or Liable to Affect Watercourses;
- PPG06 Working at Construction and Demolition;
- PPG07 Refuelling Facilities;
- PPG08 Storage and Disposal of Used Oils;
- PPG10 Highways Depots;
- PPG13 High Pressure Water and Steam Cleaners;
- PPG18 Control of Spillages and Fire Fighting Runoff; and
- PPG21 Pollution Incident Response Planning.

6.3.3 In addition, to ameliorate potential impacts, mitigation described in Table 20 will be implemented. Further details are available in Chapter 24 (Water Environment).

Table 20 – Mitigation During Construction

Source of Impact	Mitigation
Suspended Solids	provide sediment fencing were appropriate; avoid positioning stockpiles near the channel bank; cover the stockpiles when not in use; contain the stockpiles with bunds or sediment fences; prior to construction, establish sediment removal features (attenuation basins/treatment ponds) to treat surface runoff. prohibit vehicle washing near watercourses; prohibit channel fording; wheel washing from mobile pressure washers will be conducted remote from watercourses; limit the use of temporary culverts; where possible, use temporary bridges rather than culverts to cross watercourses; connection of drains to watercourses only on completion; enforce exclusion zones between earthworks and watercourses; and minimisation of vegetation clearance on banks and surrounding riparian zone.
Oils, Fuels and Chemicals	provision of bunded areas with impervious walls and floor lining for the storage of fuel, oil and chemicals. Bunded areas will have a storage capacity of at least 110% that of the storage tanks; use pollutant removal features (attenuation basins/treatment ponds) to treat surface runoff. These features would be established and functional before construction commenced; and storage of fuel, oil and chemicals would not be on a watercourse floodplain.
Concrete, Cement and Admixtures	storing potential pollutants or undertaking potentially polluting activities (e.g. concrete batching and mixing) away from watercourses, ditches and surface water drains; and preventative measures such as scaffolding screens will ensure that in situ concrete will be placed accurately and concrete pumps will not discharge into local watercourses
Sewage	if service diversions are required, 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; and chemical toilets for the use on the construction site will be waterless and any waste would be dealt with following PPG 4.
Grouting	Cut-off ditches and settlement ponds will be constructed in the vicinity of the grouting activities to intercept the runoff. Sediment that has settled in such ponds will be transported off-site, if ponds become too full.

Diversion of Watercourses During Construction of Culverts

6.3.4 Diversion of watercourses represents considerable disturbance and habitat loss and fragmentation impacts which can be greatly reduced by following the simple procedures outlined below. Watercourses to be culverted will be diverted to a temporary channel during culvert construction. Temporary channels will be lined with geotextile in areas where the ground investigation has indicated that fine particles are present. Appropriately sized particles from the main channel will be used in the diversion channel to provide temporary habitat during works and to ensure the geotextile will not be washed away. Additionally the translocation of some of the main channel substrate will enable a proportion of the macroinvertebrate assemblage present in the substrate to survive the dewatering process. For many species this level of disturbance, while not likely to result in mortality, will trigger a drift response allowing macroinvertebrates to relocate to suitable habitats downstream of the crossing point.

6.3.5 Once the diversion channel is in place, water will be diverted at the upstream end of the channel. The main channel will then be bunded at the upstream and downstream ends and electric fished to remove any resident fish from the crossing point. The fish will be relocated downstream. Once all fish have been removed the downstream bund will be removed and water at the crossing point will be allowed to flow. An ecological clerk of works will be present during this process to ensure that all fish species have been removed from the dewatered channel. Dewatering or realignment will not be carried out during the spawning or egg incubation seasons (October to May inclusive for salmonids). Any fish translocation will be agreed in advance with the relevant DDSFB.

6.3.6 Where temporary diversions are to be created, e.g. during the installation of culverts, the same protocol for dewatering must be followed with the additional requirement that electric fishing is also carried out within the temporary diversion before the watercourse is returned to its original route.

