8 ROAD DRAINAGE AND THE WATER ENVIRONMENT

8.1 INTRODUCTION

This chapter describes the baseline aquatic environment, considers the potential impacts of the proposals, sets out mitigation measures and reports on the residual effects on surface and groundwaters. The nature conservation interests of watercourses are included in Chapter 9. The locations of water features are shown on Figure 8.1.

8.2 SOURCES OF INFORMATION

The sources of information for the assessment include:

- the previous Stage 2 and Stage 3 assessments;
- the 1:25 000 Ordnance Survey (OS) map, Loch Lomond North (Explorer 364).
- SEPA's Draft River Basin Management Plan (RBMP) GIS interactive map[93];
- SEPA's River Quality Classification Reports[94];
- site visits by the project team;
- information provided by the wider project team including a water features survey, a hydrogeological assessment, a flood risk assessment and calculations of pollution impacts, risks and spill risks;
- feedback from consultees; and
- Design Manual for Roads and Bridges, Volume 11, Part 10, HA 216/06 Road Drainage and the Water Environment.

8.3 CONSULTATIONS

The key stakeholders that were consulted are Scottish Environmental Protection Agency (SEPA), Scottish Water and Scottish Natural Heritage (SNH). Details of the consultations are included in Annex A. The main issues with respect to the water environment are as follows:

- any impacts on the River Tay SAC through the input of sediment and nutrients during construction and operation should be avoided (SNH, November 2007);
- an assessment of peak flows in the watercourses is required because any flood risk is likely to arise from improperly sized culverts. The estimated peak flows are to be taken into account at detailed design stage and further consultation with SEPA is required. The culverts would need to be deep enough for the stream to establish a natural bed and to avoid any steps or overhangs (SEPA, February 2008);
- No CAR licences are required for the scheme, however SEPA's General Binding Rules (GBR's)[95] and design best practices are to be followed (SEPA, July 2009);
- An underdrain below the detention basins and filter trench would provide an adequate third level of SUDS drainage[96] for the scheme (SEPA, July 2009);

[93] http://gis.sepa.org.uk/rbmp/MapViewer.aspx

[94] http://www.sepa.org.uk/scotlands_environment/data_and_reports/water/idoc.ashx?docid=f09338c7-6f52-4f25-916a-f335f101afd5&version=-1

[95] General Binding Rules (GBRs) represent the lowest level of control and cover specific low risk activities. Activities complying with the rules do not require an application to be made to SEPA, as compliance with a GBR is considered to be authorisation. Since the operator is not required to contact SEPA, there are no associated charges.

[96] The three levels of treatment are comprised of 1) filter drain adjacent to the carriageway; 2) detention basin or filter trench; and 3) an underdrain beneath the basins and the filter trench

- the inlet and outlet mains from Crianlarich Service Reservoir cross the existing A82 and head north into Crianlarich. These mains and the bulk meter which feeds Crianlarich could require to be diverted (Scottish Water, April 2007); and
- every effort must be made to reduce the risk of soil erosion and pollution from oils etc during and after the construction stage (Scottish Water, July 2007).

8.4 STATUTORY FRAMEWORK

The Water Environment and Water Services (Scotland) Act 2003 (WEWS) implemented the Water Framework Directive (WFD)[97] in Scotland and provides Ministers with the powers to make regulations to control activities which could affect the water environment. The Water Environment (Controlled Activities)(Scotland) Regulations 2005 (CAR) came into force on 1st April 2006. Regulation 4 of CAR defines the scope of SEPA's powers to authorise activities defined within section 20(3) of WEWS[98]. This includes abstractions, impoundments, building and engineering works, and activities liable to cause pollution.

SEPA's powers under CAR are defined under section 20(1) of WEWS as for the purpose of 'protecting the water environment'. SEPA considers that the WFD and WEWS Regulations require a wider view of the water environment, which should include the protection of uses of water and mitigating the risks of flooding. WEWS requires the authorisation of building or engineering works (other than impoundments) that are carried out in:

- wetlands, rivers and lochs; or
- in the vicinity of groundwater, wetlands, rivers and lochs and likely to have a significant adverse effect upon the water environment.

SEPA aims to focus proportionate controls over those aspects of building and engineering works which clearly pose an environmental risk. Controls would be applied over the engineering process as well as the indirect consequences which might follow from the engineering works.

8.5 BASELINE

8.5.1 Watercourses

Eight small unnamed watercourses (some ephemeral) run across the proposed route of the bypass. These generally drain north east towards the valley of the River Fillan, which is the principal watercourse in the area; refer to Photograph 7, Annex E. The River Fillan is within the catchment of the River Tay, which is designated as a SAC (see Section 9.5.3). Table 8.1 provides a summary description of the watercourses which are crossed by the scheme and further details are included in Appendix 8.1. Table 3.1 in Section 3.2.2 indicates how the scheme would be designed to cross the watercourses, the locations of which are shown on Figure 8.1.

[97] The Water Framework Directive 2000/60/EC

[98] Guidance is contained in The Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide, Version 5 June 2008 (as amended).

Table 8.1: Watercourses Crossed by the Scheme.

Watercourse	Chainage (m)	Catchment Area (hectares)	Catchment Slope	Description
1	23	8.0	1 in 9	Small ephemeral watercourse within an unnatural channel
2	250 & 290	12.8	1 in 10	No discernable channel, saturated, low-lying, land with water draining to existing roadside drainage channel and culvert
3	388			Channel less than 1m wide and 0.2m deep, with a peaty bed. Drains from a number of smaller channels, collecting water from across the boggy area below the tree-line
4	527	10.8	1 in 10	Channel less than 0.5m wide and 0.1m deep, with a peaty bed. Forestry drainage channel which opens out to a saturated, boggy area at the point at which the proposed road would cross
5	730	4.1	1 in 11	Channel 1m wide and 0.2 – 0.3m deep, with a stony/gravel bed. Drains from a number of forestry drainage channels
6	915	1.2	1 in 7	Channel less than 0.5m wide and 0.1m deep, with a peaty bed
7	1105	8.6	1 in 8	Channel 1m wide and 0.2 – 0.3m deep, with a stony/gravel bed. Drains from a number of forestry drainage channels
8	1235	28.0	1 in 7	Channel up to 2m wide and 0.2 – 0.3m deep, with a stony/gravel bed. Drains to a large marshy area to the north

8.5.2 Water Quality

A review of information received as part of the consultations indicates that SEPA[99] monitors the water quality in the River Fillan at Strathfillan Bridge. Under the River Ecosystem Classification the River Fillan is classed as RE1 (the highest quality class; Table 8.2). This classification is required as input into the DMRB Detailed Assessment of Pollution Impacts from Routine Run-off[100] (Appendix 8.3).

