Appendix A10.2

Stage 2 DMRB Flood Risk Assessment

Transport Scotland

Table of contents

Tables

Figures

Glossary and Abbreviations

Terminology	Abbreviation	Description
Annual Exceedance Probability	AEP	The probability of a natural hazard occurring annually, usually expressed as
Annual Maximum Flood	AMAX	The maximum recorded flow
Atkins-Mouchel Joint Venture	AMJV	The collaboration of Atkins Limited and Mouchel.
Baseline		The existing conditions which form the basis or start point of the environmental assessment.
Bedrock		Hard rock that lies beneath a superficial cover of soils and sediments.
British Geological Survey	BGS	The British Geological Survey is a partly publicly funded body which aims to advance geoscientific knowledge of the United Kingdom landmass and its continental shelf by means of systematic surveying, monitoring and research.
British Hydrological Society	BHS	
Centre for Ecology and Hydrology	CEH	The Centre for Ecology & Hydrology is the United Kingdom's Centre of Excellence for integrated research in hydrology, terrestrial and freshwater ecosystems and their interaction with the atmosphere
Catchment		The area contributing flow to a point on a drainage system.
Catchment Wetness Index	CWI	The antecedent conditions within the catchment prior to an event.
Design Manual for Roads & Bridges.	DMRB	A series of 15 volumes that provide standards, advice notes and other documents relating to the design, assessment and operation of trunk roads, including motorways in the United Kingdom.
Dualling		The widening of an existing road in order to provide two carriageways in both directions.
Digital Terrain Model	DTM	A topographical model of the bare earth- terrain relief that can be manipulated by computer programmes.
Environment Agency	EA	Regulating body responsible for the welfare of the water environment and enforcing the WFD within England and Wales.
Environmental Impact Assessment	EIA	The process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.
Flood Estimation Handbook	FEH	The guidance document for practitioners concerned with rainfall and flood frequency estimation.
Flood Risk Assessment	FRA	A flood risk assessment is an assessment of the risk of flooding from all flooding mechanisms, and the identification of flood mitigation measures.
Flood Risk Management (Scotland) Act 2009	FRM	An act of parliament which introduced a sustainable and modern approach to flood risk management in Scotland.
Geographical Information System	GIS	A geographic information system is a computer system for capturing, storing, checking and displaying data related to positions on Earth's surface.
Hydromorphology		A term largely created for the Water Framework Directive comprising a blend of hydrology and geomorphology
Joint Venture	JV	The collaboration of two or more companies.

Terminology	Abbreviation	Description
Land Capability for Agriculture	LCA	The Land Capability Classification for Agriculture is a map which uses the physical characteristics of the land (including its soil, climate, topography and relief) to determine what crops it should be able to grow and how well it should be able to grow them. There are seven classes, class 1 being land capable of producing a wide variety of crops and class 7 being land of very limited agricultural value.
Light Detection and Ranging	LiDAR	A surveying technology that measures distance by illuminating a target with a laser light.
Main water body		Designated under the WFD and visible on 1:50k OS maps.
Minor watercourse		Not shown on 1:50k OS maps.
Metres above Ordinance Datum	m AOD	The height above the vertical datum used by an ordnance survey for deriving altitudes on maps.
Met Office Rainfall and Evaporation Calculation System	MORECS	A nationwide product giving modelled data of rainfall, evaporation and soil moisture.
National Grid Reference	NGR	The National Grid is the map reference system used on all Ordnance Survey maps to identify the position of any feature
National Planning Framework	NPF	The National Planning Framework (NPF) sets the context for development planning in Scotland and provides a framework for the spatial development of Scotland as a whole
Ordnance Survey	OS	Mapping provider.
Preliminary Engineering Support	PES	
Preliminary Source Study Report	PSSR	
Planning Policy Statement 25	PPS25	Planning Policy Statement 25 (PPS25) Development and Flood Risk (Communities and Local Government 2006) sets out the policy approach to delivering appropriate sustainable development in the right places, taking full account of flood risk.
Potentially Vulnerable Areas	PVA	Areas identified as being at the greatest risk to the impact of flooding.
Flow	Q	Volumetric rate at which water is conveyed measured in m^3/s
Median Annual Maximum Flood (m3/s)	QMED	The middle ranking value in a sample of ranked maximum flows.
Revitalised Flood Hydrograph	ReFH	A method for estimating peak flows.
Rainfall Runoff	RR	A method for estimating peak flows.
Standard Average Rainfall	SAAR	The 1961-1990 standard period average rainfall.
Special Areas of Conservation	SAC	A Special Area of Conservation (or SAC) is a site designated under the Habitats Directive. These sites, together with Special Protection Areas (or SPAs), are called Natura sites and they are internationally important for threatened habitats and species.
Strategic Environmental Assessment	SEA	Strategic environmental assessment (SEA) is a systematic decision support process, aiming to ensure that environmental and possibly other sustainability aspects are considered effectively in policy, plan and programme making.
Scottish Environment Protection Agency	SEPA	Regulating body responsible for the welfare of the water environment and enforcing the WFD within Scotland

Terminology	Abbreviation	Description
Scottish Flood Defence Asset Database	SFDAD	A website which provide users with a tool to view detailed information on flood prevention schemes and their associated assets within Scotland
Strategic Flood Risk Assessment	SFRA	Strategic Flood Risk Assessment (SFRA) is designed for the purposes of informing the development planning process, primarily, to avoid increasing overall flood risk by avoiding areas of flood hazard.
Standard of Protection	SoP	The level of protection provided
Special Protection Areas	SPA	A special protection area (SPA) is a designation under the European Union Directive on the Conservation of Wild Birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened birds
Scottish Planning Policy (SPP) Planning	SPP	It sets out national planning policies which reflect Scottish Ministers' priorities for operation of the planning system and for the development and use of land.
Site of Special Scientific Interest	SSSI	A conservation designation denoting a protected area in the United Kingdom and Isle of Man.
Sustainable Drainage System	SUDs	A sustainable drainage system (SuDs,) is designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges
Scottish Water	SW	Scottish Water is a statutory corporation that provides water and sewerage services across Scotland.
Time to Peak	T(p)	The unit hydrograph time to peak, expressed in hours.
Transport Scotland	TS	Transport Scotland is the national transport agency of Scotland

Event Severity

The severity of the events discussed in this document are defined as Annual Exceedance Probabilities (AEP), the table below provides a summary of AEP and corresponding Return Periods.

The AEP is the probability that there will be an event exceeding a particular severity in any one year. The Return Period is the average duration (in years) between events of a particular severity.

Annual Exceedance Probability	Return Period
50%	1 in 2 years
20%	1 in 5 years
10%	1 in 10 years
4%	1 in 25 years
3.3%	1 in 30 years
2%	1 in 50 years
1.33%	1 in 75 years
1%	1 in 100 years
0.5%	1 in 200 years
0.5% with 20% increase as allowance for climate change	1 in 200 years with 20% increase as allowance for climate change

1. Introduction

1.1. Background

1.1.1. In December 2011, the Scottish Government's Infrastructure Investment Plan committed to dual the A9 Trunk Road between Perth and Inverness by 2025. The A9 corridor forms a strategic link between Central Scotland and the Scottish Highlands and is vital to the growth and development of northern Scotland.

1.1.2. In September 2012, Transport Scotland commissioned the Design Manual for Roads and Bridges (DMRB) Stage 1 Assessment, A9 Dualling: Preliminary Engineering Support Services Report (PES)[i]. The PES undertook an engineering assessment of the A9 route and proposed corridor options and strategies for the improvement works in line with that of a DMRB Stage 1 assessment.

1.1.3. Concurrent with the PES, Transport Scotland also commissioned the A9 Dualling Strategic Environmental Assessment (SEA) Environmental Report[ii]. The SEA identified the key environmental and landscape issues along the length of the A9 route and assessed the potential impacts associated with dualling the A9. Alongside the SEA, a Strategic Flood Risk Assessment (SFRA) was undertaken by CH2MHill (2014)[iii]. The SFRA was a route wide assessment for the A9 between Perth and Inverness. The SFRA report provides information on the most likely sources of flooding along the A9 Route. The SFRA is a high level assessment which:

- identified areas sensitive to flooding along the A9 between Dalraddy to Slochd,
- provided a high level assessment of the potential constraints; and
- developed design principles and guidance for the A9 dualling scheme specific FRAs.

1.1.4. Following the completion of the PES and SEA, the Atkins-Mouchel Joint Venture (AMJV) was appointed by Transport Scotland to undertake a DMRB Stage 2 Assessment for the upgrade to dual carriageway of the stretch of the northern section of the A9 Trunk road between Dalraddy and Inverness. The Proposed Scheme referred to in this report is the upgrade of the A9 Dalraddy – Slochd which includes 24.75km of new road, and approximately 44 new watercourse crossings. The scheme objectives for the A9 Dualling Perth to Inverness are as follows:

- To improve the operational performance of the A9 by:
  - Reducing journey times; and
  - Improving journey time reliability.
- To improve safety for motorised and non-motorised users by:
  - Reducing accident severity; and
  - Reducing drivers stress.
- To facilitate active travel within the corridor; and
- To improve integration with Public Transport Facilities.

1.2. Legislative Background

1.2.1. The impacts of flooding are well documented and are often devastating with regard to cost of repairs, replacement of damaged property and loss of business. The Scottish

Government is working to create a sustainable approach to flood risk management and the impact of climate change, through the implementation of the Flood Risk Management (Scotland) Act 2009[iv].

1.2.2. The Act introduces a sustainable approach to flood risk management taking into consideration the impact of climate change. It creates a joined up and coordinated process to manage flood risk at both national and local level. The Scottish Environment Protection Agency (SEPA) are the overarching authority and have a strategic role for flood risk management. SEPA are working closely with local authorities, Scottish Water, and other responsible authorities to deliver flood risk management planning in Scotland.

1.2.3. The National Flood Risk Assessment (NFRA) was the first step in developing a Flood Risk Management Strategy and Local Flood Risk Management Plans. The assessment increased the understanding of the sources of flooding and the impacts, allowing areas at the greatest risk to the impact of flooding to be identified. These have been identified as Potentially Vulnerable Areas (PVAs).

1.2.4. In addition to the Act, Scottish Planning Policy (SPP) sets out national policies which reflect the Scottish Minister priorities. Managing Flood Risk and Drainage is included within the National Planning Framework 3 (NPF)[v].

1.2.5. SPP states that planning authorities should promote:

- a precautionary approach to flood risk from all sources of flooding including coastal, watercourse (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts) taking account of the predicted effect of climate change
- flood avoidance; by safeguarding flood storage and conveying capacity, and location development away from functional flood plains and medium to high risk areas
- flood reduction
- avoidance of increased surface water flooding through requirements of Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface

1.2.6. The planning system aims to prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere. For coastal and watercourse flooding SPP introduces a risk framework that characterises areas for planning purposes by their annual probability of flooding and gives the appropriate planning response:

- little or no risk area (annual probability of watercourse, tidal or coastal flooding is less than 0.1% (1 in 1000))
- low to medium risk area (annual probability of watercourse, tidal or coastal flooding in the range of 0.1% to 0.5% (1 in 1000 to 1 in 200)
- medium to high risk area (annual probability of watercourse, tidal or coastal flooding greater than 0.5% (1 in 200))

1.2.7. The Proposed Scheme will be considered as a development within the Medium to High Risk framework, under the category of ‘transport or utilities infrastructure (which should be designed and constructed to be operational during floods and not impede water flow)[vi]. The preferred scheme will be subjected to a Flood Risk Assessment (FRA) as required in accordance with the guidelines contained within the DMRB Volume 11, Section 3, Part10 HD45/09 – Road Drainage and the Water Environment and SPP.

1.3. Purpose

1.3.1. In order to assess the changes in flood risk for The Proposed Scheme and to third party land two FRAs will be required,

- DMRB Stage 2 Assessment FRA
- DMRB Stage 3 Assessment FRA

1.3.2. The DMRB Stage 2 Assessment FRA will focus on confirming the existing flood risk to the A9 and the surrounding area. It will assess the potential impacts of the Proposed Scheme Options.

1.3.3. The DMRB Stage 3 Assessment FRA will focus on confirming the flood risk impacts of the Preferred Scheme Options, identify mitigation measures and confirm the residual flood risk.

1.3.4. Table 1.1 details the key elements which will be included within both the Stage 2 and Stage 3 FRA.

Table 1.1: The Flood Risk Assessment Process

Task/element	DMRB Stage 2 FRA	DMRB Stage 3 FRA
Identification of sources of flooding	Fluvial Groundwater Surface water Review of historical flood information Identification of Sensitive receptors	
Baseline assessment of Fluvial Flood Risk	Identification of watercourse crossing Calculation of the existing culvert/crossings capacity using 1D hydraulic model Identification of floodplain extents Improvements to flood plain mapping through the development of 1D/2D linked models.	
Assessment of impact for Scheme Options	Assessment of the potential impact of upsizing culverts to accommodate the 0.5%AEP event Assessment of potential floodplain loss from The Proposed Scheme, including calculation of floodplain volume and review of downstream hydrographs and water level.	
Selection of Preferred Option		
Assessment of impact for Preferred Scheme Option		Update of 1D Hydraulic Models to represent the culvert /crossing design. Update of 1D/2D linked Models to represent the preferred route alignment. Calculation of potential floodplain loss Assessment of impact
Mitigation		Development of Mitigation measures
Residual Risk		Assessment of Residual Risk.

1.3.5. In summary the purpose of the DMRB Stage 2 FRA is to:

- Confirm the existing flood risk to the A9 and its surrounding areas from all sources;

- Identify the impacts The Proposed Scheme options will have on the existing flood risk; and
- Impacts and significance for each Scheme Option will be used to inform a preferred route alignment.

1.4. Study Area

1.4.1. The assessment study area is based on the River Spey catchment, this is to allow for the assessment of the impacts on downstream sensitive receptors as well as in the immediate vicinity of The Proposed Scheme. The immediate vicinity is considered to be 5km surrounding The Proposed Scheme, beginning south of Dalraddy at NRG2851 1880 and extending to north of Slochd Summit at NGR2813 1056. The Proposed Scheme has been divided into 13 sections as shown on Figure A10.2.1. Figure A10.2.1 shows the immediate vicinity and Figure A10.2.2 shows the River Spey catchment and the location of Potentially Vulnerable Areas.

2. Methodology

2.1. Identification of Flood Sources

2.1.1. There are three common sources of flooding to The Proposed Scheme; fluvial (river), groundwater and pluvial (surface water). Due to the locality and elevation of the coastal zone in relation to The Proposed Scheme, coastal flooding has been scoped out.

2.1.2. As part of the FRA all available data sets have been reviewed including OS mapping[vii], British Geological Survey (BGS) maps[viii] including hydrogeology maps[ix], and SEPA flood maps[x] to determine the known hydrological receptors along and surrounding The Proposed Scheme.

Fluvial Sources

2.1.3. All watercourses and crossings along The Proposed Scheme have been identified from the OS Mastermap, information provided by Transport Scotland relating to structures, and confirmed from site visits undertaken on the 22nd and 23rd March 2016.

2.1.4. Separate hydrology & hydraulic modelling was required:

- To confirm the capacity of the existing culverts and watercourse crossings; and
- To define and quantify the floodplains, which, where unavoidable may potentially be impacted by The Proposed Scheme Options.

2.1.5. The existing culvert/crossings have been assessed using 1D hydraulic models for each crossing and the floodplains were assessed using a 1D/2D linked hydraulic model.

2.1.6. The modelling will inform a preferred scheme of any potential mitigation strategies including floodplain volume compensation and connectivity. In addition flood level information will inform the design levels for structure sizes and carriageway elevations.

Groundwater

2.1.7. Groundwater flood risk is a qualitative desk-based assessment utilising information including the BGS Superficial and Bedrock geological maps[viii], the BGS Hydrogeological map of Scotland[ix] , the BGS Groundwater Vulnerability map[xi] of Scotland and preliminary geotechnical studies[i] undertaken as part of the PES.

Surface Water

2.1.8. Surface water flood risk has been assessed using a semi quantitative approach, based on information records provided by Transport Scotland. The 'As Built' drainage information was used to produce a hydrodynamic model (Micro-Drainage) of the existing drainage infrastructure. This has been used to determine the existing outfall locations and their discharge rates along the route of the existing A9. The post construction runoff rates for the additional carriageway areas associated with the scheme options were calculated using the methodology outlined in the Institute of Hydrology Report 124 (IH 124[xii]). The limiting discharge rates for each outfall has been determined to be a combination of the existing modelled discharge rates and the post-construction runoff rates for the additional carriageway areas. Where the areas downstream of an outfall have been identified as sensitive to surface water flooding, restricted limiting discharge rates have been considered.