Timing of Works

6.3.7 Potential impacts of the proposed scheme on freshwater species can be greatly reduced through the appropriate timing of works. Advice from SNH states that no in-channel works should be conducted on watercourses likely to support migratory fish between October 14th and May 31st. For day to day operation, avoiding work in the hours of darkness allows free fish, otter and bat movement along watercourses without disturbance. Works near a natal otter holt will not be permitted for three months from the birth of cubs (see Appendix A25.5: Otter Report). For all watercourses, works must be avoided during periods of low flow (i.e. $<Q_{95}$) to reduce the risk of a pollution event causing a dissolved oxygen sag, as this can lead to fish kills.

6.4 Operation Mitigation

Maintenance of Road Drainage Network

6.4.1 To avoid failure or sub-optimal operation of the road drainage network maintenance of its components is necessary. The following Pollution Prevention Guidelines will be adhered to throughout the operation of the proposed scheme:

- PPG01 General guide to the Prevention of Water Pollution;
- PPG09 Pesticides;
- PPG18 Control of Spillages and Fire Fighting Runoff;
- PPG21 Pollution Incident Response Planning; and
- PPG 22 Dealing with Spillages on Highways.

6.4.2 Detention basins will be periodically dredged and contaminated sediment removed from site. In addition, filter drains and catchpits will be regularly inspected and repaired, if necessary. Water quality monitoring downstream of key outflows will be undertaken to provide an early warning system for potential problems. Further details are provided in Chapter 24 (Water Environment).

Sedimentation/Erosion Monitoring

6.4.3 Although watercourse diversions and activities associated with the installation of culverts have been designed to minimise the risk of sedimentation and erosion, a monitoring program will be undertaken to provide an early warning system to flag any potential problems. This approach aims at reducing the risk of dramatic changes to the geomorphological character of watercourses that may lead to habitat loss or simplification. Details of the monitoring approach are provided in Appendix A24.3.

Riparian Zone Management

6.4.4 The creation and maintenance of a complex riparian zone will reduce the disturbance impact of the proposed scheme and is also aimed at offsetting impacts of habitat loss and fragmentation particularly associated with culverting. Riparian complexity provides cover for otters and bats; shade and bankside complexity for migratory fish and important allocthonous input for macroinvertebrate shredders. Riparian zone planting for watercourse realignments and as existing habitat enhancement has been described in Appendices A25.1 (Terrestrial Habitats) and A25.5 (Otter).

6.4.5 As part of the scheme maintenance schedule a riparian zone management plan will be developed to ensure that:

- channels do not become choked with vegetation;
- pest species such as Japanese knotweed do not establish; and
- riparian zone diversity is maintained.

6.4.6 If herbicides are used as part of the road maintenance program, those recommended by SEPA for use near watercourses are to be applied in line with the manufacturer's instructions.

7 Residual Impacts

7.1.1 Where mitigation measures are not completely effective in dealing with the source of potential adverse impacts, residual impacts may occur. The predicted residual impacts for watercourses that were assessed with potential impacts of Moderate or above (in Section 5) are presented in Table 21.

Direct Mortality

7.1.2 If spawning and egg incubation periods are avoided and resident fish are translocated before any de-watering or dredging operations, the magnitude of the local impact would be reduced to low negative and the overall impact would be negligible.

7.1.3 By avoiding sensitive periods, direct mortality from vibration during construction can be prevented, such that residual impacts on direct mortality are negligible, though behavioural impacts may be of minor significance.

Habitat Loss

7.1.4 The use of depressed invert culverts will reduce habitat fragmentation as a natural substrate will be retained throughout the structure. The buried structure across Blaikiewell Burn and the River Dee bridge crossing will allow the retention of the existing bed and channel structure and minimise habitat loss. Shading by structures could result in a negative impact on aquatic macroinvertebrate species assemblage at currently unshaded sites, potentially reducing food availability for fish. Overall, the impact is assessed as minor or negligible. Where more than one culvert would be installed on a watercourse, the residual impact is likely to be minor adverse with the potential for medium adverse where the watercourse and its ecology are sensitive to such disturbance.