Table 8.2: River water quality classifications for the River Fillan.

Watercourse	River Ecosystem Classification	River Quality Classification Scheme (2006)	WFD RBMP Classification (2007)
River Fillan	RE1 (highest quality)	A1 (excellent)	Moderate

The WFD RBMP Classification[101] replaced the River Quality Classification Scheme[102] during this study. The apparent reduction in water quality is a result of additional assessment criteria and a change in methodology.

[99] Consultation response, 21.11.05
[100] Design Manual for Roads and Bridges, Volume 11, Part 10, HA 216/06 Road Drainage and the Water Environment
[101] New water monitoring and classification developed by SEPA to help meet the aims of the WFD. The new classification system covers all rivers, lochs, transitional, coastal and groundwater bodies, and is based on a new ecological classification system with five quality classes. It has been devised following EU and UK guidance and is underpinned by a range of biological quality elements, supported by measurements of chemistry, hydrology (changes to levels and flows) and morphology (changes to the shape and function of water bodies). Some of the quality elements used in the new ecological classification system have not been monitored in Scotland before. http://gis.sepa.org.uk/rbmp/MapViewer.aspx
[102] Before the introduction of the Water Framework Directive (WFD), SEPA had a number of classification schemes which it used to report the status of Scotland's aqueous environment

8.5.3 Private Abstractions

A detailed water features survey was undertaken in April 2008 and the findings are included in Appendix 8.1. No public or private groundwater or surface water abstractions were identified during this survey.

8.5.4 Hydrology and Hydrogeology

The geology, hydrogeology and hydrology of the area are described in Appendices 8.2 and 8.6.

The bedrock beneath the route of the proposed bypass comprises impermeable psammite and semipelite of the Precambrian Southern Highland Group (see Section 7.3.2). There may be some fracture flow in the upper weathered horizon, which is typically less than 10m thick.

Although there are isolated outcrops, the bedrock is largely overlain by extensive Quaternary Drift, comprising hummocky glacial moraine deposits. These consist largely of sands and silts, but gravel and boulders are also present. River terrace deposits are also present associated with the River Fillan. Peat deposits are present, which are not laterally continuous and typically less than 1m thick, although up to 5m has been proved in some hollows within the glacial deposits. The distribution and nature of the peat is described in more detail in Appendix 7.3.

The principal aquifer unit is the glacial moraine. Groundwater levels in the glacial sands and gravels are generally close to the surface and in hydraulic continuity with the underlying weathered bedrock. However, the heterogeneous nature of the drift deposits and the presence of a silt horizon in particular, suggest that perched water table(s) may also be present. Tests indicate that the hydraulic conductivity of the glacial moraine is relatively low for sand and gravel deposits.

Watercourses along the floodplain of the River Fillan indicate that groundwater discharges in this area, although it is likely that groundwater also discharges directly to the river. The presence of sinks nearby suggests that the relationship between local lithological[103] variation, groundwater and surface water levels, and groundwater flow is complex within the river terrace deposits.

Crianlarich has an average annual rainfall of 2471mm (see Appendix 8.2). The high level of precipitation and generally high ground water levels lead to rapid run-off when saturation of the soil occurs during wet periods.

The ground is drained by a number of small watercourses that are culverted under Glenfalloch Road and the railway. Surface water and groundwater drainage is also affected by a railway cutting at the southern end of the route.

There are no Groundwater Protection Zones[104] in the area. The water features survey indicates that there are several septic tanks which discharge to groundwater via a soakaway in the vicinity of the scheme. The Groundwater Vulnerability Map of Scotland 2004 indicates that the uppermost aquifer in the area is in class 4a or 4b and is vulnerable to those pollutants not readily absorbed or transformed and vulnerable to individual pollution events.

[103] Composition of a rock formation
[104] Areas defined where groundwater is extracted from boreholes or springs for public water supply

8.5.5 Flooding

SEPA's indicative flood map[105] shows that the proposed bypass is outside the 1 in 200 floodplain. None of the eight watercourses that cross the proposed road were identified by SEPA as a flood risk. The floodplain of the River Fillan is approximately 170m to the east and 15m down gradient of the proposed bypass and there is no significant risk of fluvial flooding. The map does indicate flooding of the A82 approximately 1.9km north west of the proposed scheme, at the confluence of Herive Burn and the River Fillan.

There are limitations associated with SEPA's indicative flood map. It only shows the areas at risk from fluvial and tidal flooding. It does not account for flood defence structures, surface water run-off, surcharged culverts or drainage systems. The map is based on a digital terrain model whose accuracy is in the range 0.7 to 1m. It does, however, provide an overview of flood risk to the area.

8.5.6 Fisheries

There are no commercial fisheries on the River Fillan however recreational freshwater fishing permits for salmon, brown trout, perch and char (at appropriate times of year) are available[106].

8.6 ASSESSMENT METHODOLOGY

The appraisal of effects was guided by DMRB Volume 11[107] HA 216/06 (May 2006) and the following assessments were undertaken:

- an assessment of the impacts of changes to the hydraulic regime on groundwater and surface water features (see Appendix 8.2);
- an initial assessment of the pollution impacts from routine run-off followed by a detailed assessment where applicable (see Appendix 8.3);
- an assessment of the pollution impacts from run-off to groundwater (see Appendix 8.4);
- an assessment of pollution impacts from accidental spillages (see Appendix 8.5); and
- an assessment of flood impacts (see Appendix 8.6).

The requirements of The Water Environment (Controlled Activities) (Scotland) Regulations 2005 were taken into account in the outline design for the scheme and its mitigation (see Sections 8.8.2 and 8.8). The proposed road lies outside the 1 in 200 year floodplain and the appropriate planning response under the SPP7 (Scottish Planning Policy 7 – planning and flooding) is that there are *no constraints*. It does, however, specify that watercourses which are unavoidably culverted must be designed to maintain or improve the existing flow conditions (see Appendix 8.6).

8.6.1 Baseline Sensitivity

The characterisation of the baseline aquatic environment comprised a review of relevant data and identification of sensitivities (see Section 8.5). The assessment of catchment sensitivities was guided by the criteria presented in Table 8.3.

[105] SEPA online indicative flood map (2008) http:www.multimap.com/clients/places.cgi?client=sepa
[106] http://www.crianlarichyouthhostel.org.uk/fishing.html
[107] Department of Transport/Scottish Office Industry Department/Welsh Office/Department of the Environment for Northern Ireland (1993) Design Manual for Roads and Bridges, Volume 11: Environmental Assessment. HMSO. Department of Transport/Scottish Office Industry Department/Welsh Office/Department of the Environment for Northern Ireland (1994) First Amendment to Design Manual Volume 11. HMSO. The technical chapters of the DMRB have subsequently been updated and amended on a number of occasions

Table 8.4: Catchment Sensitivity Classification.