2.2. Review of Flood Receptors

2.2.1. Receptors of flood risk include anything from property to people and the surrounding environment. As part of the NFRA, SEPA compiled datasets of potentially sensitive receptors. The receptors include:

- agriculture
- community facilities
- cultural heritage
- environment
- human health
- non-residential properties
- rail
- residential properties
- roads
- utilities

2.2.2. As part of the data review, receptors located within the Medium (0.5% likelihood) flood outline have been identified along The Proposed Scheme and also those within 100m of the Medium flood outline. In addition to this OS Mastermap and historical flood information has been reviewed. The DMRB provided guidance on the assessment criteria for sensitivity of receptors. These are detailed in Table 2.1.

Table 2.1: Sensitivity Criteria for the Receptors in Accordance with the DMRB

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on regional or national scale.	Floodplain or defence protecting more than 100 residential properties from flooding.
High	Attribute has a high quality and rarity on local scale.	Floodplain or defence protecting between 1 and 100 residential properties or industrial premises from flooding.

Importance	Criteria	Typical Examples
Medium	Attribute has a medium quality and rarity on local scale.	Floodplain or defence protecting 10 or fewer properties from flooding.
Low	Attribute has a low quality and rarity on low scale.	Floodplain with limited constraints and a low probability of flooding of residential and industrial properties.

Table Source: DMRB Volume 11 Section 3

2.2.3. In addition to the sensitivity examples outlined above, the criteria and examples in Table 2.2 below were derived from DMRB Volume 11, Section 3 Part 10 (HD 45/09) and have been used to inform the DMRB Stage 2 FRA.

Table 2.2: Additional Sensitivity Criteria Examples

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on regional or national scale.	Watercourse or floodplains that provide critical flood alleviation benefits.
High	Attribute has a high quality and rarity on local scale.	Watercourse or floodplains, with a possibility of direct flood risk to less populated areas without critical infrastructure, which are sensitive to increased flood risk by the possible increase in water level. Watercourse or floodplains that provide significant flood alleviation benefits.
Medium	Attribute has a medium quality and rarity on local scale.	Watercourses or floodplains, with possibility of direct flood risk to high value agricultural areas, which are Moderately sensitivity to increased flood risk by the possible increase in water levels.
Low	Attribute has a low quality and rarity on low scale.	Watercourse or floodplains passing through low value agricultural area, which are less sensitive to increased flood risk by the possible increase in water levels. Watercourse or floodplains that provide limited flood alleviation benefits.

Table Source: DMRB Volume 11 Section 3

2.3. Assessment of Significance and Magnitude

2.3.1. Flood risk has been assessed based on impact significance and magnitude criteria, shown in Table 2.3. The DMRB sets out a criteria with regard to importance and magnitude of impact to receptors providing typical examples in relation to flood risk. However due to the extent of information available at the time of the FRA, additional examples of impact have been applied to facilitate the assessment of magnitude of impact in relation to fluvial flood risk. These include changes to flow regime and severance or loss of floodplain.

Table 2.3: Criteria used to Estimate the Significance of Potential Effects

Sensitivity	Magnitude of Impact			
	Major	Moderate	Minor	Negligible
Very High	Very Large	Large/Very Large	Moderate/ Large	Neutral

High	Large/ Very Large	Moderate/ Large	Slight/ Moderate	Neutral
Medium	Large	Moderate	Slight	Neutral
Low	Slight/ Moderate	Slight	Neutral	Neutral

Changes to Flow Regime

2.3.2. It has been assumed that all the existing watercourse crossings will likely be upgraded and or replaced as part of The Proposed Scheme. As such the structure capacity is likely to increase for some instances to allow all structures to have a capacity of 0.5% AEP event including a 20% allowance for climate change In addition to this there are ecological, construction and maintenance pressures which require the hydraulic capacity of structures to be increased.

2.3.3. Increases in hydraulic capacity will result in a change to the existing flow regime, through removal of upstream constriction easing potential flooding upstream and conveying additional flow downstream.

2.3.4. The 1D hydraulic models provide an estimation of the structures existing capacity. A matrix was developed using professional judgement to categorise the potential impact from increasing the hydraulic capacity. By applying the matrix set out in Table 2.4 an assessment of future impact can be determined.

Table 2.4: Changes to Flow Regime – Future Impact Matrix

Sensitivity	0.5% Peak Flows (m^3/s)			
	<1m^3/s	1-5m^3/s	5-25m^3/s	>25m^3/s
Existing Capacity is >0.5% (1:200yr). No flood attenuation potential, upsizing will not have an impact on downstream hydrograph.	Negligible	Negligible	Negligible	Negligible
Existing Capacity 1%-0.5% Small potential for increasing downstream flows if culvert is upsized.	Negligible	Minor	Moderate	Major
Existing Capacity 10% - 1% Some potential for increasing downstream flows if culvert is upsized.	Minor	Moderate	Moderate	Major
Existing Capacity <10% Significant potential for increasing downstream flows if culvert is upsized.	Minor	Moderate	Major	Major

Floodplain Impacts

2.3.5. The Proposed Scheme Options' have been reviewed in relation to the Medium (0.5% AEP) AMJV Flood Map. It is the view of SEPA that all land liable to flooding during a flood event up to and including the 0.5% flood, even if caused by the blockage of a structure (e.g. culvert), should be considered as 'functional floodplain'[xxv].

2.3.6. Using the AMJV 0.5% AEP the potential floodplain losses have been calculated based on the maximum flood level and earthworks footprint for each of The Proposed Scheme options.

2.3.7. The DMRB criteria for estimating magnitude of impact from flood risk is shown in Table 2.5. This criteria has been applied to the 0.5% AEP event rather the 1% set in the DMRB to be consistent with SPP.

2.3.8. In additional to considering the DMRB criteria for estimating criteria of impact, this assessment considers the requirements of the Scottish Planning Policy (SPP) in terms of impacts of changes to water levels. Changes in water levels will be assessed case by case to ensure that changes to water levels are in line with the requirements of the SPP.

Table 2.5: Assessment Criteria in Relation to Floodplain Impact

Magnitude of Impact	Criteria	Typical Example
Major Adverse	Results in loss of attribute and/or quality and integrity of the attribute.	Increase in peak flood level (0.5% annual probability) >100mm.
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute.	Increase in peak flood level (0.5% annual probability) >50mm.
Minor Adverse	Results in some measurable change in attribute quality or vulnerability.	Increase in peak flood level (0.5% annual probability) >10mm.
Negligible	Results in effect on attribute, but of insignificant magnitude to affect the use or integrity.	Negligible change in peak flood level (0.5% annual probability) <+/-10mm.

Source: DMRB Volume 11 Section 3

Magnitude

2.3.9. The overall magnitude and examples are provided in Table 2.6 below.

Table 2.6: Overall Magnitude Criteria and Examples

Magnitude of Impact	Typical Examples
Major Adverse	Changes to the hydraulic capacity where the existing culvert capacity is less than 10% AEP, with a flow >5m^3/s or existing culvert capacity is between 10% AEP and 0.5% AEP with a flow >25m^3/s which would result in increased conveyance and flood risk downstream. Loss of floodplain which results in an increase in 0.5% AEP peak levels >100mm.
Moderate Adverse	Changes to the hydraulic capacity where the existing culvert capacity <1%AEP, with a flow of 1 - 5 m^3/s or existing culverts capacity is 10% - 0.5% AEP, with a 0.5% AEP flow of 5 -25 m^3/s, which would result in increased conveyance and flood risk downstream. Loss of floodplain which results in an increase in 0.5% AEP peak levels >50mm.
Minor Adverse	Changes to the hydraulic capacity where the existing culvert capacity < 1% AEP with flow < 1m^3/s or existing culvert capacity is between 1% – 0.5%, with a flow of 1-5m^3/s. Loss of floodplain which results in an increase in 0.5% AEP peak levels >10mm.
Negligible	Changes to the existing hydraulic capacity where the existing capacity of structure is >0.5% AEP or

Magnitude of Impact	Typical Examples
	existing capacity between 1% and 0.5%AEP, with a flow of < 1m^3/s Increase in 0.5%AEP peak levels <+/-10mm.

2.3.10. Where mitigation measures are required to offset the impact of The Proposed Scheme, flood mitigation measures and strategies will be considered as part of the Stage 3 Assessment.

2.3.11. For impacts associated with floodplain loss the strategy will be to use a sequential test for storage compensation (similar to the approach used in Planning Policy Statement 25[xiii] (PPS25) to flood risk and development). This strategy aligns with SEPA's guidance to stakeholders. Table 2.7 to Table 2.9 shows the sequential test which will be undertaken when considering compensation flood storage.

Table 2.7: Floodplain Loss Sequential Test 1

Test 1	Yes/No	Actions
Can the impact on the 200 year floodplain be avoided?	Yes	No action required.
	No	Can we adjust the alignment? Do we need to improve the accuracy of the floodplain extent? If the floodplain cannot be avoided then go to Test 2.

Table 2.8: Floodplain Loss Sequential Test 2

Test 2	Yes/No	Actions
Is there is an overriding need for the development to be located on an area that is floodplain?	Yes	The Phase 1 FRA will establish the need based on the appraisal of alternative route alignments. Compensatory storage is required.
	No	No action required

Table 2.9: Floodplain Loss Sequential Test 3

Test 3	Yes/No	Actions
Can direct or indirect full replacement of floodplain volume be provided subject to these constraints? Available land take. No detrimental impact on the environment, landscape or cultural heritage. No long term issues relating to land ownership. No increase in flood risk elsewhere.	Yes	Preference will be given to direct compensatory storage which is located close to the point of impact, provides level for level compensation and is hydraulically linked with the floodplain. If necessary, in-direct compensatory storage will be used which should hydraulically connect the floodplain and storage area and be controlled to ensure level for level compensation.

Test 3	Yes/No	Actions
Other site or scheme specific issues.		
	No (like-for like compensatory storage cannot be fully achieved)	On the basis of a satisfactorily robust model it should be clearly demonstrated that there would be no increase in flood risk upstream or downstream of the development/compensatory storage area.

3. Data Collection

3.1.1. Key sources of relevant information were provided by: Transport Scotland, SEPA, and The Highland Council. This information has been supplemented with information readily available within the public domain. The following key information formed the basis of the DMRB Stage 2 FRA:

- A9 Dualling Perth to Inverness Strategic Flood Risk Assessment (SFRA)[iii]
- Topographical Survey (including aerial imagery) for the A9 Dualling Corridor (Blom)
- SEPA indicative Flood Maps[x]
- The National Flood Risk Assessment[xiv]
- OS Mapping[vii]
- NextMap DTM[xv]
- FEH CD ROM (Version3)[xvi]
- Road Drainage Record Drawings
- BGS 1:50,000 superficial and bedrock geology mapping[viii]
- BGS Hydrogeological Map of Scotland 1:625,000 scale, both the 1988 hardcopy and 1995 digital version available via the BGS GeoIndex online data viewer [ix]
- BGS Groundwater Vulnerability Map of Scotland 1:625 000 scale, the 1988 hardcopy only [xi]
- A9 Perth to Inverness Dualling Geotechnical Preliminary Sources Study Report (PSSR) Moy to Inverness (Rev 2) (October 2013), Jacobs [i]

3.2. Topographical Survey

3.2.1. Transport Scotland appointed Blom AEROFILMS to undertake topographical survey works to provide information to facilitate outline and detailed design work for the A9 Dualling Programme. Transport Scotland provided the following key information:

- 1:2500 ortho-photo and grid DTM
- Topographical survey at 1:500 Scale
- High precision 1:500 survey of the carriageway envelopes
- 3D models, including elevations and information of spans, headroom and clearance for each watercourse crossing and road structure

3.2.2. In addition to the above information, Transport Scotland provided the LiDAR ground model for a 10km wide strip surrounding the A9.

3.2.3. Ground model data facilitates hydrological catchment delineation and hydrological flow estimation and can also be utilised for 2D overland flow modelling.

3.2.4. AMJV undertook additional topographical survey of nine watercourse and their floodplains in December 2015 and April 2016. This included:

- Allt an Fhearna
- Allt Chriochaidh
- Loch Alvie
- Allt na Criche (Lynwilg)
- Aviemore Burn
- The Shieling / Easter Aviemore Burn
- Allt na Criche (Granish)
- Feith Mhor
- River Dulnain

3.3. Road Drainage

3.3.1. Road drainage record drawings were obtained from Transport Scotland dating back to 1973 including the As Built Information. These drawings were available for the area of carriageway stretching from Dalraddy to Slochd, covering the full length of the scheme. The drawings provided base information the existing road drainage networks and watercourse crossings.

3.4. Potentially Vulnerable Areas (PVAs)

3.4.1. The FRM Act 2009[iv] identified areas at the greatest risk to the impact of flooding. PVAs have been identified across Scotland, as areas where the potential impact from flooding is sufficient to justify further assessment and appraisal of FRM actions. The PVAs have been identified based on the following criteria:

- Likelihood – (frequency)
- Hazard (characteristic in terms of extent, depth, duration)
- Exposure (what receptors are exposed to a flood)
- Value
- Vulnerability (ability to recover once damaged)

3.4.2. SEPA has produced extents and datasheets for each PVA designated in Scotland, which summarises the main flooding issues, the sources of flooding, estimated damages, properties at risk of flooding and the main villages and towns affected. PVAs are a focus for SEPA and local authorities in terms of better understanding and mitigating flood risks in these prioritised areas.

3.4.3. PVAs are important to consider when appraising The Proposed Scheme Options as there is the potential to impact upon sensitive downstream flood risk receptors, particularly where numerous small ‘insignificant’ impacts could possibly be cumulatively significant. The need for appropriate mitigation of any potential post scheme flood risk impacts will be particularly important where there are downstream PVAs present.

3.5. SEPA Flood Maps

3.5.1. The 2014 flood maps are published on the SEPA website[x]. These maps were developed to provide an estimate of areas potentially at risk from flooding. SEPA's web site provides details on how the maps were developed, their limitations and advice on how the map should be interpreted.

3.5.2. These maps can assist in the screening of areas for potential flood risk but cannot be used as a sole source of information and/or for design. The maps have been used to provide an indicative overview of flood risk along the development route, and inform the scope and extents of detailed hydraulic modelling which is required to assess the fluvial flood risk.

3.5.3. The published flood map return periods are consistent with SPP in terms of categorisations of flood risk:

- **High likelihood**: A flood event is likely to occur in the defined area on average once in every ten years (1:10). Or a 10% chance of happening in any one year
- **Medium likelihood**: A flood event is likely to occur in the defined on average once in every two hundred years (1:200). Or a 0.5% chance of happening in any one year
- **Low likelihood**: A flood event is likely to occur in the defined area on average once in every one thousand years (1:1000). Or a 0.1% chance of happening in any one year

3.5.4. A9 flood risk design standard is to be 0.5% AEP and also designed to include consideration of long term sustainability and resilience.

3.5.5. SEPA have provided the Medium (0.5% (1:200 year) fluvial flood outline in a GIS format to inform the flood screening activities for The Proposed Scheme.

3.5.6. In addition to river and coastal maps, SEPA has also produced surface water flood maps. These maps combine rainfall, sewer model outputs and the national surface water study to show the risk of surface water flooding.

3.6. Historical Flood Information

3.6.1. The Highland Council maintain a database of historical flood events within the Council boundary. The database contains information on the location of event, date, flooding source, waterbody name description and scale of the event.

3.7. Hydrometric Data

3.7.1. The National River Flow Archive provides hydrometric data for the gauging station networks across the UK. This website will be reviewed to establish the location of river gauging within the vicinity of the Proposed Scheme.

3.7.2. SEPA maintain a network of rainfall and river gauging stations. Data from this network has been made available to the AMJV.

4. Baseline Information

4.1. Site Overview

4.1.1. The Proposed Scheme lies between approximately 33km and 55km southeast of Inverness, skirting the southern extent of the Monadhliath Mountains and northern extent of the Cairngorms Mountains and National Park. The Proposed Scheme is located in the glacial valley of the River Spey.

4.1.2. The southern extent of the study area at Dalraddy lies at approximately 220 mAOD (above Ordnance Datum), where the Allt an Fhearna crosses the existing A9. Continuing north the elevation of The Proposed Scheme rises to 280m AOD at Carrbridge and 405mAOD at Slochd Summit (NGR2832 1258).

4.1.3. There are two main areas of settlement within the study area, Aviemore, which is close to the southern extent, and Carrbridge. There are also a number of small isolated properties and settlements along the route, including Dalraddy, Lynwilg, Granish, Avielochan, Kinveachy and Slochd.

4.1.4. The Highland Mainline Railway runs parallel to The Proposed Scheme, running east of the existing A9 from Aviemore to Slochd Beag at NGR2852 9681 where it crosses under the existing A9.

4.2. Geology

Bedrock Geology

4.2.1. As determined from available BGS maps, much of The Proposed Scheme is underlain by metamorphic bedrock geology. Igneous bedrock in the form of Major and minor intrusions is also shown along The Proposed Scheme but to a lesser extent than the metamorphic deposits. The distribution of bedrock geology is shown in Figure 9.1a-d.