Habitat Fragmentation and Isolation

7.1.5 The use of culverts containing natural substrates and/or single span bridges will avoid the creation of physical barriers or changes to water velocities. Culvert construction will avoid the sensitive periods for migratory fish species in relevant watercourses to avoid behavioural effects and delays in migration resulting in a minor or negligible impact on fish migration (depending upon the value of the watercourse for migratory species).

Disturbance

7.1.6 Avoidance of particular sources of disturbance during sensitive periods (e.g. spawning and the first one third of egg incubation) will result in a negligible impact.

7.1.7 As adult salmon are known to enter the River Dee system throughout much of the year, it may not be a practical approach to carry out all construction outside the migration period. Use of a soft start approach to any procedures likely to generate high noise / vibration levels will allow resident fish to

move away and reduce the impact but there is still potential for a slight residual impact magnitude on migrating adult salmon. This would result in an overall impact of minor significance.

Pollution and Other Indirect Impacts

7.1.8 Road drainage will be collected and treated using SUDS to minimise the risk of pollution during the operational phase, reducing the risk of accumulation of pollutants in silts. This would reduce the risk to species such as lamprey, resulting in a negligible impact.

7.1.9 The use of SUDS reduces the impact of a major accidental spillage, but some potential risk to fish populations would remain. This has been assessed as a residual impact of minor significance for the River Dee.

Table 21 – Residual Impacts

Watercourse & Evaluation	Crossing(s)	Realignment	Road Drainage	Impact Description	Impact Significance	Mitigation	Residual Impact Significance	
							Construction	Operation
Burnhead Burn County	65m long culvert at ch200100	No realignment of burn	Via detention ponds	Release of sediment or pollutants during culvert construction	Moderate	Use best practice during construction to protect water environment such as: minimise area of disturbance, implementation of erosion control measures, periodic monitoring of effectiveness of mitigation (refer to Chapter 24).	Minor	N/A
				Reduction in habitat complexity and alteration of species distribution		Depressed invert culverts with suitable replacement substrate to be installed.	N/A	Minor
Blaikiewell Burn Regional	Buried structure of 43m at ch100150	No realignment of burn	N/A	Release of sediment or pollutants during culvert construction	Moderate	Use best practice during construction to protect water environment such as: minimise area of disturbance, implementation of erosion control measures, periodic monitoring of effectiveness of mitigation (refer to Chapter 24).	Minor	N/A
				Reduction in habitat complexity and alteration of species distribution due to shading		Ensure substrate and habitat complexity is retained through minimising disturbance to habitat during construction.	N/A	Minor
Kingcausie Burn Regional	47m long culvert at ch101470	Realigned length of 404m resulting in shortening of the burn by 37m	N/A	Release of sediment or pollutants during culvert construction and realignment	Major	Use best practice during construction to protect water environment such as: minimise area of disturbance, implementation of erosion control measures, periodic monitoring of effectiveness of mitigation (refer to Chapter 24).	Minor	N/A
				Permanent loss of in-stream habitat and macroinvertebrate populations (e.g. notable weevil species *Litodactylus leucogaster*)		Create suitable habitat within, and transfer substrate to, the new realignment channel.	N/A	Minor
				Reduction in habitat complexity and alteration of species distribution due to culvert		Depressed invert culverts with suitable replacement substrate to be installed.	N/A	Minor

Watercourse & Evaluation	Crossing(s)	Realignment	Road Drainage	Impact Description	Impact Significance	Mitigation	Residual Impact Significance	
							Construction	Operation
River Dee International	3-span viaduct bridge of 120m at ch102000	N/A	Via detention ponds	Release of sediment or pollutants during bridge construction and creation of detention pond discharge	Major	Use best practice during construction to protect water environment such as: minimise area of disturbance, implementation of erosion control measures, periodic monitoring of effectiveness of mitigation (refer to Chapter 24).	Minor	Minor
				Noise and vibration issues associated with the bridge construction		Avoid sensitive periods of the salmonid life cycle (migration, spawning and egg incubation)	Minor	Minor
				Night-time lighting of the bridge may affect migratory fish behaviour		Ensure street lighting is directed away from the water surface	Minor	Minor

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