Sensitivity Category	Sensitivity Criteria	
	Along Route and/or Access Roads	**Downstream in Catchment**
High Sensitivity	Protected site affected Wetland/watercourse habitat of particular ecological importance Directly affects a waterbody classed as 'at risk' by SEPA Highly vulnerable groundwater Significant peat deposits on sloping ground	Protected site immediately downstream/adjacent
Moderate Sensitivity	Wetland/watercourse habitats of some ecological importance Indirectly affects a waterbody classed as 'at risk' by SEPA Moderately vulnerable groundwater Significant peat deposits	Protected site further down catchment
Low Sensitivity	Low vulnerability groundwater Superficial peat deposits	
Not Sensitive	No aquatic habitats or watercourses present No significant groundwater present	

The criteria for sensitivity are based on a hierarchy of factors relating to the quality of the aquatic environment including international and national designations, water quality information, waterbody status from the WFD review work undertaken to date by SEPA, consultations, site visits and the professional judgement of the team. The criteria were used to guide the analysis of the sensitivity of the baseline hydrological, hydrogeological and water quality environment along the scheme.

8.6.2 Impact Prediction and Evaluation

The prediction and assessment of impacts on hydrology, hydrogeology and other aquatic resources was undertaken using the guideline criteria for impact magnitudes set out in Table 8.5.

Table 8.5: Impact Magnitude

Impact Magnitude	Guideline Criteria
High	Total loss of, or alteration to, key features of the baseline resource such that post development characteristics or quality would be fundamentally and irreversibly changed e.g. watercourse realignment
Moderate	Loss of, or alteration to, key features of the baseline resource such that post development characteristics or quality would be partially changed e.g. instream permanent bridge works
Low	Small changes to the baseline resource, which are detectable but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions
Negligible	A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no-change' situation e.g. short term compaction from plant movements

Using these criteria, a series of impacts was predicted for the project.

The significance of the predicted impacts was assessed in relation to the sensitivities of the baseline resource. A matrix of impact significance was developed to provide a consistent framework for the evaluation of impacts, and this is presented in Table 8.6. Guideline criteria for the various impact categories are included in Table 8.7.

Table 8.6: Impact Significance Matrix.

Magnitude	Sensitivity of Baseline Resource			
	High	Moderate	Low	Not Sensitive
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	None
Negligible	Minor	Minor	None	None

Table 8.7: Effect Significance Categories.

Significance	Definition	Guideline Criteria
None	No detectable change to the environment	No impacts to drainage patterns, surface and groundwater quality or aquatic habitat
Minor	A small but detectable change to the environment	Localised changes in drainage patterns or groundwater flows, or changes resulting in minor and reversible impacts to surface and groundwater quality or aquatic habitats
Moderate	A larger, but non-material change to the environment	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability, or changes resulting in loss of conservation value to aquatic habitats or designated areas.
Major	A material change to the environment	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance, or changes resulting in substantial loss of conservation value to aquatic habitats and designations

For the purpose of this assessment, those effects identified as being ‘major’ or ‘moderate’ were evaluated as ‘significant’ (see Section 1.6.4).

The matrices used to guide the assessment were applied with a degree of flexibility since the evaluation of impacts would always be subject to particular location-specific characteristics which need to be taken into account. Cumulative effects were taken into account through prediction and evaluation of impacts at a catchment-wide level.

8.7 POTENTIAL IMPACTS

The potential for the following impacts was considered:

8.7.1 Permanent

- Changes to surface water morphology through realignment and/or culverting of watercourses, and alterations to the beds of watercourses and drains;
- changes to drainage characteristics, aquatic habitats and hydrology in the locality of the site through physical works;
- changes to the hydrogeology/hydrology of the area through physical works;
- impacts on groundwater and surface water abstractions;
- impacts to existing discharges; and
- the potential for the scheme to affect the flood risks in the area.

8.7.2 Construction

- Discharge of construction drainage potentially contaminated with sediments or materials used on site (fuels, lubricants, hydraulic fluids, cement etc) impacts potentially affecting both surface water and groundwater;
- impacts from excavations (generation of turbidity), including dewatering;
- impacts from dust deposition in existing water features;
- impacts from discharge of sewage and effluent from the site compound;
- pollution from accidental spillages or discharges of fuels, oils, chemicals etc; and
- pollution from waste materials, dust etc from handling contaminated land on-site.

8.7.3 Operational

- Pollution of watercourses and groundwater from road run-off (fuel, oil, metals from vehicle wear and tear, rubber, de-icing etc);
- impacts from spills of fuel as a result of an accident;
- release of polluted materials from maintenance activities such as cleaning gully pots; herbicides used to control plant growth on verges or the central reserves; and
- biological effects of pollution from pollution incidents.

8.8 MITIGATION MEASURES

Dr1 The detailed drainage design would be carried out in accordance with the DMRB, SEPA[108], CIRIA[109] and other best practice guidance and to meet all requirements of the Water Environment (Controlled Activities) Regulations 2005 (CAR).

Dr2 All detailed drainage proposals would be discussed and agreed with SEPA. Method statements for works in proximity to or in watercourses would be discussed with SNH because of the importance of the River Fillan as part of a site designated for its European importance.

Dr3 The detailed drainage design would ensure that there is not an increased risk of flooding of areas in proximity to the works.

Dr4 All pipes, basins or filter drains would be isolated from existing surface and groundwaters using impermeable membranes in any locations where land is found to be contaminated.

Dr5 The detailed design would include appropriate Sustainable Urban Drainage System (SUDS[110]) measures including filter drains, detention basins and filter trench (the detention basins and filter trench would each have an underdrain) (see Section 8.8.1).

Dr6 All detailed drainage measures would be designed to benefit nature conservation where this is practical and feasible taking account of future maintenance requirements. The contractor would be required to follow best practice guidance.

Dr7 The filter trench would be infilled with suitable material and covered with geotextile and a layer of topsoil.

Dr8 All existing watercourses to be crossed would be culverted to maintain the existing flow path. The existing and proposed culverts would be designed to pass the peak flows of a 1 in 200 year return period

[108] Current list of relevant guidance available at: SEPA website www.sepa.org.uk
[109] CIRIA, Control of Water Pollution from Linear Construction Projects, Technical guidance (C648)
[110] Sustainable Urban Drainage Systems (SUDS) are drainage methods which are based on natural processes to achieve attenuation of run-off water quality and quantity. Guidance on SUDS systems is available from SEPA, CIRIA etc (see relevant web links)

(including climate change) as advised in SPP7[111] and the SEPA Technical Flood Risk Guidance[112].