Superficial Geology

4.2.2. The Proposed Scheme is underlain by a range of Quaternary Age superficial deposits including Quaternary Age glacial sand and gravel, till and diamicton which are a result of the Ice Age conditions which dominated up to 3 million years ago.

4.2.3. There is also evidence for pockets of peat of approximately the same age which were formed from organic accumulations in anaerobic conditions. The local environment was controlled by rivers up to 2 million years ago, resulting in alluvium deposits which dominate on the present-day floodplains.

4.2.4. The alluvium is comprised of sands which would have been deposited by rivers to form river terraces, as well as fine silts and clays from subsequent overbank floods.

4.2.5. The distribution of the superficial geology is shown in Figure 9.2a-d. A more comprehensive study of the bedrock geology and superficial deposits can be found in the Chapter 9 Geology, Soils and Groundwater.

4.3. Hydrogeology

4.3.1. Most of the igneous and metasedimentary bedrock in the study area are described on the BGS Bedrock Aquifer Productivity mapping as being very low productivity aquifers. Within these very low permeability rocks groundwater storage and flow is limited to the near surface weathered zone and secondary features such as fractures. Sustainable yields of less than 0.1 litres per second (l/s) are typical in suitably sited boreholes. The direction of groundwater flow in the bedrock is not known.

4.3.2. There are two areas of the Pityoulish Formation at Kinakyle and at Granish, which feature low productivity aquifers and where groundwater storage and flow is also limited to fractures. Sustainable yields are typically around 0.1 to 1 l/s in suitably sited boreholes.

4.3.3. The BGS Superficial Aquifer Productivity mapping indicates that the glaciofluvial sheet and ice contact deposits comprising gravel, sand and silt are considered to be high productivity intergranular flow aquifers. Typical sustainable borehole yields are expected to be greater than 10l/s. These aquifer types are located around Lynwilg, Aviemore, Kinveachy and west of Slochd.

4.3.4. The river terrace and alluvial deposits within the study area are described as intergranular flow aquifers with moderate to high productivity i.e. sustainable yields of between 1 and 10l/s are typical. There are small areas described as intergranular flow aquifers with low to moderate productivity and yields of 0.1 to 10 l/s, which correspond to talus deposits. These aquifer types are located at Dalraddy, south of Lynwilg, along the River Dulnain at Carrbridge, west of Baddengorm woods and at Slochd settlement.

4.3.5. Finally the Devensian Till and Peat deposits are not considered significant aquifers, with typical sustainable yields (if any) of less than 0.1l/s. These form large areas of the scheme west of the existing A9 north of Aviemore, and along the sections of the Study Area at Baddengorm Woods and Black Mount.

4.3.6. Groundwater flow within the superficial deposits is expected to follow surface topography, draining towards local surface watercourses.

4.4. Watercourses

4.4.1. The Proposed Scheme is located almost entirely within the River Spey hydrological catchment with its northernmost extent just encroaching upon the River Findhorn catchment. The Proposed Scheme crosses several larger tributaries of the River Spey including the River Dulnain and its tributary Allt Ruighe Magaig, the Allt an Fhearna and Allt-na-Criche; in addition to numerous minor burns and ditches which flow directly into the Spey.

4.4.2. The individual watercourses are discussed in Table 4.1 below, including summary hydromorphology baseline descriptions; further hydromorphology details are available in Appendix A.10.1 Hydromorphology Assessment.

Table 4.1: Watercourse Descriptions

Scheme Section	River Description	Photograph
2, 3a, 8	**River Spey** The River Spey is the longest river in Scotland, rising 2km northwest of Loch Spey in the Monadhliath Mountains at 500m AOD (above Ordnance Datum) and flowing northeast to discharge into the Moray Firth at Spey Bay,). The river drains a total area of 2948km^2. The river is characteristic of an alpine watercourse with high flow levels often attributed to snow melt. Its upper reaches drain upland landscapes such as open moorland and conifer plantation forestry, with arable agricultural land in lower valley floors. The upper and lower reaches of the watercourse are of a steep gradient and fast flowing with the middle reaches having a gentle gradient with a slower flow. The Proposed Scheme does not cross the River Spey, but is orientated roughly parallel with the river in the vicinity of Aviemore, with the nearest point located 200m southeast of the existing A9 carriageway at NGR 2885 8104. In this area, the river exhibits a gentle channel gradient with a moderate flow and a meandering course. Bed and bank sediments mainly comprise cobbles and gravel with deposition visible on inside channel meanders.	
1	**Allt an Fhearna** The Allt an Fhearna has a catchment area of approximately 22.4km^2, with its headwaters rising on the steep mountainous slopes between An Suidhe, Carn Coire Dhugain and Garbh-mheall which rise to an altitude of 590m AOD. It flows east, across a steep gradient course and is crossed by the existing A9 carriageway at NGR 2854 8092, approximately 700m upstream of its confluence with Loch Alvie at NGR 2859 8095. Loch Alvie drains to the east via the Allt Dibheach, which discharges to the River Spey at NGR 2884 8100. The channel has been historically modified (straightened), but does possess a diverse range of sedimentary features and processes, including mid-channel and marginal gravel bars, riffles and large woody debris. The channel suggests some lateral adjustment and incision occurring upstream of the existing A9 crossing and is considered a sediment exchange system. Downstream the channel is considered a stable transfer system.	

<table>
<tr><th>Scheme Section</th><th>River Description</th><th>Photograph</th></tr>
<tr><td>1</td><td>Allt Chriochaidh
The Allt Chriochaidh is a small mountainous watercourse rising between the peaks of An Sguabach, Geal-charn Mor and Creag Ghleannain, which reach an altitude of 700m AOD. The catchment is approximately 2.9km^2 draining steep moorland slopes via an incised channel before discharging into Loch Alvie at NGR 2859 8096. Upstream of this confluence the watercourse is crossed by the existing A9 carriageway at NGR 2857 8095.
The channel upstream of the crossing has formed a step-pool sequence indicating a reasonable amount of stream power potential but with no evidence of erosion or deposition suggesting a stable transfer system. The channel is significantly modified around the existing crossing (see photo). Downstream of the crossing, there is some evidence of lateral adjustment with some bank erosion, and some incision around the culvert outlet; here the channel is considered to be a stable sediment exchange system.</td><td></td></tr>
<tr><td>1</td><td>Caochan Ruadh
The Caochan Ruadh is a small upland watercourse and has a catchment area of approximately 1.83km^2. It initially drains open moorland, flowing predominantly southeast via a steep, narrow channel prior to flowing through modified field drains and a small network of ponds, before being joined by a smaller tributary stream approximately 35m upstream of the existing A9 crossing at NGR 2866 8101. The burn subsequently discharges to Loch Alvie at NGR 2866 8099.
At the existing crossing location the channel is narrow, approximately 1m wide with a shallow channel gradient. Approximately 40m upstream of the existing A9 crossing, a track with a small bridge crosses the watercourse at NGR 2866 8101 (see photo for upstream view). Flows were highly energetic upstream of the crossing location at the time of survey, with a number of chutes and cascades of step features, with some areas of rippled flow. Erosion and bank slips were common along the steeper parts upstream of the channel and there were occasional gravel bars suggesting some lateral adjustment was occurring, but overall the channel was relatively stable. Downstream of the crossing, there were no visible signs of erosion, although there were some large woody material present. At this location the channel is considered to be a stable sediment transfer system.</td><td></td></tr>
</table>

Scheme Section	River Description	Photograph
1	**Ballinluig Burn** An unnamed tributary of Loch Alvie rises on the south eastern slopes of Creag Ghleannain at 320m AOD and has a catchment area of 1.05km^2. The watercourse flows predominantly south and is crossed by the existing A9 carriageway at NGR 2869 8102, near Ballinluig, continuing south to discharge to Loch Alvie at NGR 2870 8099. While unnamed on the OS maps this stream is referred to as the Ballinluig Burn throughout this chapter for ease of reference. The channel has been historically straightened and crossed several times by numerous access roads and the A9. Rippled flows were observed upstream of the crossing, with some cascades over infrequent steps, but there was little sign of any fluvial activity, with few areas of erosion and no deposition features. There were few signs of instability and flows were slightly less energetic downstream of the crossing. Overall, the channel is considered to be a stable sediment transfer system.	
2	**Allt-na-Criche (Lynwilg)** The Allt-na-Criche has a catchment area of 6.28km^2 and drains headwaters that rise at approximately 630m AOD between the steep slopes of Cairn Creag Ghleannain and Carn Dearg Mor. From its source, the watercourse flows southeast and is crossed by the existing A9 carriageway at NGR 2884 8106. At this crossing the watercourse is heavily modified with a straightened channel and bank modifications. The B9152 and Highland Mainline railway cross the watercourse 50m and 90m downstream of the existing A9 crossing location, respectively, before its confluence with the River Spey at NGR 2885 8104. Upstream of the crossing, there were a number of step-pools and large gravel bars. The channel overall was primarily a sediment transfer system, and largely stable except for some isolated areas of bank failure. Downstream of the crossing, there were few signs of fluvial erosion; however, there were a number of side bars underneath the crossings. The channel appears to be narrowing through the preferential deposition of coarse material, however this may be localised underneath these crossings.	

Scheme Section	River Description	Photograph
4	**Aviemore Burn (Steallan Dubh/Milton Burn)** The Aviemore Burn has a catchment area of 7.45km^2 and predominantly drains forestry via several smaller tributaries, including the Steallan Dubh and Milton Burn, on the northbound side of the existing A9 carriageway. These tributaries converge upstream of the existing A9 before flowing east to the existing A9 crossing location at NGR 2893 8139. The watercourse then flows south via a straightened and realigned channel that has been diverted to accommodate properties on the western fringe of Aviemore, before flowing southeast through the town to discharge to the River Spey at NGR 2898 8125. There were a range of energetic flows observed, including chute flow over and around boulders, cascades, rippled flow, and some ponding. There were few obvious signs of erosion, and only localised deposits. Overall, the channel is considered primarily to be a stable sediment transfer system.	
4	**The Shieling / Easter Aviemore Burn** An unnamed tributary of the River Spey with a catchment area of 1.4km^2 drains forest and grassland on the northbound side of the existing A9 carriageway. It flows predominantly southeast towards the crossing location at NGR 2894 8142. From this location the watercourse flows generally east, skirting the Shieling, Easter Aviemore and the northern fringe of Aviemore, before discharging to the River Spey at NGR 2907 8140. While unnamed on the OS maps this stream is referred to as the Shieling / Easter Aviemore throughout this chapter for ease of reference. Step-pools were noted, helping to create chute flow, cascades and rippled flows and overall there was little erosion or deposition to indicate instability. The channel is considered to be functioning as a stable sediment transfer system.	

Scheme Section	River Description	Photograph
5	**Allt na Criche (Granish)** Allt na Criche rises on the southern slopes of Carn Avie and has a catchment area of approximately 2.94km^2. The watercourse flows southeast towards Sluggangranish, before turning northeast to flow parallel with the northbound carriageway of the existing A9 for approximately 1.2km. Within this reach two separate bifurcating channels branch off from the main stem and flow towards the existing A9, in the vicinity of Sluggangranish and Granish respectively. The main stem of the watercourse continues to flow northeast, draining forestry on the south eastern slopes of Carn Avie before the existing A9 crossing at NGR 2901 8157 (photo 1). From this location, the watercourse flows east to drain to Loch nan Carraigean at NGR 2907 8156. Flows in the main channel, in the vicinity of the existing crossing, ranged from rippled to chute flow, and unbroken standing waves were noted in some locations, as well as some ponded flows behind the boulders. There were some areas of erosion noted and some fine sediment deposition along the bed. Overall the channel is considered to be functioning primarily as a stable transfer system. The bifurcated channel near Sluggangranish flows southeast away from the main channel, initially in culvert but emerging immediately to the west of the existing A9. It passes under the A9 at NGR 2897 8147, at the same location as an access underpass, before flowing southeast to join the previously discussed unnamed Spey tributary on the northern edge of Aviemore. The bifurcated channel near Granish flows southeast away from the main stem in a bunded channel, and passes under the existing A9 carriageway at NGR 2898 8150 in a long culvert. It should be noted that during a visit in April 2016 the channel bunds had been damaged by cattle trampling such that no flow was reaching the A9 culvert, but was ponding in low lying ground in the adjacent field. Although no flow was observed entering the culvert a significant amount of running water could be heard within the culvert, suggesting a possible inflow from the existing A9 drainage. The channel reappears at NGR 2899 8150 flowing via a manmade concrete channel (photo 2) for approximately 6m before being crossed by a track. It then continues to flow southeast and is crossed by the B9152 road at NGR 2900 8149. No channel is shown on OS mapping downstream of this location, however, it is likely that this	 

Scheme Section	River Description	Photograph
	branch discharges to a small cluster of standing waterbodies, the largest being Lochan Ban, centred on NGR 2902 8150 at Granish.	
5	**Southern Avie Lochan Burn** An unnamed tributary of Avie Lochan with a catchment area of 1.5km^2 drains forestry on the northbound side of the existing A9 carriageway flowing east to the crossing location at NGR 2902 8164. On the northbound side of the crossing the channel is wide with concrete bed and banks and a large stepped channel bed on the approach to the existing culvert. Downstream of the crossing the channel continues to flow east to discharge to Avie Lochan at NGR 2904 8164. The channel possessed a diverse range of flow types, primarily comprising energetic flows such as chute, cascade, but where sheltered, pond areas were formed. Despite the high energy, there was very little erosion observed; however, some deposition features were noted, mostly corresponding with natural fluvial activity (point bars) and not widespread. Overall, the channel is considered to be functioning as a stable transfer system, with some function as a minor sink for fine sediment.	
5	**Northern Avie Lochan Burn** Another small unnamed tributary of Avie Lochan is located approximately 350m north of the previous tributary described, and drains forestry on the northbound side of the existing A9 carriageway. It flows east to its crossing location at NGR 2903 8167. Upstream the gradient is very steep and the channel has been stepped down the slope; there was little flow observed during the walkover survey. Downstream, on the southbound side, there is a small manmade structure which is suspected to be related to water abstraction. The watercourse is too small for a catchment size to be derived using FEH software.	

Scheme Section	River Description	Photograph
6b	**Allt Cnapach** Allt Cnapach is a small watercourse with a catchment area of 1.2km^2 that drains forestry on the northbound side of the existing A9 carriageway at Kinveachy. The watercourse flows east to be crossed by the A9 at NGR 2910 8185 and the adjacent Highland Mainline railway. OS mapping and aerial images suggest that the watercourse drains to groundwater at NGR 2913 8184, approximately 350m downstream, east-southeast of the existing crossing. Upstream of the crossing, the channel exhibited energetic and diverse flow types along its course, dominated by a series of cascades over steps. There was minimal evidence of erosion and deposits and overall the channel was a stable transfer. Downstream, the flows were mainly rippled, however the channel became increasingly ponded downstream as the channel becomes increasingly more modified and affected by downstream impoundments. The function relevant to the A9 scheme is considered to be a sediment transfer and downstream sink, overall the channel is considered stable.	
7	**Feith Mhor** The Feith Mhor is a tributary of the River Dulnain, rising in the low lying hills to the south east of Carrbridge and the current A9, with an approximate catchment area of 12.1km^2. The watercourse drains forestry and grassland and predominantly flows northeast to be crossed by the existing A9 at NGR 2908 8207 and then the Highland Mainline railway, approximately 130m downstream. The channel continues to flow northeast to its confluence with the River Dulnain downstream of Carrbridge, at NGR 2943 8241. Upstream of the current A9 crossing, a series of knickpoints were observed with energetic cascades and evidence of incision. Lengths of rippled and smooth running flows, however, are more common, with riffles also present. Downstream the flows become more uniform as the gradient reduces. Large trees were noted to be regulating flows, creating both pooled and rippled flows. The channel on the whole was a stable sediment transfer system.	

Scheme Section	River Description	Photograph
8	**River Dulnain** The River Dulnain is a major tributary of the River Spey with an upstream catchment area of 272.2km^2 from the NRFA gauging station 8009[xvii] (NGR 2977 8247). Its headwaters rise in the Monadhliath Mountains at an altitude of approximately 800m AOD, flowing northeast towards its confluence with the River Spey at NGR 3004 8238. The River Dulnain is crossed by the existing A9 carriageway at NGR 2897 8226 and then the Highland Mainline railway, approximately 90m downstream. Upstream of the A9 crossing the channel exhibited many large mobile gravel bars and there were few signs of significant active erosion. Flows were energetic and dynamic, with standing waves and rippled flow prevalent. Downstream of the A9 crossing, bank erosion was noted on the Right Hand Bank (RHB) immediately downstream of the railway. The channel is considered overall to be a stable transfer system.	
8	**Allt nan Ceatharnach (Allt Ruighe Magaig/Baddengorm Burn)** The Allt nan Ceatharnach has catchment area of 17.2km^2, and rises on the hills of Carn Loisgte, Creag a' Bhainne and Can a' Chuaille. It is formed from three major tributaries, the Allt Ruighe Magaig, the Allt a' Bhainne and the Bogbain Burn. Draining open grassland and forestry, the burn flows broadly south and is crossed by the Highland Mainline railway at NGR 2892 8233. A further 160m downstream it is crossed by the existing A9 at NGR 2891 8232, before flowing south to its confluence with the River Dulnain approximately 1.2km downstream. In the vicinity of the existing A9 crossing there was a good range of high energy flows, including cascades, broken and unbroken standing waves over the boulder formations and fallen trees; however, there were higher flows than considered normal at the time of the survey. Some bank erosion was noted on the Left Hand Bank (LHB), but mostly appeared quite stable. Terraces on the RHB suggested the channel had previously shifted its course, but there was little evidence to suggest this process was ongoing. Overall, the channel is considered to be a stable transfer system.	