Dr9 Any existing forestry drainage severed by the scheme would be picked up in the new drainage system.

Dr10 All surface water drainage from the scheme would pass through detention basins/filter trench before being discharged to the watercourses. This would provide flow attenuation and pollution benefits. The detention basins would have an underdrain which would provide additional treatment and capacity. The detention basins would be unlined and act as soakaways during periods when the basins levels exceed groundwater levels. This is most likely in the summer months.

Dr11 A herringbone system would be incorporated into the design of the cuttings to ensure that any run-off from the cuttings and any groundwater (throughflow) are intercepted and drained.

Dr12 The contractor would be required to identify and implement measures to prevent any sediment rich or polluted run-off or contaminated groundwater produced by the works entering and polluting the local drainage system and watercourses, and to adopt all specific measures identified in the contract requirements.

Dr13 The contractor would be required to develop contingency plans, emergency procedures and joint response plans which would be implemented in the case of accidental spillages during construction. These would be developed in compliance with all best practice guidance and would include a drainage catchment plan detailing the drainage system. This would be made available by the contractor to emergency services to aid in the event of a major spill.

Dr14 Sewage from construction compounds would either pass to a temporary septic tank which would be periodically emptied and removed for off-site disposal at a licensed sewage treatment facility, or would be temporarily connected to an existing sewer.

Dr15 During operation of the road the maintenance contractors would be required to comply with current SEPA guidance and specifications to avoid the risk of pollution.

Dr16 All SUDS measures would be maintained by Transport Scotland's trunk road maintenance appointee at the end of the contract maintenance period.

8.8.1 Sustainable Urban Drainage Systems

The proposed bypass would cross eight watercourses and it is intended to culvert these on their existing courses (see Section 3.2.2). Drainage measures would be required mainly on the upslope side of the road. In order to maintain the integrity of the cuttings in soil, ditches (approximately 0.5m deep) would be required at the top of the slope. Cascades would be used to link the cut-off drains and culverts (see Section 3.2.2). Given that the cuttings would intercept groundwater flows, it may be necessary to install herringbone drains to pick up individual seepages (see Section 3.2.2). Cuttings in rock would require similar drainage measures at rockhead but seepages from the rock are not expected to be problematic.

Areas of embankment would require upslope ditches to divert surface water into the watercourses.

---

111 Scottish Planning Policy 7: Planning and Flooding

112 SEPA Technical Flood Risk Guidance For Stakeholders Version 3 http://www.sepa.org.uk/flooding/flood_risk/planning__flooding.aspx

SUDS measures for the bypass were developed as an integral part of the outline design (see Section 3.2.2). Such measures would provide settlement to deal with suspended solids, some breakdown of pollutants by natural processes and attenuation to ensure that run-off is limited to greenfield rates. The rate of recharge from a detention basin to the underlying strata is dependant upon the drift composition and the difference in water levels. The detention basins are designed to cope with run-off associated with a 1 in 200 year event.

The SUDS measures which would be implemented are:

- surface water run-off from the carriageway would be collected by filter drains in the verge. These would provide for attenuation and improve water quality by filtration and some biological degradation;
- at the roundabouts, kerbing would be provided at the carriageway edge with gullies and carrier drains as the primary form of drainage. The gullies would have a sump for the collection of sediment;
- chambers in the form of catchpits and manholes, would be located at no more than 90m intervals to facilitate the rodding of the system. The sumps in the catchpits would be able to collect sediment and provide another form of treatment;
- two unlined detention basins would be provided at the carriageway drainage outfall locations (see Table 8.8). The basins would have shut off valves to minimise the risk of any spillages to the watercourses. Each basin would have sufficient volume to allow solids to settle;
- one filter trench at the north end of the bypass (see Table 8.8); and
- the two detention basins and the filter trench would each have an underdrain which would provide additional treatment and capacity below the basin base;

Short lengths of existing roads would continue to drain into the drainage systems. The SUDS measures including the drainage networks are shown on Figure 8.1.

Table 8.8: SUDS Measures.

SUDS Measure	Location	Land Take Area	Catchment	Outlet
Detention Basin (with underdrain) – Network A	Located around Chainage 300 adjacent to the existing A82.	Approximately 630 m^2	Approximately 1.0 hectare	Outfalls to an existing culvert and drains generally northward towards the valley of the River Fillan
Detention Basin (with underdrain) – Network B	Located to the East of the proposed north roundabout at Chainage 1050.	Approximately 715 m^2	Approximately 2.7 hectares	Outfalls to an existing culvert and drains generally northward towards the valley of the River Fillan
Filter Trench (with underdrain) – Network C	Located to the north of the proposed north roundabout. Chainage 1180-1230	Approximately 175 m^2	Approximately 1.0 hectare	Outfalls to an existing watercourse and drains generally northward towards the valley of the River Fillan

8.8.2 CAR Licensing

A preliminary assessment of the CAR licence requirements for the proposed culvert crossings and SUDS features was undertaken in accordance with the Water Environment (Controlled Activities)(Scotland) Regulations 2005. The findings of the preliminary assessment are given in Table 8.9a and 8.9b.

Table 8.9a: Potential Culvert CAR Licence Requirements.

Culvert Number[113]	Chainage	Description	CAR Licence Requirement
1	23	Minor watercourse (<3m width) existing culvert extension, crossing A82 (approximately 20m long)	None required. (as watercourse does not appear on 1:50,000 OS map)
2	388	Minor watercourse (<3m width) culvert, crossing A82 (approximately 45m long)	None required. (as watercourse does not appear on 1:50,000 OS map)
3	527	Minor drainage watercourse (<3m width) culvert, crossing A82 (approximately 45m long)	None required. (as watercourse does not appear on 1:50,000 OS map)
4	730	Minor watercourse (<3m width) culvert, crossing A82 (approximately 65m long)	None required. (as watercourse does not appear on 1:50,000 OS map)
5	915	Minor watercourse (<3m width) culvert, crossing A82 (approximately 50m long)	None required. (as watercourse does not appear on 1:50,000 OS map)
6	1105	Minor watercourse (<3m width) culvert, crossing A82 junction, approx 85m length	None required. (as watercourse does not appear on 1:50,000 OS map)
7	1060	Minor watercourse (<3m width) existing culvert extension, crossing A82 slip road (approximately 30m long)	None required. (as watercourse does not appear on 1:50,000 OS map)
8	1235	Minor watercourse (<3m width) existing culvert extension, crossing A82 (approximately35m long)	None required. (as watercourse does not appear on 1:50,000 OS map)

Table 8.9b: Potential Detention Basin CAR Licence Requirements.