Scheme Section	River Description	Photograph
9	**Bogbain Burn** Bogbain Burn is situated at Black Mount and is formed from several headwaters which rise on the southeastern slopes of Carn a' Chuaille and Carn nam Bain-tighearna, which subsequently converge to the north of the Highland Mainline railway. The burn then flows broadly southeast through forestry plantation, roughly parallel with the existing A9, and is crossed several times by the railway and the A938 before joining the Allt nan Ceatharnach at NGR 2888 8239. Although not crossed by the existing A9 the Bogbain Burn lies close to several of the Proposed Black Mount Junction Options. In this area (NGR 2871 8243) the burn is confined within a narrow, steep sided valley and was approximately 2m wide with a cobble and gravel bed.	
10,11	**Slochd Mhuic (Allt an Aonaich)** The Slochd Mhuic has a catchment area of 7.3km^2 draining upland moor and forestry. A heavily modified section of the headwater drains Slochd Summit, flows southeast, and is crossed several times over a distance of approximately 1.3km by the existing A9 carriageway (NGR 2841 8250, NGR 2838 8254, NGR 2835 8256 and NGR 2835 82567). The watercourse continues south, running broadly parallel to the existing A9, to the confluence with Allt Ruighe an t-Sabhail, at NGR 2843 8243. From here the Slochd Mhuic flows predominantly south for approximately 4km, converging with several large streams to become the Allt an Aonaich, which converges with the River Dulnain at NGR 2864 8217. The headwaters of the burn are very heavily modified where it criss-crosses the existing A9, Highland Mainline railway and cycle path, with 7 culverts of varying lengths, several straightened reaches, a concrete channel over 400m long and several piped inflows from existing road and rail discharges and one cascade chamber. Downstream of the heavily modified reach the observed flows were mainly rippled, with some cascades over boulders and some very small steps. Overall there was no erosion and little deposition, except for some fine sediment on the bed. The channel	

Scheme Section	River Description	Photograph
	did not possess the capacity to undertake any fluvial activity and was mostly a stable sediment transfer system.	
11	**Allt Cosach** Allt Cosach is a small tributary of the River Findhorn and is located within 200m of the Proposed Scheme at its northern extent. A small headwater drain rises adjacent to the existing A9, is crossed by the Highland Mainline Railway, and joins the main headwater approximately 350m downstream. The Highland Mainline Railway remains between the A9 and the watercourse as the Allt Cosach flows northwest, roughly parallel with the A9 for approximately 400m before continuing to flow northwest beyond the Proposed Scheme and to converge with the River Findhorn approximately 3km downstream at NGR 2806 8287.	

Scheme Section	River Description	Photograph
11	**The River Findhorn** The River Findhorn is one of the longest rivers in Scotland, with headwaters rising in the Monadhliath Mountains at 940m AOD (above Ordnance Datum), approximately 23km southwest of Slochd, flowing generally northeast to the Moray Firth. The catchment drains a total area of 786km^2 with the Proposed Scheme interacting indirectly via the Allt Cosach tributary. The upper reaches of this catchment drains land characterised by upland landscapes such as open moorland and conifer plantation forestry, with channel morphology often of steep gradient and typically flashy. The River Findhorn is crossed by the existing A9 dual carriageway at NGR 2808 8290, approximately 200m downstream of the Findhorn Viaduct Highland Mainline crossing. In this area the River Findhorn is characterised by a meandering, moderate gradient channel, wide floodplain, cobble, gravel and boulder bed, and pool and riffle sequences. At the existing A9 carriageway crossing location, the channel width is approximately 20m.	

4.5. Historical Flooding Information

4.5.1. Historical flood information has been assessed within a 1.5km buffer from the current A9 carriageway between Dalraddy and Slochd.

4.5.2. The buffer enabled an assessment of flood risk upstream and downstream of the affected river reaches and provides an overview of flood risk in relation to the existing A9.

4.5.3. Table 4.2 details some of the most significant documented flood events surrounding The Proposed Scheme providing a snap shot of the flood risk. Each event has been ascribed a reference by The Highland Council, this may not be a complete record of flooding. The location of historical flooding is shown in Figure A10.2.4 a-d.

Table 4.2: Historical Flood Events

Date	Location	Description	Flood Source	Reference	Highland Council Event Reference
1829	Carrbridge	"Great destruction was done to the land, many acres having been swept away. The bridge of Curr*, had its southern abutment undermined by water" "Force of the water was so great that it made the arch spring 15 feet into the air".	Fluvial	Great Moray Floods of 1829, Sir Thomas Dick Lauder, 1998 (Inverness Reference Library	Hig1312 Hig1311
1829	Strathspey	In August 1829 the year of the Muckle Spate there was phenomenal rain and wind which persisted unceasingly for 2 whole days and affected the Nairn, the Findhorn, the Lossie and the Spey. The very air seemed to be descending in one mass of water. The Muckle Spate of 1829 devastated much of Strathspey and Speyside including many of the bridges on the river.	Fluvial	Great Moray Floods of 1829, Sir Thomas Dick Lauder, 1998 (Inverness Reference Library	N/A
1829	Aviemore	"The river broke away from its channel, and, running in parallel, at the distance of 200 yards, it bore down every object, natural or artificial that presented itself."	Fluvial	Great Moray Floods of 1829, Sir Thomas Dick Lauder, 1998 (Inverness Reference Library	N/A
1875, 1892, 1914	Carrbridge	"Significant river floods in 1875 and 1892, with a bridge being swept away in 1914 causing a serious rail accident and the death of 5 people."	Fluvial	SEPA: Findhorn, Nairn and Speyside Local District Plan	Hig2088
1923	Carrbridge	"In 1923 there was flooding at Carrbridge, resulting in four bridges being destroyed and a two mile stretch of road closed for over a month".		SEPA: Findhorn, Nairn and Speyside Local District Plan	

Date	Location	Description	Flood Source	Reference	Highland Council Event Reference
1990	Aviemore	Flooding on the Aviemore Burn occurred in 1990 at the same time the Spey was in spate" The RH Cuthbertson and Partners (Nov, 1999), report documents that several home in Craig-na-Gower Avenue and the Primary School*, were flooded. This document states further flooding of Aviemore occurred on 1865,1868,1869,1875,1887,1888,1892,1894,1898,1906,1973,1975,1978,1979,1981,1983,1984,1986,1989,1997 and 2006 without mention of magnitude.	Fluvial	SEPA: Findhorn, Nairn and Speyside Local District Plan	Hig1457 Hig2099 Hig1148 Hig1166 Hig1458
2005	Aviemore	"The Aviemore Burn flooded due to an undersized culvert which has subsequently been replaced."	Fluvial	SEPA: Findhorn, Nairn and Speyside Local District Plan	Hig1542
2014	Carrbridge	Part of the A938 near Carrbridge fell away due to volume of water.	Fluvial	BBC Scotland	

*N.B Aviemore Primary School has since relocated, with the site being proposed for future commercial development.

4.5.4. On assessment of the HIG1311 and HIG1312 events and review of the Great Moray Floods, it was clear that the flooding in August 1829 was a significant regional event and impacts were seen throughout the region including the area surrounding the existing A9, at Carrbridge and Aviemore.

4.6. Hydrometric Data

4.6.1. A review of the data contained on the National River Flow Archive[xviii] shows that there are number of gauging stations in the River Spey Catchment, which are operated by SEPA. All the gauging stations are quality checked and are suitable for peak flow estimations. Table 4.3 details the gauges identified within the study area of The Proposed Scheme.

Table 4.3: Gauging Stations within the River Spey Catchment

Gauging Station Number	Name	Watercourse	NGR	Catchment Area	Record Length
8002	Kinrara	River Spey	NH 880082	1012	1951-Present
8005	Boat of Garten	River Spey	NH 946192	1268	1951-Present
8009	Balnaan Bridge	River Dulnain	NH 977247	272	1952-Present
8010	Grantown	River Spey	NJ 032267	1749	1951-Present

4.6.2. In addition to the gauges identified in Table 4.3, a level only gauge was identified at Sluggan on the River Dulnain upstream of The Proposed Scheme. This gauge is operated and maintained by SEPA.

4.6.3. Annual maxima (AMAX) flow series were received from SEPA for Boat of Garten, Balnaan Bridge and Grantown. Based on the available information eight high flow events were identified as potential for model calibration or verification:

- 18/12/1966
- 05/02/1990
- 03/01/1992
- 17/01/1993
- 02/03/1997
- 11/01/2005
- 05/12/2014
- 30/12/2014

4.6.4. SEPA also provided 15minute rainfall data for 3 gauges located within the River Spey catchment and a further 2 gauges within the River Findhorn Catchment. Summary information for each gauge is given in Table 4.4.

4.6.5. Figure A10.2.6 shows the location of the hydrometric gauging stations.

Table 4.4: Rain Gauges relevant to the modelled reach

Rain Gauge	NGR	Catchment Location	Record Type	Records Available 1966	Records Available 1990	Record Available 1992	Record Available 1993	Record Available 1997	Record Available 2005	Record Available 2014
Coignafearn	270963 817820	River Findhorn	15 minute		Yes	Yes	Yes	Yes		
Freeburn	279547 830023	River Findhorn	15 minute					Yes	Yes	Yes
Sluggan	286980 821930	River Dulnain	15 minute					Yes		Yes
Auchdergannach	300345 815642	River Spey	15 minute							Yes
Glenmore Lodge No2	298640 809400	River Spey.	15 minute						Yes	Yes

4.7. Potentially Vulnerable Areas (PVAs)

4.7.1. There are two PVAs between Dalraddy and Slochd, PVA 05/11 and 05/10, the locations of which are shown on Figure A10.2.2.

4.7.2. PVA 05/11[xix] covers Aviemore and Boat of Garten, and identifies 70 residential properties and 30 non-residential properties at risk of flooding. The sources of flooding are 37% river and 63% surface water. Surface water flood risk is noted for Aviemore, with River from the River Spey mostly affecting agricultural land. However there are small impacts on built up areas in Aviemore from the Aviemore Burn. The PVA identifies the A95, A9, B970 and B9153 as being potentially affected by flooding. There are 80 roads within the PCA identified as having a Medium Likelihood of flooding.

4.7.3. PVA 05/10[xx] covers Carrbridge, and identifies fewer than 10 residential properties and a further 10 non-residential properties at risk of flooding. The sources of flooding are 43% river and 57% surface water. The PVA identifies the A9, A938 and B9153 as being potentially affected by flooding. It documents that there are 3 sections of the A9, with a total length of 90m at risk of flooding and have outlined an objective to reduce the physical risk and disruption risk.

4.7.4. In addition to the PVAs located along the route of The Proposed Scheme, PVA 05/09[xxi] has been identified as a potential downstream receptor, which is located 65km downstream of Aviemore on the River Spey. PVA 05/09 covers Rothes and Aberlour, with 350 residential properties at risk of flooding. The sources of flooding are 52% river and 48% surface water.

4.8. Flood Defences

4.8.1. A review of the Scottish Flood Defence Asset Database (SFDAD)[xxii], shows that there are no formal defence schemes under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 within The Proposed Scheme.

4.8.2. The SFDAD database identified two formal flood prevention schemes, which are located approximately 65 and 75km downstream respectively of The Proposed Scheme at Aviemore. These are the Aberlour Flood Prevention Scheme, which was completed in 1982 and the Rothes Flood Prevention Scheme, which was completed in 2011 (PVA 05/09).

4.8.3. The Aberlour Flood Prevention Scheme included improvements and the realignment of existing ditches, culverts and cut off channels, within the village. There were no works on the River Spey.

4.8.4. The Rothes Flood Prevention Scheme was built to provide protection to the village from the flooding from the Black Burn. The scheme includes channel widening, replacement of bridges, flood walls, earth embankment and bank protection works. The scheme was designed to provide Rothes with a standard of protection of 1 in 100 years (1% AEP) plus an allowance for climate change[xxiii]. There were no works on the River Spey.

4.9. Site Walkover

4.9.1. The purpose of the site walkover on the 22nd and 23rd March 2016, was to identify potential floodplain areas surrounding The Proposed Scheme. The SEPA flood maps were initially reviewed in order to locate likely floodplain locations.

4.9.2. The following watercourses were visited during the walkover: Allt na Criche (Lynwilg), Aviemore Burn, Allt na Criche (Granish), Feith Mhor, and River Dulnain and a selection of photographs are shown in Annex B.

4.9.3. From the site visit it was noted that the Allt na Criche (Granish), flows steeply down from Cairn Mor to the west before flowing parallel to the A9 in a relatively low gradient valley. The floodplains in this area are contained by steep hillside on the left bank and the forestry track embankment on the right bank. The channel is naturally straight, and at NGR 2896 8151 and 2894 8147 some flow is diverted towards and under the existing A9.

4.9.4. The Feith Mhor is located in a forestry area, with a number of Forestry Commission tracks crossing or in the vicinity of the watercourse. Between the existing A9 and the Highland Mainline Railway the topography of the watercourse is relatively flat with a meandering planform and a number of adjoining tributaries. Due to the relatively flat topography, the floodplains potential in this area requires confirmation around The Proposed Scheme.

4.9.5. The River Dulnain, upstream of Carrbridge, is of particular interest as the topography on the left bank is relatively shallow suggesting that the fields on the left bank could be utilised during flood events. The right bank has a higher elevation, and the preferential flow direction would be to the left bank The Proposed Scheme would cross the River Dulnain and the associated floodplains and the flood extents around The Proposed Scheme requires confirmation.

4.9.6. The Allt an Fhearna could not be visited during the site walkover due to ongoing construction works associated with the A9 Kincraig to Dalraddy dualling.

4.9.7. Prior to the site visit, the topographical survey data was analysed in order to determine if all the relevant data, needed to build the 1D hydraulic models, was present. Any gaps or inconsistencies in the data was then recorded or verified where possible at the relevant locations.

4.9.8. A number of small drains were also identified which run parallel to the A9 carriageway. These drains convey a combination of some local runoff and carriageway drainage and provide some longitudinal cross connectivity between A9 crossings.

5. Existing Flood Risk

5.1. Flooding From Rivers (Fluvial Flooding)

5.1.1. There are 34 watercourse crossings shown on the 1:25,000 and 1:10,000 OS maps. In addition to this there are a number of smaller watercourses/drains, which have associated crossings. An additional 10 crossings were identified from the topographical survey and site visit information. A total of 44 natural watercourses/drains were identified which cross under the existing A9 carriageway between Dalraddy and Slochd. The watercourse crossing locations are shown in Figures A10.1.2a to A10.1.2i.

5.1.2. The crossings type vary from bridges, pipes and box culverts to corrugated steel arch structures. Table 5.1 details the structure details.

5.1.3. For each watercourse crossing identified the catchments were delineated using the Flood Estimation Handbook (FEH) CD Rom Version 3, NextMap DTM, topographical survey, and aerial imagery. Peak flow estimations were derived for each catchment using the FEH standard methodologies[xi] including the:

- FEH Rainfall Runoff Method
- FEH Statistical Approach (where catchment > 5km2)
- FEH Revitalised Flood Hydrograph Method V2 (ReFH2)

5.1.4. The catchment plans can be seen in Figures A10.2.7a to j with Table 5.1 provides details for each watercourse, catchment description, crossing type, and peak flows.

5.1.5. The precautionary approach has been applied to the determination of the peak flows for each watercourse crossing at this stage (i.e. generally, the highest value for flow estimation has been adopted and from FEH Rainfall Runoff method).

5.1.6. Each watercourse crossing has been provide a unique crossing reference id, this is reference as DS-WC-xx and is numbered sequential from south to north. In addition to this each watercourse crossing will have a corresponding watershed/catchment reference id, this is referenced as DS-WS-xx. The Transport Scotland reference ID has been retained, for continuity. Herein we will be referring to the Watercourse Crossing ID.

Table 5.1: Delineated Catchment Information between Dalraddy and Slochd

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km^2)	Catchment Description	Type	Size	Method	Peak Flow (m^3/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
1	DS-WC-001	A9 1090	DS-WS-038	Allt an Fhearna	20.21	Draining a large area, several tributaries contribute to flows as Allt an Fhearna crosses the A9 in an easterly direction before flowing into Loch Alvie.	Bridge	4.38m x7.3m	Statistical	10.39	20.56	32.43	38.92
1	DS-WC-002	A9 1100	DS-WS-037	Allt Chriochaidh	2.58	Originating in the Geal-charn Mor, Chriochaidh Allt flows south westerly as it crosses the A9 before flowing into Loch Alvie	Bridge	1.5m x 4m	Rainfall Runoff	2.11	4.21	6.60	7.92
1	DS-WC-004	A9 1100 C70	DS-WS-036	Caochan Ruadh			Circular Culvert Corrugated	2.0m Ø	Rainfall Runoff	1.59	3.20	5.02	6.03
1	DS-WC-005	A9 1110 C10	DS-WS-035	Ballinluig Burn	0.99	Draining Creag Ghleannain the unnamed watercourse flows south before crossing the A9 and flows into Loch Alvie.	Circular Culvert Corrugated	2.4m Ø	Rainfall Runoff	0.65	1.32	2.08	2.5

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km^2)	Catchment Description	Type	Size	Method	Peak Flow (m^3/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
2	DS-WC-005A	A9 1120	DS-WS-034B	Unnamed Drain	0.21	Drainage path	Culvert	0.9m Ø	Rainfall Runoff	0.41	0.91	1.42	1.71
2	DS-WS-006	A9 1120 C19	DS-WS-034A	Unnamed Drain	0.008	Drainage path	Circular Culvert, Concrete	0.9m Ø	Rainfall Runoff	0.16	0.35	0.54	0.65
3a	DS-WC-007	A9 1130	DS-WS-034	Allt na Criche (Lynwilg)	6.47	Draining from the Carn Dearg Mor the Allt na Criche (Lynwilg) flows south towards the A9, before crossing under the A9, and discharging into the River Spey.	Bridge	4m x 6m	Rainfall Runoff	4.78	9.55	14.95	17.94
3a	DS-WC-010 DS-WC-011		DS-WS-033	Loch Puladdern	1.18	Loch Puladdern and an associated Loch are within this catchment with a drain crossing the A9.	2 x Circular Culvert, Corrugated	0.9m Ø 0.5m Ø	Rainfall Runoff	1.53	3.23	4.97	5.97
3b	DS-WC-013	A9 1150 C49	DS-WS-032	Unnamed Drain	0.44	Draining Craigellachie National Nature Reserve the drain flows north before crossing the A9.	Circular Culvert, Corrugated	1m Ø	Rainfall Runoff	0.47	0.97	1.53	1.84
4	DS-WC-013A	Unrecorded	DS-WS-031	Unnamed Drain	0.23	Drainage path	Culvert	0.8m Ø	Rainfall Runoff	0.25	0.52	0.82	0.98

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km^2)	Catchment Description	Type	Size	Method	Peak Flow (m^3/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
4	DS-WC-014	A9 1150 C95	DS-WS-030	Aviemore Burn	6.29	Aviemore Burn, consists of 3 main tributaries including Milton Burn, Steallan Dubh and Allt Dubh flowing east through Aviemore before joining the River Spey.	Circular Culvert, Corrugated	2.4m Ø	Rainfall Runoff	4.83	9.69	15.32	18.39
4	DS-WC-016	A9 1150 C11	DS-WS-029	The Shieling / Easter Aviemore Burn	0.6	The unnamed watercourse flows east as it crosses the A9 before joining the River Spey.	Circular Culvert, Corrugated	0.9m Ø	Rainfall Runoff	0.53	1.10	1.76	2.11
5	DS-WC-017	3534	DS-WS-028B	Southern bifurcation of Allt na Criche (Granish)	1.71	Originating in the Allt na Criche, the unnamed watercourse flows east as it crosses the A9 before joining the River Spey.	Circular Culvert, Corrugated	1.2m Ø	Rainfall Runoff	1.72	3.59	5.75	6.90
5	DS-WC-019		DS-WS-028A	Northern bifurcation of Allt na Criche (Granish)	0.22	Originating in the Allt na Criche, the unnamed watercourse flows east as it crosses the A9 as it flows	Circular Culvert, Corrugated.	0.4m Ø	Rainfall Runoff	0.20	0.41	0.66	0.79

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km^2)	Catchment Description	Type	Size	Method	Peak Flow (m^3/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
						toward Lochan Ban							
5	DS-WC-022	A9 1170 C12	DS-WS-028	Allt na Criche (Granish)	2.71	Watercourse flowing east as it crosses the A9 before flowing into Loch na Carraigean.	Circular Culvert, Corrugated	0.7m Ø	Rainfall Runoff	2.52	5.21	8.35	10.02
5	DS-WC-023	A9 1170 C18	DS-WS-027	Unnamed Drain	0.12	Drainage path	Circular Culvert, Corrugated	0.9m Ø	Rainfall Runoff	0.17	0.37	0.59	0.71
5	DS-WC-024	3690 A9 1170 C22	DS-WS-026	Southern Avie Lochan Burn	1.15	Watercourse flowing east as it crosses the A9 before flowing into Avie Lochan	Circular Culvert, Corrugated	1.45m Ø	Rainfall Runoff	1.23	2.59	4.14	4.97
5	DS-WC-025	3689 A9 1170 C20	DS-WS-025	Unnamed Drain	0.16	Drainage path	Circular Culvert, Corrugated	0.9m Ø	Rainfall Runoff	0.16	0.34	0.55	0.66
5	DS-WC-026	3688	DS-WS-024	Northern Avie Lochan Burn	0.51	Drainage path flowing east toward Avie Lochan	Circular Culvert, Corrugated	0.9m Ø	Rainfall Runoff	0.50	1.09	1.75	2.10
6a	DS-WC-027	A9 1170 C26	DS-WS-023	Unnamed Drain	0.31	Drainage path originating from Beinn Ghuilbin	Circular Culvert, Corrugated	0.4m Ø	Rainfall Runoff	0.31	0.66	1.06	1.27
6a	DS-WC-029	A9 1170 C32	DS-WS-022	Unnamed Drain	0.16	Drainage path	Circular Culvert,	0.6m Ø	Rainfall Runoff	0.16	0.34	0.55	0.66

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km²)	Catchment Description	Type	Size	Method	Peak Flow (m³/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
							Corrugated						
6a	DS-WC-031		DS-WS-021	Unnamed Drain	0.02	Drainage path	TBC	0.4m Ø 0.5m Ø	Rainfall Runoff	0.03	0.06	0.09	0.11
6b	DS-WC-032		DS-WS-020	Allt Cnapach	2.09	Rising through Kinveachy Forest, flowing east as it crosses the A9.	Circular Culvert, Corrugated	1.5m Ø	Rainfall Runoff	2.12	4.38	6.91	8.3
7	DS-WC-032A	A9 1170 C53	DS-WS-019	Unnamed Drain	0.13	Drainage path	Circular Culvert, Corrugated	0.8m Ø	Rainfall Runoff	0.12	0.24	0.38	0.46
7	DS-WC-035		DS-WS-018	Unnamed Drain	0.31	Drainage paths originating from Torr Mhuic	Circular Culvert, Corrugated	0.3m Ø	Rainfall Runoff	0.28	0.59	0.93	1.12
7	DS-WC-035A		DS-WS-017	Unnamed Drain	0.0	Drainage path	Circular Culvert, Corrugated	0.3m Ø	Rainfall Runoff	0.10	0.22	0.35	0.41
7	DS-WC-036	A9 1170 C75	DS-WS-016	Feith Mhor	2.37	Rising from Carn na h-Eilde and flows northeast, where it crosses the A9 before joining the River Dulnain.	Circular Culvert, Corrugated	2.0m Ø	Rainfall Runoff	1.8	3.9	6.2	7.4
7	DS-WC-039	A9 1170 C77	DS-WS-015	Unnamed Drain	0.60	Drainage path draining Carn	Circular Culvert,	1.58m Ø	Rainfall Runoff	0.4	0.87	1.42	1.70

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km²)	Catchment Description	Type	Size	Method	Peak Flow (m³/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
						Lethendry before flowing into Feith Mhor	Corrugated						
7	DS-WC-041	A9 1170 C81	DS-WS-014	Unnamed Drain	0.004	Drainage path	Circular Culvert, Corrugated	0.5m Ø	Rainfall Runoff	0.01	0.01	0.02	0.02
7	DS-WC-042		DS-WS-013	Unnamed Drain	0.02	Drainage path	Circular Culvert, Corrugated and Mitred.	0.5m Ø	Rainfall Runoff	0.02	0.04	0.07	0.08
7	DS-WC-043	4160	DS-WS-012	Unnamed Drain	0.87	Drainage path	Circular Culvert, Corrugated with a square headwall.	1.1m Ø	Rainfall Runoff	0.84	1.81	2.90	3.48
8	DS-WC-045		DS-WS-011	Unnamed Drain	0.18	Drainage path draining Torr na Mallachd	Catch pit	0.45m	Rainfall Runoff	0.13	0.28	0.47	0.56
8	DS-WC-046	A9 1190	DS-WS-010*	River Dulnain	188.1	Rising in the Monadhliath Mountains draining peaks such as Carn Sgulain and Cnoc Fraing the watercourse flows in a north westerly direction before its crossing with the existing A9	Bridge	14m x 34m	Statistical	71.82	135.26	206.06	247.42

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km²)	Catchment Description	Type	Size	Method	Peak Flow (m³/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
						before flowing through Carrbridge.							
8	DS-WC-048	A9 1200	DS-WS-009*	Allt nan Ceatharnach	16.0	Rising from Carn lain Ruaidh and flowing south towards its confluence with Allt a Bhainne and Bogbain burn before crossing the existing A9 as Allt nan Ceatharnach where it meets the River Dulnain.	Bridge	10m x 13m	Statistical	10.29	21.37	34.84	44.74
9	DS-WC-049	4159	DS-WS-008	Unnamed Drain	0.10	Drainage path	Circular Culvert, Corrugated and Mitred.	0.45m	Rainfall Runoff	0.11	0.25	0.38	0.45
9	DS-WC-050	3421	DS-WS-007	Unnamed Drain	0.17	Drainage path draining Black Mount	Circular Culvert, Corrugated and Mitred.	0.6m	Rainfall Runoff	0.19	0.41	0.66	0.79
9	DS-WC-051		DS-WS-006	Unnamed Drain	0.01	Drainage path	Culvert	0.45m Ø	Rainfall Runoff	0.02	0.04	0.07	0.09
10	DS-WC-052		DS-WS-005	Unnamed Drain	0.24	Drainage path	Circular Culvert,	0.5m Ø	Rainfall Runoff	0.39	0.88	1.41	1.69

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km^2)	Catchment Description	Type	Size	Method	Peak Flow (m^3/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
							Corrugated and Mitred.						
10	DS-WC-053	3422	DS-WS-004	Unnamed Drain	0.27	Drainage path draining Carn nam Bain-tighearna	Circular Culvert, Corrugated and Mitred.	1.0m Ø	Rainfall Runoff	0.44	0.98	1.56	1.88
10	DS-WC-055		DS-WS-004A	Unnamed Drain	0.27	Drainage path	Circular culvert, Corrugated and Mitred.	0.7m Ø	Rainfall Runoff	0.45	1.0	1.61	1.93
11	DS-WC-057	A9 1210 C31	DS-WS-003	Slochd Mhuic	0.27	Drainage path draining Carn nam Bain-tighearna	Rectangular, concrete box with 90degree headwall with 45 degree bevels.	1.6m x 2.7m	Rainfall Runoff	0.45	1.0	1.6	1.92
11	DS-WC-060	3649	DS-WS-002	Unnamed tributary of Slochd Mhuic	1.4	Drainage paths originating from Torr Mor	Rectangular, concrete box with 90degree headwall with 45 degree bevels.	1.6m x 2.7m	Rainfall Runoff	2.2	4.8	7.6	9.1
11	DS-WC-061	A9 1210 C45	DS-WS-002	Slochd Mhuic	1.4	Drainage paths originating from Torr Mor	Circular Culvert,	1.6m Ø	Rainfall Runoff	2.2	4.8	7.6	9.1

Scheme Section	Water Crossing ID	TS Structure ID*	Catchment ID	Water-course Name	Catch-ment Area (km^2)	Catchment Description	Type	Size	Method	Peak Flow (m^3/s)			
									AEP:	50%	4%	0.5%	0.5% Climate Change
							Corrugated						
11	DS-WC-062	3648 A9 1210 C46	DS-WS-002	Slochd Mhuic			Circular Culvert, Corrugated	1.6m Ø					

*Statistical estimates.

5.2. Existing Culvert Capacity

5.2.1. The existing hydraulic capacity of the watercourse crossings was calculated through the use of a steady-state one dimensional (1D) hydraulic models. The models were built in ISIS 3.7 modelling software, with cross sectional information extracted from the existing Blom Ortho topographical survey. Each model typically consists of three cross sections upstream of the culvert, with a spacing of approximately 10 metres (m) between each section, with sufficient cross sections downstream to minimise the potential for downstream boundary impact on the culverts.

5.2.2. The 1D hydraulic models have been used to estimate existing culvert capacity based on an upstream surcharge to soffit level. The flow capacity associated with a spill level that would either result in overland flows across the A9 carriageway or parallel to the A9 towards a different culvert crossing has also been estimated. The latter flow would be that associated with the maximum headwater possible at the culvert entrance before spilling elsewhere. The internal hydraulic pipe capacity has also been estimated for comparison (which excludes any inlet and outlet influences).

5.2.3. Table 5.2 below summaries the catchment, flow, and capacity details for the existing watercourse crossings.

5.2.4. The following watercourse crossings have been exclude from the assessment at this stage:

- DS-WC-013; and
- DS-WC-031

5.2.5. This is due to limited information on the structure details including inlet, and outlet levels. These are piped structures, with relatively small catchments. Additional survey information has been requested and these structures will be assessed as part of Stage 3 Assessment.

5.2.6. The capacity of the culverts is based on the surcharge to the soffit. This is the flow required in the model to achieve a water level at the culvert inlet equal to the soffit level. The maximum surcharge available is the flow required in the model to achieve a water level that exceeds the highest point on the existing road surface or laterally to the channel whereby flow will exceed a high point on the bank and flow towards the next adjacent crossing structure.

5.2.7. There are some culverts (DS-WC-017, DS-WC-029, and DS-WC-039) where the surcharge to spill level is lower than the surcharge to soffit. This is due to an overtopping route upstream of the crossing location.