SUDS Measure	Chainage	Description	CAR Licence Requirement
Detention Basin (with underdrain) – Network A	300	Detention basin receiving runoff from approximately 400m carriageway and road junction	None required. (as Network is less than 1km in length)
Detention Basin (with underdrain) – Network B	1050	Detention basin receiving runoff from approximately 650m carriageway	None required. (as Network is less than 1km in length)
Filter Trench (with underdrain) – Network C	1180	Filter Trench receiving runoff from approximately 110m of carriageway and road junction	None required. (as Network is less than 1km in length)

[113] See Figure 8.1

8.9 ASSESSMENT OF RESIDUAL EFFECTS

8.9.1 Permanent

8.9.1.1 Watercourse Characteristics, Hydrology[114] and Hydrogeology[115]

The permanent development of the road has the potential to impact on the hydrological and hydrogeological regimes due to permanent changes in land drainage and land profile.

There would be an overall increase in the area of impermeable surface, which would generate an increase in the volume of surface run-off. The flow detention features are designed to control the predicted increase in run-off and would ensure that significant residual effects on the existing hydrology and hydrogeology are avoided. SEPA generally discourages the use of culverts, although on this scheme culverting is unavoidable. Removal of extensive areas of peat would affect the local hydrology and has potential to change habitats in the area. They are likely to become drier and grass and rush species could become more prevalent. The habitats at the edge of watercourses could similarly change to reflect this (see Section 9.10.1).

The construction of the road would alter the beds of some of the watercourses and field drains and some would be culverted. Table 8.10 summarises all watercourse crossings and details of the proposed method of crossing. An indicative cross section of a culvert is included in Chapter 3 (see Figure 3.4).

Table 8.10: Watercourse Realignment and Culvert Requirements.

Watercourse (numbered from south to north)**	Culverts (numbered from south to north)	Details of Culverts
1	1	Existing culvert – would possibly have to be extended and upsized (Ch 23)
2	-	Watercourse connects into cut-off ditch at chainages 250 and 290
3	2	Proposed culvert – 1,200mm square internal dimensions box culvert (including otter passage) (Ch 388)
4	3	Proposed culvert – 1,200mm square internal dimensions box culvert (including otter passage) (Ch 527)
5	4	Proposed culvert – 1,200mm square internal dimensions box culvert (including otter passage) (Ch 730)
6	5	Proposed culvert – 1,200mm square internal dimensions box culvert (including otter passage) (Ch 915)
7	6	Proposed culvert – 1,200mm square internal dimensions box culvert (including otter passage) (Ch 1105)
-	7	Existing culvert to be extended for north detention basin outfall. (Ch 1060)
8	8	Existing culvert 900mm Ø – would possibly have to be extended and upsized to 1,200mm square internal dimensions box culvert (including otter passage) (Ch 1235) [116]

** See Figure 8.1

The contractor would be required to follow best practice guidance for all works in watercourses and in the detailed design of detention basins. All opportunities would be taken to benefit nature conservation (see Sections 9.9, 9.10 and 10.7).

[114] The science dealing with the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere
[115] The science dealing with the occurrence and distribution of underground water
[116] Ø = diameter

New culverts would include otter ledges to facilitate their passage (see Section 9.10) and the detention basins would be designed to encourage local biodiversity.

Some groundwater would discharge into the drainage ditch and the drainage channels that run along the western side of the bypass. The greatest volumes are likely where the bypass is in cutting and a large percentage of the permeable drift cover would be removed (see Appendix 8.2). The road drainage system would be designed to cope with additional flow from groundwater seepage, although calculations show that the volumes would be very small in comparison to the surface run-off and groundwater level monitoring indicates that any additional flow from groundwater seepage may only be seasonal. The risk of ditch saturation is likely to be negligible provided the topography of the ditch is profiled to allow free flow of inflowing surface and groundwater flows and the drainage system is free from blockages. Ongoing groundwater level monitoring will provide greater understanding of groundwater flows with time.

The cuttings would have an impact on groundwater flows, particularly in the central and southern sections. However, the potential reduction in groundwater flow down-gradient of the bypass cuttings is not considered to have a significant impact on the surface water features. This is due to the overriding contribution of surface water run-off to these features compared to the likely baseflow. Moreover, the ground adjacent to the existing road is already artificially drained through culverts and by the railway cutting at the southern end.

The proposed embankments at the southern end are also not considered to have a significant potential impact on the water features in the area. Any risk of groundwater flow restrictions causing groundwater flooding and groundwater flow reductions would be mitigated by the proposed drainage systems.

The proposed detention basins would be unlined (with an underdrain), which means that they would act as point sources of recharge to the underlying glacial sands and gravels during periods when the basin levels exceed groundwater levels. The rate of recharge in any location would be dependent on the permeability of the glacial deposits and the difference in water level.

8.9.1.2 Surface Water and Groundwater Abstractions

There are no groundwater or surface water abstractions that would be affected by the proposed scheme (see Section 8.5.3 and Appendix 8.1).

8.9.1.3 Existing Discharges

There are five septic tank discharges to surface water or groundwater within the study area (see Figure 8.1, and Appendix 8.1). The three that discharge to groundwater are located at the southern end and are down-gradient of the scheme. The predicted impact of the cuttings on groundwater flow in this area is low and the septic tanks are down-gradient of existing drainage ditches in the village. This and the fact that groundwater flow in the area is already controlled to some extent by the railway cutting, means that the impact on the potential dilution of these discharges is likely to be negligible.

8.9.1.4 Detention Basins

The detention basins would require relatively small areas (see Section 8.8) and no permanent significant adverse effect on local hydrology and drainage is predicted. The basins would be designed to attenuate surface run-off and discharge to the existing watercourses at a rate no greater than the existing greenfield run-off. The basins would be designed to potentially become dry during times of sustained dry weather. As the basins would be unlined (with an underdrain) there is a moderate risk of pollution to groundwater from the build-up of pollutants in them. The basins would be designed in accordance with best practice to meet SEPA's requirements and the risk of pollution to groundwater would therefore be controlled (see Section 8.9.3 and Appendix 8.4).

8.9.1.5 Flooding

The proposed road is approximately 1.3km long and would cross eight small watercourses that drain into the River Fillan which is approximately 0.2km north east of the site. The proposed drainage of the minor watercourses would involve the use of three existing culverts and five new ones and a cut-off ditch along the western edge of the scheme.