Table 5.2: Existing Watercourse Crossing Capacities

Scheme Section	Watercourse Crossing ID	TS-Culvert ID	Inlet Coordinate	Culvert Size	Catchment	Watercourse Name	0.5% Flow (m3/s)	Current Estimated Culvert Capacity (m^3/s / AEP)	
								Surcharge to Soffit*	Max Surcharge Available**
1	DS-WC-001	A9 1090	2854 8091	4.38m x7.3m	DS-WS-038	Allt an Fhearna	32.43**	95.2 / >0.1%*	126.2 / >0.1%*
1	DS-WC-002	A9 1100	2856 8095	1.5m x 4m	DS-WS-037	Allt Chriochaidh	6.60	20.9/ >0.1%*	28.3/ >0.1%*
1	DS-WC-004	A9 1100 C70	2866 8100	2.0m Ø	DS-WS-036	Caochan Ruadh	5.02	5.42 / 0.5%	21.83 / >0.1%
1	DS-WC-005	A9 1110 C10	2868 8101	2.4m Ø	DS-WS-035	Ballinluig Burn	2.26	9.1 / >0.1%	12.00 / >0.1%
2	DS-WC-005A	A9 1120	2876 8103	0.9m Ø	DS-WS-034B	Unnamed Drain	1.42	0.76/ 10%	1.18/ 2%
2	DS-WC-006	A9 1120 C19	2877 8103	0.9m Ø	DS-WS-034A	Unnamed Drain	0.54	0.98 / 0.5%	2.13 / >0.1%
3a	DS-WC-007	A9 1130	288357 810590	4m x 6m	DS-WS-034	Allt na Criche (Lynwilg)	14.95	83.7 / >0.1%*	109.9 / >0.1%*
3a	DS-WC-010 DS-WC-011	Unrecorded	289144 812150	0.9m Ø 0.5m Ø	DS-WS-033	Loch Puladdern	4.97	0.3 / <50%	0.5 / <50%
3b	DS-WC-013	A9 1150 C49	289203 813032	1m Ø	DS-WS-032	Unnamed Drain	1.53	Awaiting topo	
4	DS-WC-013A	Unrecorded	289306 813779	0.8m Ø	DS-WS-031	Unnamed Drain	0.82	0.99 / 0.5%*	2.46/ >0.1%*
4	DS-WC-014	A9 1150 C95	289320 813850	2.4m Ø	DS-WS-030	Aviemore Burn	15.32	8.05 / 10%*	9.64 / 4%*
4	DS-WC-016	A9 1150 C11	289439 814153	0.9m Ø	DS-WS-029	The Shieling / Easter Aviemore Burn	1.76	0.89 / 10%*	2.15 / 0.5%*
5	DS-WC-017	3534	289678 814722	1.2m Ø	DS-WS-028B	Southern bifurcation of Allt	5.75	1.78 / <50%	1.12 / <50%

Scheme Section	Watercourse Crossing ID	TS-Culvert ID	Inlet Coordinate	Culvert Size	Catchment	Watercourse Name	0.5% Flow (m3/s)	Current Estimated Culvert Capacity (m^3/s / AEP)	
								Surcharge to Soffit*	Max Surcharge Available**
						na Criche (Granish)			
5	DS-WC-019		289818 815020	0.4m Ø	DS-WS-028A	Northern bifurcation of Allt na Criche (Granish)	0.66	0.124 / <50%	0.163 / <50%
5	DS-WC-022	A9 1170 C12	290081 815660	1.1m Ø	DS-WS-028	Allt na Criche (Granish)	8.35	1.44 / <50%	3.08 / 50%
5	DS-WC-023	A9 1170 C18	290202 816267	0.9m Ø	DS-WS-027	Unnamed Drain	0.59	1.05 / >0.1%	2.09 / >0.1%
5	DS-WC-024	3690 A9 1170 C22	290231 816404	1.45m Ø	DS-WS-026	Southern Avie Lochan Burn	4.14	1.43 / 50%	1.85 / 20%
5	DS-WC-025	3689 A9 1170 C20	290242 816463	0.9m Ø	DS-WS-025	Unnamed Drain	0.55	1.00 / >0.1%	1.33 / >0.1%
5	DS-WC-026	3688	290355 816744	0.9m Ø	DS-WS-024	Northern Avie Lochan Burn	1.75	0.9/ 1%	0.9/ 1%
6a	DS-WC-027	A9 1170 C26	290455 816905	0.4m Ø	DS-WS-023	Unnamed Drain	1.06	0.09 / <50%	0.20 / <50%
6a	DS-WC-029	A9 1170 C32	290874 817531	0.6m Ø	DS-WS-022	Unnamed Drain	0.55	0.38 / 3.3%	1.21 / >0.1%
6a	DS-WC-031		290931 817717	0.4m Ø 0.5m Ø	DS-WS-021	Unnamed Drain	0.09	Awaiting topo	
6b	DS-WC-032		291044 818519	1.5m Ø	DS-WS-020	Allt Cnapach	6.91	3.17 / 20%	6 / 2%
7	DS-WC-032A	A9 1170 C53	291074 818984	0.8m Ø	DS-WS-019	Unnamed Drain	0.4	0.65 / >0.5%	0.84 / >0.1
7	DS-WC-035		291066 819208	0.3m Ø	DS-WS-018	Unnamed Drain	0.93	0.11 / <50%	0.16 / <50%

Scheme Section	Watercourse Crossing ID	TS-Culvert ID	Inlet Coordinate	Culvert Size	Catchment	Watercourse Name	0.5% Flow (m3/s)	Current Estimated Culvert Capacity (m^3/s / AEP)	
								Surcharge to Soffit*	Max Surcharge Available**
7	DS-WC-035A		290920 820172	0.3m Ø	DS-WS-017	Unnamed Drain	0.35	0.04 / <50%	0.12 / 50%
7	DS-WC-036	A9 1170 C75	290760 820721	2.0m Ø	DS-WS-016	Feith Mhor	6.2	4.74 / 2%*	3.13 / 10%*
7	DS-WC-039	A9 1170 C77	290760 820721	1.58m Ø	DS-WS-015	Unnamed Drain	1.4	2.69 / 0.1%	2.08 / 0.5%+CC
7	DS-WC-041	A9 1170 C81	290637 821030	0.5m Ø	DS-WS-014	Unnamed Drain	0.02	0.19 / >0.1%	0.32 / >0.1%
7	DS-WC-042		290606 821148	0.5m Ø	DS-WS-013	Unnamed Drain	0.07	0.16 / >0.1%	0.31 / >0.1%
7	DS-WC-043	4160	290561 821235	1.1m Ø	DS-WS-012	Unnamed Drain	2.9	1.35 / 20%	1.78 / 10%
8	DS-WC-045		289761 822453	0.45m	DS-WS-011	Unnamed Drain	0.47	0.15 / 50%	N/A
8	DS-WC-046	A9 1190	289659 822556	14m x 34m	DS-WS-010	River Dulnain	206.1**	5550 / >0.1%*	N/A
8	DS-WC-048	A9 1200	289116 823155	10m x 13m	DS-WS-009	Allt nan Ceatharnach	34.84**	3765 / >0.1%*	N/A
9	DS-WC-049	4159	288509 823837	0.45m	DS-WS-008	Unnamed Drain	0.38	0.15 / 50%	0.26 / 3.33%
9	DS-WC-050	3421	286840 823959	0.6m	DS-WS-007	Unnamed Drain	0.66	0.24 / 50%	0.34 / 10%
9	DS-WC-051		286246 823867	0.45m Ø	DS-WS-006	Unnamed Drain	0.07	0.15 / >0.1%	0.40 / >0.1%
10	DS-WC-052	Unrecorded		0.5m Ø	DS-WS-005	Unnamed Drain	1.4	0.20 / 50%	0.62 / 20%
10	DS-WC-053	3422	284605 824151	1.0m Ø	DS-WS-004	Unnamed Drain	1.6	1.22 / 1%	2.5 / >0.1%

Scheme Section	Watercourse Crossing ID	TS-Culvert ID	Inlet Coordinate	Culvert Size	Catchment	Watercourse Name	0.5% Flow (m3/s)	Current Estimated Culvert Capacity (m^3/s / AEP)	
								Surcharge to Soffit*	Max Surcharge Available**
10	DS-WC-055	Unrecorded	284259 824652	0.7m Ø	Unrecorded	Unnamed Drain	1.6	0.47 / 50%	1.4 / 1%
11	DS-WC-057	A9 1210 C31	284058 825032	1.6m x 2.7m	DS-WS-003	Slochd Mhuic	1.6	10.35 / >0.1%	N/A
11	DS-WC-060	3649	283755 825412	1.6m x 2.7m	DS-WS-002	Unnamed tributary of Slochd Mhuic	7.6	7.6 / 0.5%	15.6 / >0.1%
11	DS-WC-060a	Unrecorded	283703 825447	0.4m Ø	DS-WS-002	Unnamed tributary of Slochd Burn	7.6	0.13 / >0.1%	>0.1%
11	DS-WC-061	A9 1210 C45	283540 825610	1.6m Ø	DS-WS-002	Slochd Mhuic	7.6	2.7 / 50%	8.83 / 0.5%
11	DS-WC-062	3648 A9 1210 C46	283479 825672	1.6m Ø	DS-WS-002	Slochd Mhuic	7.6	3.53 / 20%	9 / 0.5%

*Results have been extracted from the 1D/2D linked models ** Statistical Estimates

NB: Surcharge to soffit refers to the flow required in the model to achieve a water level at the culvert inlet equal to the soffit level.

NB: Surcharge to spill level refers to the flow required in the model to achieve a water level that exceeds the highest point on the existing road surface or laterally to the channel whereby flow will exceed a high point on the bank and flow towards the next adjacent crossing structure.

5.3. Floodplain Extents

5.3.1. The SEPA Flood Maps have been reviewed as part of the baseline assessment for The Proposed Scheme. Figure A10.2.5a to A10.2.5e shows the existing A9 in relation to Medium flood risk scenarios. The following flood plains and watercourses have been identified:

- Allt an Fhearna, Loch Alvie within River Spey catchment
- Aviemore Burn, River Spey catchment
- Feith Mhor, River Dulnain catchment
- River Dulnain
- Allt nan Ceatharnach

5.3.2. The SEPA flood maps provides a strategic national overview of areas estimated to be at risk of flooding from river and/or sea[x], showing the indicative flood extents from fluvial and coastal flooding. It is acknowledged that the maps have limitations, as these are based on broad scale hydrological and hydraulic modelling techniques along with a coarse digital terrain model. They also do not take account of hydraulic structures or flood prevention schemes. However, the flood maps are a valuable tool when screening and identifying flood sources and potential flood extents.

5.3.3. It is considered that these maps were suitable to use as part of the screening exercise for establishing the general location of the floodplains in relation to the existing A9 and The Proposed Scheme Options to allow for the specification of additional topographical survey information and improve the confidence in the floodplain extents. The additional topographical survey was undertaken in December 2015 and April 2016, and included open channel river sections, hydraulic structures, embankments and spot level at numerous locations.

5.3.4. To improve the floodplain definition hydrological and 1D/2D linked hydraulic models were required for the following locations:

- Allt an Fhearna
- Loch Alvie
- Allt na Criche (Lynwilg)
- Aviemore Burn
- The Shieling / Easter Aviemore Burn
- Allt na Criche (Granish),
- Feith Mhor
- River Dulnain

5.3.5. The hydrological model for each of the 1D/2D linked models involved the detailed catchment delineation, which takes account of the inflows to the river reach. The catchments were delineated using the FEH CD Rom version 3, and detailed topographical information.

5.3.6. Peak flow were calculated for each catchment using a combination of Rainfall Runoff and Statistical estimations. For each of the model reaches the storm duration was optimised hydraulically. Table 5.3 details the chosen methodology for each model reach and the final peak flows derived.

5.3.7. The catchments are mainly small and ungauged. It has therefore not been possible to calibrate the models.

5.3.8. Although the River Dulnain has a river gauging station located approximately 10km downstream of the model boundary, with a catchment area of 272km^2, which is significantly larger than the study area catchment. Given the distance to the gauge, model calibration was considered to be difficult.

Table 5.3: Peak Flow Estimations

Model	Watercourse	Number of catchments delineated	Chosen Flood Risk Methodology	Critical Storm Duration (hrs)	Downstream 0.5% Peak Flow (m^3/s)
Allt an Fhearna	Allt an Fhearna Downstream Extent	3	Statistical	4.9	32.4
Loch Alvie	Allt Dibheach – Downstream Extent	1	Rainfall Runoff	60	54.89
Allt na Criche (Lynwilg)	Allt na Criche	3	Rainfall Runoff	3.7	14.1
Aviemore Burn	Aviemore Burn	3	Rainfall Runoff	3.5	15.55
The Shieling /Easter Aviemore Burn	Easter Aviemore	1	Rainfall Runoff	3.5	1.92
Allt na Criche (Granish)	Allt na Criche (Granish)	4	Rainfall Runoff	3.1	8.26
Feith Mhor	Feith Mhor, at Crannaich	6	Rainfall Runoff	2.9	8.18
River Dulnain	River Dulnain Downstream extent	4	Statistical	10.3	211.11

5.3.9. With the exception of the Allt an Fhearna, and Loch Alvie all the 1D/2D linked hydraulic models were constructed using ISIS TuFlow.

5.3.10. The Allt an Fhearna and Loch Alvie had been previously modelled using InfoWorks RS, as part of the Kincraig to Dalraddy scheme. This model was reviewed and updated to incorporate additional survey and requirements for the Dalraddy to Slochd scheme.

5.3.11. The 2D model domains for each of the models were generated from the following data sets:

- Nextmap 5m DTM
- 10m BLOM LiDAR
- BLOMTopo Survey data for the A9 Dualling Corridor

5.3.12. The 2D component of the TuFLOW and InfoWorks RS model was constructed mainly using a mosaic of these three terrains. The 5m DTM is extended enough to cover the whole area of interest, but the accuracy is not sufficient to define small watercourses and drains. The two sets of BLOM data include more detail but they don't extent enough to cover all the area of interest. The channel and floodplain roughness coefficients are estimated from site inspection and photographs taken during the survey and are based on Manning's 'n' values[xxiv]. Table 5.4 shows the range used within the 1D/2D Linked Hydraulic model.

Table 5.4: Manning's 'n' Range within the Hydraulic Models

River Reach	River Channel Manning's 'n' values	Bank / Floodplain Mannings 'n' values
Allt an Fhearna	0.030	0.050
Loch Alvie	0.030	0.030 – 0.050
Allt na Criche (Lynwilg)	0.015-0.040	0.015-0.045
Aviemore Burn	0.015-0.035	0.060
The Shieling/ Easter Aviemore Burn	0.015-0.035	0.060
Allt na Criche (Granish)	0.025 – 0.040	0.045 – 0.060
Feith Mhor	0.040	0.045-0.060
River Dulnain	0.030-0.060	0.030-0.060

5.3.13. Model schematics for each 1D/2D linked model are shown in Figure A10.2.3 a-f.

5.3.14. Full details of the hydrological and hydraulic methodology is shown in Annex A.

5.3.15. Following the modelling of selected watercourses and floodplains by AMJV the floodplain extents have been refined as discussed in Table 10.6 below. This table also provides a summary of receptors sensitive to flood risk for each watercourse/floodplain. Figure 10.1 Surface Water shows the floodplain extents for the SEPA Medium – High flood risk scenarios and the AMJV 0.5% AEP, for baseline conditions i.e. with the existing A9.

Table 5.5: Floodplain Description

Scheme Section	Floodplain	Floodplain Description	Flood Risk Receptors	Sensitivity
1	Allt an Fhearna	The floodplain of the Allt an Fhearna is constrained through forested areas until approximately 15m upstream of the confluence with Allt Each. At this location the Allt an Fhearna appears to be spilling to both the left and right bank, with potential interaction of floodwater from the Allt Each and Allt an Fhearna, upstream of the confluence. Downstream of the Allt Each confluence the Allt an Fhearna floodplain appears to be primarily located on the left bank following the 245m contour, maintaining a constant width. As the channel flows toward the crossing of the existing A9 the floodplain begins to increase in width and flows along the toe of the A9 embankment. In this area the AMJV floodplain is narrower than the SEPA floodplain extents Downstream of the A9 crossing the Allt an Fhearna flows to Loch Alvie with the floodplain widening from 40m to approximately 300m and following the shape of the 220m contour. In this area the AMJV floodplain is similar in extent and shape to the SEPA flood map.	Agricultural Land	Medium
1	Loch Alvie	Loch Alvie is approximately 500m downstream of the existing A9. At Loch Alvie, the flood extents generally surround the loch, with the AMJV modelling indicating that the floodplain extent is uniformly wider than the area of flooding shown on the SEPA flood map. Along the existing A9 route corridor a minimum distance of 20m is maintained between the A9 and flood extents. To the south of Loch Alvie the floodplain width increases to inundate the B9152, with residential and non-residential properties potentially being inundated at NGR 2867 8091.	B9152	High
			Residential & Non Residential Properties	High
			Agricultural Land	Medium
			Grasslands	Low
2, 3a	Allt na Criche (Lynwilg)	The modelling shows that the floodplains upstream of the A9 are constrained by the valley and follows the 225m contour. It remains a relatively constant width on the approach to the existing A9 crossing. The floodplain width increases on approach to the B9152 and again on the Highland Mainline Railway, this is due to a reduction in channel capacity at these locations. The flood extents at these locations are slightly greater than those shown on the SEPA flood map, although there are no additional third parties receptors identified. In addition to the fluvial flood extents, the modelling has identified two locations where surface water ponding would occur at the 0.5% AEP. These are located at Lynwilg Farm immediately upstream of the A9, on both the east and west of the Allt na Criche (Lynwilg)	Agricultural land	Medium
			Grassland	Low
			B9152	High
			Highland Mainline Railway	High
4	Aviemore Burn	The Aviemore Burn is fed by three main tributaries including Milton burn, Steallan Dubh and Allt Dubh draining the slopes of Carn Dearg Mor (712mAOD). The SEPA flood maps show that there is limited flood risk at the upstream extents of the tributaries and becomes defined at the confluence, 500m from the crossing of the A9. The AMJV floodplain modelling shows that there are differences in the SEPA and AMJV floodplains and flow pathways along the existing A9 between chainage 7400 and 7600 (NGR 2893 8139 and NGR 2892 8137).	Residential & Non Residential Properties	High
			Grassland	Low

Scheme Section	Floodplain	Floodplain Description	Flood Risk Receptors	Sensitivity
		The Aviemore Burn comes out of bank on both the left and right bank upstream of the A9 Crossing (DS-WC-014), and flows both north and south along the line of the existing A9. These flood flows are conveyed through the existing A9 underpasses and cattle-creeps (A9 1150 C87, unnamed at NGR 2893 8137, and A9 1162) and subsequently over land to the east of the A9 to rejoin the Aviemore Burn channel. The channel then continues through Aviemore with no defined floodplain before its confluence with the River Spey There are several residential and non-residential receptors within the AMJV flood outline.		
4	The Shieling/ Easter Aviemore Burn	The Shieling/Easter Aviemore Burn, is not shown on the SEPA flood outline. The AMJV floodplain extents are approximately 4m wide and are well contained to the channel. Receptors are restricted to agricultural land in the immediate vicinity of the channel.	Agricultural Land	Medium
			Grassland	Low
5	Allt na Criche (Granish)	The Allt na Criche (Granish), and the two separate bifurcating channels, are not shown on the SEPA flood outline. The AMJV floodplain modelling shows that the Allt na Criche (Granish) spills onto the right bank immediately upstream of the northern bifurcation channel (NGR 289662, 815130) and along the length of the northern bifurcation channel. The floodplain extents on the right bank of the bifurcating channel varies between 25m to 100m, and flows towards and overtops the A9 at two locations NGR 2898 8149, and 2898 8149. This flow pathway continues towards the B9152, connecting with the southern bifurcation channel of Allt na Criche, at Granish Farm. Immediately downstream of the of the bifurcating channel, the Allt na Criche spills onto the right bank for approximately 100m and flows towards and overtops the A9 at 2898 8150. The extent of overtopping of the A9 at this location is 40-50m. It continues to flow north east and surrounds the Residential Property. Between 2898 8153 and 2901 8156 the Allt na Criche floodplains are constrained by the surrounding topography with the floodplain width varying between 10 and 20m. Downstream of the A9 the floodplain extends between 20-40m with no preferential spill direction. There are several receptors to flooding in this area including the A9, B9152, General Wades Road, and both residential and non-residential properties.	Forestry Commission Land	Medium
			A9	High
			B9152	High
			Residential & Non Residential Properties	High
			Grassland	Low
7	Feith Mhor	The SEPA flood maps show no flooding on the Feith Mhor upstream of the existing A9 crossing. However the AMJV flood extents indicate the floodplain upstream of the A9 watercourse crossing DS-WC-036 is approximately 70m wide. Downstream of the A9 the floodplain is approximately 250-300m wide in the land between the A9 and the Highland Mainline railway. This is significantly larger than the SEPA flood extents.	Forestry Commission Land	Medium
			Highland Mainline Railway	High
8	River Dulnain	The River Dulnain drains a catchment of approximately 190km^2 with a defined network of functional floodplain within the upstream extent. The rural areas within the upstream extent contain no known receptors with approximate floodplain extents reaching 120m. In this area the SEPA and AMJV flood extents are generally similar.	Agricultural Land	Medium

Scheme Section	Floodplain	Floodplain Description	Flood Risk Receptors	Sensitivity
		As the River Dulnain approaches the A9 there are differences in the SEPA and AMJV flood extents, with the SEPA flood outline extending south of the Dulnain. However the AMJV extents show that flow is contained close to the channel on the approach to the existing A9 crossing (DS-WC-046) with limited floodplain in this area. Downstream of the A9 and Highland Mainline crossing towards Carrbridge there is little to no floodplain with most flow remaining in channel.		
8	Allt nan Ceatharnach	Allt nan Ceatharnach is fed by several watercourses that include Allt Ruighe Magaig, Allt a Bhainne and Bogbain Burn. The SEPA flood extents indicate an increased area at risk of flooding at the confluence of these burns, in the vicinity of the A938 and the HML railway. Functional floodplain extents are reduced in the vicinity of the A9 crossing and are constant until the confluence with the River Dulnain begins to have a hydraulic influence.	Agricultural Land	Medium

5.4. Ground Water

5.4.1. The SEPA flood map for groundwater shows that there is mostly no likelihood of flooding from groundwater; within The Proposed Scheme. An area at Kinveachy has been classified as low likelihood of flooding from groundwater.

5.4.2. The BGS superficial aquifer maps indicate glaciofluvial sheet, at Lynwilg, Kinveachy, Aviemore and to the West of Slochd. The Groundwater flow within these superficial deposits is expected to follow surface topography, draining towards local surface watercourses.

5.4.3. Although categorised as low or no risk, groundwater is often a contributing factor to flooding rather than a primary source. For example groundwater flows contribute to river baseflows.

5.5. Surface Water

5.5.1. The SEPA surface water flood maps show that there are some relatively small localised pockets of flooding on and adjacent to the A9 between Aviemore and Carrbridge, with high likelihoods of flooding shown on the A9 at Dalraddy and Crannaich.

5.5.2. A review of the available As Built drawings for the existing single carriage has identified that carriageways are generally drained via kerb and gully with occasional lengths of combined kerb drainage units and over the edge filter drains. The conveyance varies between carrier and filter drains, which generally discharges un-attenuated flows either directly into receiving watercourses or indirectly via a network of ditches. The drainage areas for The Proposed Scheme were split into networks according to the route sections (Figure A.10.2.1).

5.5.3. Table 5.6 details the route section, the drainage network, contributing area, and limiting discharge. Figure A10.2.2 shows the Route Section locations.

Table 5.6: Existing A9 Runoff Rates

Route Section	Drainage Network	Total Area (ha)	Impermeable area (ha)	Existing Limiting Flow Rate (l/s)			
				1	5	30	200
1	B	2.40	1.15	88.7	133.3	192.9	250.6
1	C	6.1	2.30	123	176	214.2	262.7
1	E	3.01	1.28	76.7	112.6	149.7	190.9
1	F	1.04	0.55	39.9	60.1	87	109.1
2	A	7.73	3.84	74.4	96.5	112.4	140.6
3A	B1	4.67	2.77	124.1	171.7	216.9	251.2
3A	C	3.38	2.03	125.5	187.3	245.7	276.2
3B	B	7.26	4.25	190.2	258.2	336.2	426.5
4	A	4.78	2.40	78.9	117.7	157.1	189.8
5	A	1.30	0.76	19.3	19.9	19.9	19.9
5	B	1.05	0.78	50.6	75.6	97.5	94.2
5	C	1.69	0.86	51.6	77.3	96.8	122.7
5	D	1.86	1.02	72.9	105.6	137.9	173.4
5	E	0.75	0.44	32.6	45.3	53.6	55.9
5	F	2.47	1.15	73.6	103.9	125.8	164.4
5	G	0.43	0.61	14.5	22.1	31.4	43
6A	A	3.77	1.57	N/A	N/A	N/A	N/A
6A	C	2.19	1.08	N/A	N/A	N/A	N/A
6A	E	0.69	0.35	33.3	50.4	68.6	96.2
6B	A	2.59	1.53	85.5	110.7	150.5	181.9
6B	B	4.19	2.59	149.7	215.5	280.1	339.1
7	A	4.26	3.55	203.7	294.6	356.2	383.1
7	B	7.86	4.73	112.5	242.5	332.4	433.7

Route Section	Drainage Network	Total Area (ha)	Impermeable area (ha)	Existing Limiting Flow Rate (l/s)			
				1	5	30	200
8	A	4.46	1.83	86.1	127.8	160.6	198.5
8	C	1.40	0.63	39.1	57.5	73.1	87.5
8	D	4.88	2.20	149.6	201.2	233.41	258.8
9	A	3.04	1.72	105.5	147	163.6	164.6
9	B	6.00	3.55	196.6	281.9	321.50	334.5
9	D	4.04	2.89	186.8	267.6	363.9	368.4
10	A	0.75	0.60	57.4	80.1	99.0	126.7
10	B	7.06	5.38	359.8	531.6	618.6	766.9
10	C	10.21	7.92	510.3	550.1	680.6	837.6
11	C	3.44	2.83	220.4	307.6	372.3	410.2
11	D	8.59	1.80	356.9	520.4	577.2	622
11	J	1.64	1.18	84.5	120.1	149.4	191.4
11	K	1.97	1.25	81.8	122	154.1	176.9

6. Proposed Development

6.1.1. Table 6.1 summaries The Proposed Scheme Options which are described in more detail in Chapter 5. A total of 16 options have been assessed, comprising three mainline alignment options and 13 junction options for three junction locations

Table 6.1: Summary of Proposed Scheme Options

Option Name		Description
1	Mainline	Southbound widening for the entire route
1A	Mainline	Southbound widening with a Hybrid alignment at Aviemore South
2	Mainline	Northbound widening, with south bound widening at section 2, 6a, 10 and 11
A02	Aviemore South Junction	Half clover leaf quadrants 1 & 4 (overbridge /southbound mainline widening) – sections 1 & 2
A09	Aviemore South Junction	Diamond left right stagger with Ghost Island (overbridge/southbound mainline widening) section 1 & 2
A18	Aviemore South Junction	Diamond left right stagger with B9152 realigned (overbridge/southbound mainline widening) sections 1 & 2
C18	Granish Junction	Diamond (underbridge/northbound mainline widening) section 5
C21	Granish Junction	Half Dumbbell Clover leaf (underbridge/northbound mainline widening) section5
C31	Granish Junction	Diamond (underbridge/southbound mainline widening) section 5
C34	Granish Junction	Half Dumbbell Clover leaf (underbridge/southbound mainline widening) section 5
D02	Black Mount Junction	Diamond with Left-right stagger (overbridge/northbound mainline widening) section 9
D03	Black Mount Junction	Half Diamond (North facing slips) (overbridge/southbound mainline widening) section 9
D07	Black Mount Junction	Half Clover lead Quadrants 2 & 4 (overbridge northbound mainline widening) section 9
D12	Black Mount Junction	Diamond with left-right stagger (overbridge/southbound mainline widening) section 9
D13	Black Mount Junction	Half Diamond (North facing slips) (overbridge/northbound mainline widening) section 9
D51	Black Mount Junction	Half Clover leaf Quadrants 2&4 (overbridge/southbound mainline widening) Section 9

7. Proposed Flood Risk

7.1. Flooding From Rivers (Fluvial Flooding)

7.1.1. The Proposed Scheme is likely to result in temporary and permanent changes to the hydrological regime of watercourses and flooding risk during both the construction and operational phases. The flood risk impacts are associated with flow conveyance and flood flow pathways. There are 44 existing watercourse crossings, which will either need to be extended and or replaced to accommodate The Proposed Scheme. In addition, there are 5 known floodplain interactions with The Proposed Scheme which have been identified during the Stage 2 assessment.

Construction impacts

7.1.2. The construction of The Proposed Scheme will include the upgrade, replacement, extension and/ or new watercourse crossings, which may include construction of crossings offline in the dry. Under this scenario the watercourse will be temporarily diverted through a temporary channel and/or pumping, which could result in flows being:

a) Conveyed more effectively downstream increasing the flood risk to the site and third parties; or
b) Water backing up due to insufficient capacity resulting in washout to the construction area.

7.1.3. Materials and plant equipment stored on site could result in the blockage to existing structure and localised flooding to the site and sensitive receptors.

7.1.4. Excavation and construction works on the site could lead to blockage and or severance of surface water that could lead to localised flooding to the site and sensitive receptors.

7.1.5. During construction, localised ground-raising could result in displacement of floodwater and changes to the surface water runoff pathways increasing the flood risk to the surrounding area.

7.1.6. During construction, movement of materials on site including the creation of stockpiles could alter flow pathways and displace flood water.

7.1.7. The operation of plant may result in compaction of soils, which may reduce the infiltration capacity. This could result in an increase in surface water runoff leading to localised flooding and runoff into the receiving watercourse.

7.1.8. The magnitude of impact and significance of flood risk associated with the construction of The Proposed Scheme has not been assessed at Stage 2 due to insufficient information on construction sequences and methods. These will be assessed as part of the Stage 3 assessment and mitigation measures will be identified where required.

Operational Impacts with Watercourse Crossings

7.1.9. The Proposed Scheme will see the introduction of new watercourse crossings and the upgrade and/or replacement of the existing watercourse crossings. Table 7.1 and Table 7.2 and detail the number of watercourse crossings associated with the mainline and junctions, shown on the 1:10,000 and 1:50,000 OS maps for each of The Proposed Scheme Options. In addition to the 34 crossings shown on the 1:10,000 OS map there are a number of small drains, which will require crossings. The total number of crossings required is 54. This includes all existing watercourse crossings which may be extended, refurbished and/or replaced and new crossings.

Table 7.1: Watercourse Crossings for each of the Proposed Scheme Mainline Options

	Proposed Mainline Options		
	1	**1a**	**2**
Total Watercourse Crossings	34	34	34

Table 7.2: Watercourse Crossings for each of the Proposed Scheme Junction Options

	Proposed Junctions												
	A02	A09	A18	C18	C21	C31	C34	D02	D03	D07	D12	D13	D51
Total Watercourse crossing	x	x	x	x	2	1	1	x	x	x	x	x	x

7.1.10. Current guidance from SEPA indicates that all water crossings should be designed to include for climate change allowance and freeboard on the 0.5% AEP flood event[xxv]. In addition to this there are ecological, operational and maintenance requirements, which could see structures upsized beyond the 0.5% AEP.

7.1.11. It has been assumed that all existing watercourse crossing will be upsized to accommodate the above criteria.

7.1.12. From the baseline capacity assessment, 23 existing culverts have been identified as having a Slight to Major significance to the downstream receptors, if the culvert are to be upsized to accommodate higher flows. Table 7.3 below details the impact magnitude attributed to these flow increases compared to the existing capacity.

7.1.13. DS-WC-17, DS-WC-29 and DS-WC-39 have been identified as having an overtopping flow route upstream of the culvert inlet, and therefore the surcharge to spill is lower than the surcharge to soffit.

Table 7.3: Impact of Magnitude on Existing Culverts

Section	Watercourse Crossing ID	TS- Culvert ID	Culvert Size	Catchment	Watercourse Name	Overall Catchment	0.5% Flow (m3/s)	Current Estimated Culvert Capacity		Impact Magnitude (conveyance & Flood Risk)	Downstream Sensitive Receptor	Sensitivity	Significance
								Surcharge to Soffit**	Max Surcharge Available**				
Section 1 Ch 2100	DS-WC-004	A9 1100 C70	2.0m Ø	DS-WS-036	Caochan Ruadh	Loch Alvie	5.02	5.42 / 0.5%	21.83 / >0.1%	Moderate	Rural Land, with land classification as land capable of producing a narrow range of crops.	Low	Slight
Section 2 Ch 3000	DS-WC-005A	A9 1120	0.9m Ø	DS-WS-034B	Unnamed drain	River Spey	1.42	0.762/ 10%	1.18/ 2%	Moderate	Rural land associated with Lynwilg Farm, with land classification as land capable of moderate crop ranges and good yields.	Medium	Moderate
Section 3a Ch 5800	DS-WC-010 DS-WC-011		0.9m Ø 0.5m Ø	DS-WS-033	Loch Puladdern	River Spey	4.97	0.3 / <50%	0.48 / <50%	Moderate	Rural Land, with classification as land capable of producing a narrow range of crops.	Low	Slight
Section 3b Ch 6600	DS-WC-013	A9 1150 C49	1m Ø	DS-WS-032	Unnamed Drain	Aviemore Burn	1.53	Awaiting topo		Negligible-Moderate*	Craigellachie National Nature Reserve. Forestry land.	Medium	Moderate*
Section 4 Ch 7400	DS-WC-013A	Unrecorded	0.8m Ø	DS-WS-031	Unnamed Drain	Aviemore Burn	0.82	0.99 / 0.5%	2.46/ >0.1%	Negligible	Aviemore Residential and Non Residential properties.	High	Neutral*
Section 4 Ch 7560	DS-WC-014	A9 1150 C95	2.4m Ø	DS-WS-030	Aviemore Burn	Aviemore Burn	15.32	8.05 / 10%	9.64 / 4%	Major	Aviemore Residential, Non Residential properties and former Aviemore Primary School.	High	Large/Very Large
Section 4 Ch7880	DS-WC-016	A9 1150 C11	0.9m Ø	DS-WS-029	The Shieling / Easter Aviemore Burn	River Spey	1.76	0.89 / 10%	2.15 / 0.5%	Moderate	Rural grasslands of Easter Aviemore. Land use is grazing and rough pasture.	Low	Slight
Section 5 Ch8500	DS-WC-017	3534	1.2m Ø	DS-WS-028B	Southern bifurcation of Allt na Criche (Granish)	River Spey	5.75	1.78 / <50%	1.12/ <50%	Major	Land use is a mixture of forestry and agricultural land associated with Granish Farm.	Low	Slight/Moderate
Section 5 Ch8800	DS-WC-019		1.2m Ø	DS-WS-028A	Northern bifurcation of Allt na Criche (Granish)	Allt na Criche (Granish)	0.66	0.124 / <50%	0.163 / <50%	Minor	Rural grassland and General Wades military road.	Low	Neutral
Section 5 Ch9500	DS-WC-022	A9 1170 C12	1.1m Ø	DS-WS-028	Allt na Criche (Granish)	Allt na Criche (Granish)	8.35	1.44 / <50%	3.08 / 50%	Major	Forestry commission land.	Medium	Large
Section 5 Ch101	DS-WC-024	3690 A9 1170 C22	1.45m Ø	DS-WS-026	Southern Avie Lochan Burn	Avie Lochan	4.14	1.43 / 50%	1.85 / 20%	Moderate	Forestry commission land. Discharges to Avielochan.	Medium	Moderate
Section 5 Ch 10500	DS-WC-026	3688	0.9m Ø	DS-WS-024	Northern Avie Lochan Burn	Avie Lochan	1.75	0.9 / 10%	0.9 / 1%	Moderate	Residential Properties at Avielochan	High	Large
Section 6 Ch 11100	DS-WC-027	A9 1170 C26	0.4m Ø	DS-WS-023	Unnamed Drain	Avie Lochan	1.06	0.09 / <50%	0.20 / <50%	Moderate*	Agricultural Land. No land classification.	Low	Slight
Section 6a Ch 11600	DS-WC-028	A9 1170 C32	0.6m Ø	DS-WS-022	Unnamed Drain	Loch Vaa	0.55	0.38 / 3.3%	1.21 / >0.1%	Minor	Agricultural Land. No Classification.	Low	Neutral
Section 6b Ch 12600	DS-WC-032		1.5m Ø	DS-WS-020	Allt Cnapach	Loch Roid	6.91	3.17 / 20%	6 / 2%	Moderate	Highland Mainline Railway.	High	Moderate/Large
Section 6b Ch 13600	DS-WC-035		0.3m Ø	DS-WS-018	Unnamed Drain	Gormack Stripe	0.93	0.11 / <50%	0.16 / <50%	Minor	Highland Mainline Railway.	High	Slight/Moderate
Section 7 Ch 14700	DS-WC-035A		0.3m Ø	DS-WS-017	Unnamed Drain	Gormack Stripe	0.35	0.04 / <50%	0.12 / 50%	Minor	Forestry Land.	Medium	Slight
Section 7 Ch 14850	DS-WC-036	A9 1170 C75	2.0m Ø	DS-WS-016	Feith Mhor	Feith Mhor	6.2	4.74 / 2%	3.13 / 10%	Moderate	Forestry Commission Land.	Medium	Moderate
Section 7 Ch 15350	DS-WC-043	4160	1.1m Ø	DS-WS-012	Unnamed Drain	Feith Mhor	2.9	1.35 / 20%	1.78 / 10%	Moderate	Forestry Commission Land.	Medium	Moderate