The route of the proposed bypass is not within the floodplain of the River Fillan thus the probability of fluvial flooding is less than 1 in 1000 years and the risks from the other flooding sources are considered to be low. Consequently, in terms of national policy, there are no planning constraints arising from the risk of flooding. Consultation with Stirling Council indicates that there are no records of historic flooding (see Annex A).

Appendix 8.6 includes the Flood Risk Assessment (FRA) which was completed for this scheme. SEPA require an assessment of the peak flows so that the risk of any flooding from culverts would be minimised. Using the ADAS method[117] the culverts would need to pass peak flows of a 1 in 200 year return period including climate change (SEPA Technical Flood Risk Guidance[118]). The flows are summarised in Table 8.11.

Table 8.11: Watercourse Realignment and Culvert Requirements.

Culvert Number	Existing / Proposed	Chainage (m)	Q200 m3/s including climate change
1	Existing	23	4.09
2	Proposed	388	6.21
3	Proposed	527	5.27
4	Proposed	730	2.22
5	Proposed	915	1.08
6	Proposed	1105	4.52
7	Existing	1060	13.49
8	Existing	1235	13.72

The culverts for the scheme have been designed to accommodate the flow conditions and the cuttings would be drained using a herring-bone system. In addition, flows from the new road drainage system would be attenuated by detention basins and a filter trench to limit the flows to the watercourses to greenfield rates. Detailed design, taking further consideration of the peak flows would ensure that the existing and proposed culverts would be able to maintain/improve the flow conditions, thus minimising flood risk.

[117] The Agricultural Development and Advisory Service (ADAS) is a method for estimating flood flows in small catchments up to 0.3km^2 based on widely available catchment descriptors. A full definition of the equation can be seen in flood risk assessment in Appendix 8.6

[118] http://www.sepa.org.uk/flooding/flood_risk/planning__flooding.aspx

Long term maintenance of the drainage ditch and culverts to remove any blockages, such as plant debris, would ensure the water is free flowing at all times. The risk of peat blocking the ditch or culverts is unlikely as the peat slide hazard is negligible (see Appendix 7.3).

Given these mitigation measures, it is considered that there would be no adverse impacts on the watercourses or the surrounding areas and that there would be no additional flood risk to the area caused by the proposed bypass.

8.9.2 Construction

8.9.2.1 Hydrology, Hydrogeology and Water Quality

During site preparation and construction activities, the run-off characteristics of the roadwork sites would be altered by temporary mounding and earthworks activities. The resulting increase in slope gradient would increase the run-off but this would be partially offset by the higher porosity and permeability of the loosely mounded soil. A slight increase in run-off is predicted.

It is likely that there would be an increased loading of sediment (suspended solids from surface earthworks and excavation activities) during the temporary works. This could affect a number of the small watercourses either directly or indirectly through groundwater baseflow. The route of the bypass would cross a number of small burns and drainage ditches. The proposed mitigation, including early installation of cut-off drains, SUDS detention basins etc, would provide sufficient mitigation to ensure that any deterioration in water quality is minor and temporary and the residual effects were insignificant. The drainage ditch would collect any run-off from the adjacent hillside during both the construction and operation phases. The ditches would be designed to direct flow towards the proposed culverts and would therefore outfall into the existing flow paths. The contractor would be required to plan all temporary works carefully and agree these with SEPA in advance of construction. In particular, detailed method statements of how potential pollution of the River Fillan would be controlled would be required, including contingency plans to be implemented in case of an accident.

Pollutant sources and pollutants that may be present in construction site drainage include:

- suspended solids from surface earthworks;
- hydrocarbons, lubricants and other fluids from fuel stores and machinery;
- concrete liquors;
- construction wastes and domestic wastes (sanitary water, sewage); and
- mobilised pollutants from in-situ contaminated land.

All run-off from the construction area would be managed in accordance with SEPA's best practice and the detention basins would be constructed as soon as possible to provide attenuation of pollutants and sediments. The proposed route would not pass through any known pockets of contaminated land but if any are encountered the contractor would be required to follow all best practice to mitigate any potential effects (see Section 7.6).

It is not known at this stage whether any groundwater pumping would be required during construction. The need for this would be identified by the contractor and all best practice would be followed in the disposal of any water.

Dewatering might be required during construction of the sections of road in cuttings. Although groundwater levels are near the surface, the aquifer units are heterogeneous and only of limited thickness, which means that it is unlikely that significant volumes of water would be abstracted during any dewatering operation. However, to avoid long-term and significant effects on the aquifer units as a whole, there might be some local impacts on springs and any burns seasonally dependent on baseflow. This would be particularly the case if dewatering takes place during summer months.

8.9.2.2 Sewage/Effluent from Site Compound(s)

Sewage from construction compound(s) would either pass to a temporary septic tank which would be periodically emptied and removed for off-site disposal at a licensed sewage treatment facility, or temporarily connected to an existing sewer. The method of disposal would be agreed between the contractor, SEPA and Scottish Water. No discharges of sewage or other domestic effluents from site compounds would be permitted to watercourses or surface water drains.

8.9.2.3 Accidental Spillages

Adherence to the Water Environment (Oil Storage) (Scotland) Regulations 2006[119] together with implementation of SEPA best practice on the storage of fuels, oils and chemicals and on the operational use of these substances during the construction works would reduce the risk of a spill. As part of the environmental management system for the proposed works planned emergency response procedures would be in place to prevent, contain or deal with spills and SEPA would be notified immediately.

Accidental Spillage Pollution Impact Assessments are included in Appendix 8.5 and these indicate that no further pollution control measures would be required to reduce the spillage risk within any section of the scheme.

8.9.3 Operation

8.9.3.1 Pollution in Road Run-off

Pollutant sources and pollutants that may be present in road run-off and which have the potential to impact on water quality include:

- hydrocarbons, oils and chemicals from exhaust emissions and leaks introduced in liquid form and through atmospheric deposition;
- heavy metals from tyre and brake wear, corrosion of car bodies and parts and from exhaust emissions in solid and liquid form and through atmospheric deposition;
- sediments from atmospheric deposition;
- chemicals, minerals and sediments introduced through maintenance activities such as de-icing or the use of herbicides on roadside verges.

8.9.3.2 Hydrocarbons

Hydrocarbons have a high affinity for sediment and tend to settle out with the sediment fraction in detention basins. In addition a percentage would be filtered out either by the filter drains (where used) or via the passage of a filter trench and within other SUDS systems (detention basins and similar SUDS systems have what is regarded as a good performance in removal capacity i.e. >50% for run-off

[119] The Water Environment (Oil Storage) (Scotland) Regulations, Scottish Statutory Instrument 2006 No. 133

hydrocarbons[120]). Hydrocarbons would also be degraded by micro-organisms in the sediments within the detention basins. The SUDS measures incorporated into the drainage design are designed to have the capacity to ensure hydrocarbons would be removed from the routine run-off prior to its release and thus no significant residual effects are predicted (see Table 8.12).

Table 8.12: Treatment Systems Efficiency for removing Certain Pollutants[1]

Treatment System	Pollutant Removal Efficiencies			
	Fine Sediments <63um	Metals	Herbicides	Organics
Filter (French) Drains	Medium - High	High	High	High
Infiltration Basins	High	High	Medium	High
Soakaways & infiltration trenches	High	High	Medium	High

1. Extract from Table 5.7 of Control of Pollution from Highway Drainage Discharges. CIRIA Report 142, 1994

8.9.3.3 Heavy Metals

Lead

Lead concentrations in road run-off have fallen in recent years as the majority of vehicles now use unleaded fuels. The low solubility and low toxicity (of the predicted solid state) of the metal would not be expected to have a significant impact on the biological environment. Any lead that is present is likely to be removed during the filtering and settling out phases of the SUDS and is not considered to be significant (see Table 8.12).

Zinc

Zinc (mainly from tyre and brake wear) can have potentially significant ecological impacts as it can be toxic in certain forms. This is particularly the case for waters of low pH (i.e. acidic) and with low calcium and hardness concentrations. Forms of zinc associated with particulates should be removed by the SUDS measures (sedimentation and filtration (see Table 8.12). Soluble forms would remain in the discharge. The calculations carried out for the Detailed Assessment of Pollution Impacts from Routine Run-off (see Appendix 8.3) indicate that soluble zinc levels would be likely to be low, and no significant effects are predicted to result from their release to any of the watercourses.

Copper

Copper (mainly from brake wear) is potentially more soluble than zinc and in acid waters of low calcium and hardness concentrations it can be toxic. It can form insoluble non-reactive complexes with humic and fulvic acids that are commonly found in peaty areas and soils. The calculations carried out in the Detailed Assessment of Pollution Impacts from Routine Run-off (see Appendix 8.3) indicate that soluble copper levels could reach concentrations that might pose a risk to the receiving waters. Table 8.13 shows the estimated copper concentrations in watercourses receiving routine road run-off.

120 Department of Transport/Scottish Office Industry Department/Welsh Office/Department of the Environment for Northern Ireland (1993) Design Manual for Roads and Bridges, Volume 4: Geotechnics and Drainage. HMSO. Department of Transport/Scottish Office Industry, update May 2006

Table 8.13: Estimated Copper Concentrations in Watercourses receiving Routine Road Run-off

Watercourse	Grid Reference	Estimated Burn Copper Concentration ($\mu g\ l^{-1}$)	Copper EQS ($\mu g\ l^{-1}$)	Does it Fail?
Network A (South Detention Basin)	NGR 238434, 725043	17.04	22	No
Network B (North Detention Basin)	NGR 238047, 725576	8.41	22	No
Network C (filter trench)	NGR 237930, 725654	Detailed assessment is not required, as the dilution is above the minimum requirement level for impacts from routine run-off		No

The assessment is based on estimated upstream concentrations of copper (at half the EQS[121] figure i.e. half of 0.040 mg l^{-1} which is 0.020 mg l^{-1}) and estimated build-up rates rather than measured values for the road run-off. These assumed upstream concentrations could be higher than the actual. From SEPA's data, the actual upstream total copper concentration measured on the River Fillan was 1.017 µg l^{-1}, however, dissolved copper values were not available therefore the half EQS figure was used. The above calculated downstream concentrations of dissolved copper are below the EQS figure. It is likely that a significant proportion of the soluble copper would be removed by all run-off passing through the SUDS measures (see Table 8.12). Copper would be absorbed either onto clay particles or by humic/fulvic acids in soil and peaty materials and also by vegetation. No significant effects are therefore predicted to result from copper concentrations in the run-off discharged to the aquatic environment.

8.9.3.4 Effects of Fuel Spills

Pollution or large influxes of contaminated water may be caused by:

- a vehicular accident releasing a cargo of pollutant (oil, petrol, diesel, chemicals etc);
- an intentional dumping of pollutants (fly tipping);
- fire fighting water introduced after a fire brigade response to a vehicular fire or accident;
- large volumes of water following a storm event or snow melt.

The SUDS mitigation measures would help to mitigate the impacts from extreme pollution events (see Section 8.8.1). Detention basins with underdrains would hold large volumes of run-off and contaminated water, allowing time for pollution response plans to move into action and the resulting clean up to take place. Catchment drainage plans, contingency plans, emergency response procedures and joint response plans (involving other organisations that may be involved in the event of a spill) would be developed in accordance with SEPA guidance. These measures would further reduce the potential for any significant pollution of the River Fillan from such events.

Accidental Spillage Pollution Impact Assessments are included in Appendix 8.5 and they indicate that no further pollution control measures would be required to reduce the spillage risk within any section of the scheme.

[121] Environmental Quality Standards are a set of requirements which must be fulfilled at a given time by a given environment or particular part of it as set out in EU legislation under the Council Directive 96/61/EC 1996 concerning IPPC

8.9.3.5 Effects of Pollutants on Groundwater

An appraisal was undertaken of the effects of pollutants on groundwater (see Appendix 8.4). This indicates that there could be a moderate risk of pollution of groundwater because of local aquifer characteristics in the vicinity of the detention basins and filter trench. The Groundwater Vulnerability Map of Scotland indicates that the uppermost aquifer(s) in the area (mostly glacial sands and gravels), are in Class 4a or 4b (vulnerable to those pollutants not readily adsorbed or transformed and vulnerable to individual pollution events). All drainage measures would be designed in accordance with best practice to meet SEPA's requirements and the risk of pollution to groundwater would therefore be controlled.

8.9.3.6 Release of Polluted Materials from Maintenance Activities

The use of herbicides in controlling weeds on roadside verges and in central reservations has the potential to contaminate run-off. Also, the cleaning out of gulley pots that can accumulate a variety of materials and the use of de-icing agents (sodium chloride and grit) can contribute polluting substances. Transport Scotland's maintenance contractors are required to adhere to best practice including SEPA guidance, in the planning of operations and the choice of compounds used (e.g. preference given to biodegradable substances) and no significant effects are predicted to result to the receiving watercourses.

Sudden high levels of salinity (chloride) would adversely affect watercourses but the SUDS measures and the dilution of run-off in the detention basins prior to discharge would mitigate any possible adverse impacts. No significant effects on the receiving watercourses are predicted.

8.10 SUMMARY

8.10.1 Permanent

- Residual effects on, or changes to, the hydrological and hydrogeological environments or flooding within the proposed scheme corridor are predicted to be minor or negligible, providing that the mitigation measures are implemented. Removal of extensive areas of peat would affect the local hydrology and has potential to change the habitats in the area. They are likely to become drier and grass and rush species could become more prevalent. The habitats at the edge of watercourses could similarly change to reflect this (see Section 9.10.1).

8.10.2 Construction

- Providing that SEPA guidance and best practice requirements are followed during construction and pollution prevention measures implemented, construction is not predicted to result in significant adverse effects on the aquatic environment.
- Dewatering may be required during the construction of the sections of the road in cuttings. Although groundwater levels are near surface, the aquifer units are heterogeneous and only of limited thickness. Therefore it is unlikely that significant volumes of water would be encountered during any dewatering operation. However, there may be some local impacts on springs and any burns seasonally dependent on baseflow, particularly if dewatering takes place during summer months.
- The proposed works and drainage from the construction site would not significantly affect the quality of the receiving watercourses provided all committed mitigation measures were successfully implemented.

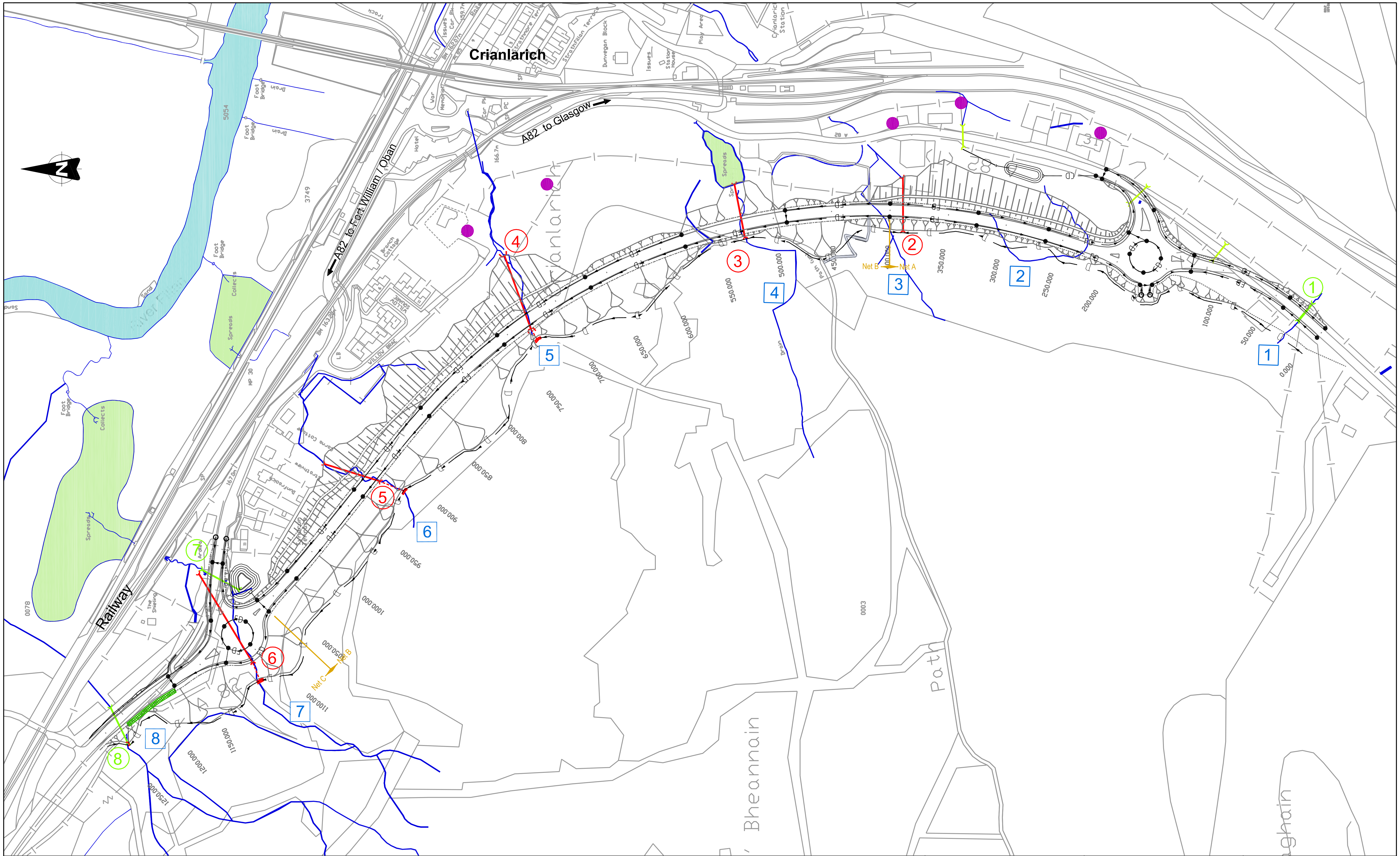
8.10.3 Operational

8.10.3.1 Routine Operation

- The outline design for the scheme was developed in accordance with SEPA's requirements and following best practice and SUDS guidance. Checks were made of the effects of run-off and these indicate that the potential impacts would not be significant. The detailed design would require that all detention basins, filter drains and other SUDS systems were installed and maintained. It is therefore not predicted that any significant adverse effects on surface water and groundwater quality would occur as a result of the routine operation of the scheme.

8.10.3.2 Accidents and Pollution Incidents

- The mitigation measures include filter drains, detention basins and other SUDS measures which would help mitigate the impacts from extreme pollution events. The detention basins and the filter trench would each have an underdrains which would act as a thirds level of SUDS treatment. Each detention basin outfall would be fitted with cut-off valves for use in an emergency. The basins would hold large volumes of run-off and contaminated water, allowing time for pollution response plans to move into action and the resulting cleanup to take place. All drainage measures would be designed in accordance with best practice to meet SEPA's requirements and the risk of pollution to groundwater would therefore be controlled. Catchment drainage plans, contingency plans, emergency response procedures and joint response plans would be developed for the scheme in accordance with SEPA's guidance.



Key:

CD	Carrier Drain
FD	Filter Drain
D	Ditch
	Divide between Drainage Networks
No.	Minor Watercourses/ Water features
	Location of Septic Tanks
	Chambers
	Direction of flow
No.	New Culverts (inc otter passage)
No.	Existing Culverts
	Cascade to Culvert
	Filter Trench
	Detention Basin (with underdrain)

DRAWN BY:	CHECKED BY:	DATE:
GMcI	INS	07/09

A82(T) Crianlarich Bypass

Figure 8.1:Proposed Drainage Design

Scale : 1:3000 at A3

TRANSPORT SCOTLAND