Section	Watercourse Crossing ID	TS- Culvert ID	Culvert Size	Catchment	Watercourse Name	Overall Catchment	0.5% Flow (m3/s)	Current Estimated Culvert Capacity		Impact Magnitude (conveyance & Flood Risk)	Downstream Sensitive Receptor	Sensitivity	Significance
								Surcharge to Soffit**	Max Surcharge Available**				
Section 8 Ch 16840	DS-WC-045		0.45m	DS-WS-011	Unnamed Drain	River Dulnain	0.47	0.15 / 50%	N/A	Minor	Highland Mainline Railway and Carrbridge train station.	High	Slight/Moderate
Section 9 Ch 18710	DS-WC-049	4159	0.45m	DS-WS-008	Unnamed Drain	Allt nan Ceatharnach	0.38	0.15 / 50%	0.26 / 3.33%	Minor	Forestry Land.	Medium	Slight
Section 9 Ch 20400	DS-WC-050	3421	0.6m	DS-WS-007	Unnamed Drain	Bogbain Burn	0.66	0.24 / 50%	0.34 / 10%	Minor	Grassland and scrub.	Low	Neutral
Section 10 Ch 22700	DS-WC-052	Unrecorded	0.5m Ø	DS-WS-005	Unnamed Drain	Bogbain Burn	1.4	0.20 / 50%	0.62 / 20%	Moderate	Grassland and scrub.	Low	Slight
Section 10 Ch 23100	DS-WC-053	3422	1.0m Ø	DS-WS-004	Unnamed Drain	Allt Slochd Mhuic	1.6	1.22 / 1%	2.5 / >0.1%	Minor*	Grassland and scrub.	Low	Neutral
Section 10 Ch 23500	DS-WC-055	unrecorded	0.7m Ø	Unrecorded / DS-WS-004a	Unnamed Drain	Allt Slochd Mhuic	1.6	0.47 / 50%	1.4 / 1%	Moderate	Steep hillside consisting of grassland and scrub.	Low	Slight
Section 11 Ch 24300	DS-WC-060	3649	1.6m x 2.7m	DS-WS-002	Unnamed tributary of Slochd Mhuic	Allt Slochd Mhuic	7.6	7.6 / 0.5%	15.6 / >0.1%	Moderate	Steep hillside within a rock outcrop.	Low	Slight
Section 11 Ch 24600	DS-WC-061	A9 1210 C45	1.6m Ø	DS-WS-002	Slochd Mhuic	Allt Slochd Mhuic	7.6	2.7 / 50%	8.83 / 0.5%	Major	National Cycle Network track.	High	Large/Very Large
Section 11 Ch24700	DS-WC-062	3648 A9 1210 C46	1.6m Ø	DS-WS-002	Slochd Mhuic	Allt Slochd Mhuic	7.6	3.53 / 20%	9 / 0.5%	Major	Grassland and scrub.	Low	Slight/Moderate

**Surcharge to soffit refers to the flow required in the model to achieve a water level at the culvert inlet equal to the soffit level.
***Surcharge to spill level refers to the flow required in the model to achieve a water level that exceeds the highest point on the existing road surface or laterally to the channel whereby flow will exceed a high point on the bank and flow towards the next adjacent crossing structure.

7.1.14. The impact for each structure is the same for all options associated with the Proposed Scheme. There are five watercourse crossings which have the potential to have a Major magnitude of impact on peak flows downstream of the structure:

- DS-WC-014 Aviemore Burn, Carn Elrig View
- DS-WC-017 Southern bifurcation of Allt na Criche Granish Farm
- DS-WC-022 Allt na Criche, Granish
- DS-WC-061 Slochd Mhuic and
- DS-WC-062 Slochd Mhuic.

7.1.15. In addition to Major impacts there are 14 watercourse crossings with a Moderate impact and a further six with Minor impacts. For each watercourse the significance of the impact varies depending on the receptor.

7.1.16. There are two structures which are considered to have a Large/Very large impact significance these are DS-WC-014 Aviemore Burn and DS-WC-061 Slochd Mhuic. One structure with a Large significance (DS-WC-022 Allt na Criche (Granish)) and eight with a Moderate or Slight /Moderate significance.

7.1.17. Downstream receptors of Carn Elrig View (DS-WC-014) are the residential and non-residential properties including Aanside, Millside house, Croftside, Grampian Way, and the town of Aviemore. Historical flooding information indicate that Craig-na-Gower Avenue and the former Aviemore Primary School, flooded in February 1990. This is considered to be a High sensitivity receptor with an associated Large/Very Large significance of impact. At this location mitigation measures will be required.

7.1.18. The immediate downstream receptors of DS-WC-061 is the National Cycle Network (NCN) route 7 and the Highland Mainline Railway. Increases in culvert capacity could increase flow conveyance upstream of these assets. This is considered to be a High sensitivity receptor with an associated Large/Very Large impact significance. At this location mitigation measures and further assessment will be required.

7.1.19. The immediate downstream receptor of the Allt na Criche (DS-WC-022) is forestry land, which is considered to be of Medium Sensitivity with a Large significance of impact. The B9152 would be considered to have a High sensitivity, however there is no evidence of historical flooding at either locations. Mitigation measures will be required to address the impact here.

7.1.20. Downstream of DS-WC-026 is a small area of residential properties, which are considered to be of High Sensitivity with Moderate/Large Significance of impact and further assessment and mitigation will be considered.

7.1.21. Downstream of DS-WC-032 is the Highland Mainline Railway. The sensitivity of this receptor is High and increasing flow conveyance could increase the flood risk to the railway. The significance of the impact is considered to be Moderate/Large and further assessment and mitigation will be considered.

7.1.22. There are two structures which were not assessed for capacity due to limitations in the topographical survey information but are considered to have a Negligible to Moderate impact, when considering contributing catchment and flows at the structures. The impacts and significance of impact will be confirmed for these structures as part of the Stage 3 Assessment.

7.1.23. DS-WC-017 and DS-WC-022 will be considered within the hydraulic model for the Allt na Criche (Granish) and will be subject to further assessment as part of the Stage 3 Assessment. The impact of increasing culvert capacity will be assessed at that point and mitigation measures considered.

7.1.24. For all structures where the existing capacity is less than the 0.5% AEP event and the significance is greater than Slight, mitigation and/or further assessment will be required at Stage 3. This will include the assessment of the proposed structure at each location. All increases in watercourse crossing capacity could potentially impact on the wider catchment hydrology and sensitive receptors downstream of The Proposed Scheme.

Operation Impacts on Floodplains

7.1.25. There are 8 areas of significant floodplains along the route of the Proposed Scheme, as identified in Section 5.3. The sequential test, will be applied to all identified floodplains.

7.1.26. From the review of the Mainline Options, The Shieling/Easter Aviemore Burn and the River Dulnain are not impacted by any of the Proposed Options and pass Test 1. Accordingly the magnitude of impact on the flood risk receptors associated with these floodplains will be Negligible, resulting in a significance of Neutral, for all Mainline Options.

7.1.27. The assessment has therefore identified 6 locations of floodplain which would be impacted by The Proposed Scheme options via either disconnection, displacement and/or encroachment onto the floodplain. These locations (shown in Figure A10.2.8) are:

- Allt an Fhearna
- Loch Alvie
- Allt na Criche (Lynwilg)
- Aviemore;
- Allt na Criche (Granish); and
- Feith Mhor

7.1.28. A review of the mainline alignment options shows that all options will have an impact on the 6 existing floodplains identified. The assessment has sought to understand the flood risk impacts associated with the disconnection, displacement and/or encroachment from The Proposed Scheme. The 1D/2D linked models were updated to represent The Proposed Scheme alignment.

7.1.29. The volume of water affected by each mainline route option and the impacts on the downstream receptors can vary between The Proposed Scheme Options. Table 7.4 details the impacts, magnitude, and significance for each of the mainline options.

Table 7.4: Impact of Magnitude Associated with Floodplain Loss for Mainline Options

Floodplain	Receptor	NGR	Sensitivity	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
				FP Vol (m^3) Change in extent Change in depth (mm)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
Allt an Fhearna (Section 1 Ch	Rural land on right bank with LCA classification of land capable pf producing a narrow crop range	285310 809145	Med	2677 No 200	Maj	Large	2677 No 200	Maj	Large	2689 No 0	Neg	Neutral
	Forestry land on the left bank	285359 809253	Med	2667 No 30	Min	Slight	2677 No 30	Min	Slight	2689 No 0	Neg	Neutral
	Agricultural land used for rough grazing, downstream of existing A9	285432 809204	Med	2667 No 0	Neg	Neutral	2677 No 0	Neg	Neutral	2689 No 20	Min	Slight
Loch Alvie Section 1, Ch 1000 - 2700	Rural land, with LCA as grassland with limited potential	285886 809578	Low	4632 No <5	Neg	Neutral	4530 No <5	Neg	Neutral	4835 No <5	Neg	Neutral
	Rural, unpopulated area with a primary land use of forestation.	286645 891000	Low	4632 No <5	Neg	Neutral	4530 No <5	Neg	Neutral	4835 No <5	Neg	Neutral
Loch Alvie Section 1,	The B9162 road between Kincraig and Aviemore	286821 809173	High	4632 No <5	Neg	Neutral	4530 No <5	Neg	Neutral	4832 No <5	Neg	Neutral

Floodplain	Receptor	NGR	Sensitivity	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
				FP Vol (m^3) Change in extent Change in depth (mm)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
Ch 1000 - 2700	Downstream of Loch Alvie	287097 809299	Low	4632 No <5	Neg	Neutral	4530 No <5	Neg	Neutral	4832 No <5	Neg	Neutral
Alt na Criche – Lynwilg (Section 2 & 3a Ch 3300 – 4500)	Agricultural land to the east of the Allt na Criche. LCA of moderate crop range and good yields.	288412 810661	Med	725 No 50-400	Maj	Large	730 No 50-400	Maj	Large	1160 No 50-400	Maj	Large
	Lynwilg Farm to the west of the Allt na Criche. Land classification of moderate crop range and good yields.	288087 810503	Med	725 No 30-100	Maj	Large	730 No 30-100	Maj	Large	1160 No 30-100	Maj	Large
	Grassland area between the existing A9 and B9152.	288384 810593	Low	725 No 5-10	Min	Neutral	730 No 5-10	Min	Neutral	1160 No 5-10	Min	Neutral
	Agricultural land, with land classification of moderate crop range and good yields.	?/	Med	725 No 5-10	Min	Slight	730 No 5-10	Min	Slight	1160 No 5-10	Min	Slight
Aviemore	Grassland area between the existing A9 and Carn Elrig,	289317 813889	Low	237 Yes	Maj	Slight / Moderate	194 Yes	Maj	Slight / Moderate	1661 Yes	Maj	Slight / Moderate

Floodplain	Receptor	NGR	Sensitivity	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
				FP Vol (m^3) Change in extent Change in depth (mm)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
(Section 4 Ch 7100 – 8000)	north of DS-WC-014. Land Classification as grassland with limited potential. A9 road embankment retains water upstream of Aviemore.			200			200			200		
	Aviemore Burn downstream of DS-WC-014, residential properties.	289394 813871	High	237 Yes 20	Min	Slight / Moderate	194 Yes 20	Min	Slight / Moderate	1661 Yes 20	Min	Slight / Moderate
	Residential Properties at Strathspey Avenue	289375 813705	High	237 Yes <5	Maj	Large / Very Large	194 Yes <5	Maj	Large / Very Large	1661 Yes <5	Maj	Large / Very Large
	Aviemore Burn at Strathspey Avenue	289459 813646	High	237 Yes 30	Min	Slight / Moderate	194 Yes 30	Min	Slight / Moderate	1661 Yes 30	Min	Slight / Moderate
Allt na Criche (Granish) (Section 5 Ch8300-9600)	Forestry Commission Land	289731 814913	Med	1075 Yes >-100	Maj Ben	Large Benefit	1075 Yes >-100	Maj Ben	Large Benefit	1999 Yes >-50	Maj Ben	Large Benefit
	B9152 road to the east of Granish	289941 814737	High	1075 Yes -20	Min Ben	Slight / Moderate Benefit	1075 Yes -20	Min Ben	Slight / Moderate Benefit	1999 Yes -20	Min Ben	Slight / Moderate Benefit

Floodplain	Receptor	NGR	Sensitivity	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
				FP Vol (m^3) Change in extent Change in depth (mm)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
	Residential & Non Residential Properties at Red Stags Lodge (off General Wade's Road)	289885 815047	High	1075 Yes 40	Min	Slight / Moderate	1075 Yes 40	Min	Slight / Moderate	1999 Yes >-100	Maj Ben	Large / Very Large Benefit
	Grassland between the A9 and B9152	289869 814935	Low	1075 Yes 30	Min	Neutral	1075 Yes 30	Min	Neutral	1999 Yes <-5	Neg	Neutral
	A9	289905 814999	High	1075 Yes 70	Mod	Moderate/ Large	1075 Yes 70	Mod	Moderate/ Large	1999 Yes 50	Mod	Slight/Mod erate
	Forestry Commission land downstream of DS-WC-022	290140 815672	Med	1075 Yes -25	Min Ben	Slight Benefit	1075 Yes -25	Min Ben	Slight Benefit	1999 Yes -45	Min Ben	Slight Benefit
Feith Mhor (Section 7 Ch14700 - 15000)	Forestry Commission Land Upstream of the A9 DS-WC-039	290687 820841	Med	5016 No 0	Neg	Neutral	5000 No 0	Neg	Neutral	1417 No 0	Neg	Neutral
	Forestry Commission Land Upstream of the DS-WC-036 A9 Crossing	290712 820712	Med	5016 Yes 300-400	Maj	Large	5000 Yes 300-400	Maj	Large	1417 Yes 300-400	Maj	Large

Floodplain	Receptor	NGR	Sensitivity	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
				FP Vol (m^3) Change in extent Change in depth (mm)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
	Forestry Commission Land Between the Highland Mainline Railway and A9	290808 820873	Med	5016 No 60	Mod	Moderate	5000 No 60	Mod	Moderate	1417 No 0	Neg	Neutral
Feith Mhor (Section 7 Ch14700 - 15000)	Highland Mainline Railway embankment	290825 820931	High	5016 No 60	Mod	Moderate/ Large	5000 No 60	Mod	Moderate / Large	1417 No 0	Neg	Neutral
	Downstream of the Highland Railway	290878 820896	Med	5016 No 10	Min	Slight	5000 No 10	Min	Slight	1417 No 0	Neg	Neutral

7.1.30. A review of junction options associated with The Proposed Scheme indicate that there are two locations which have the potential to impact on the floodplains. These are the Aviemore South Junction options and the Granish Junction options.

7.1.31. Table 7.5 details the impacts, magnitude, and significance for the Aviemore South Junction options. Table 7.6 details the impacts, magnitude and significance for the Granish Junction options

Table 7.5: Impact of Magnitude Associated with Floodplain Loss for the Aviemore South Junction Options

Floodplain	Receptor	NGR	Sensitivity	Junction Option A02			Junction Option A09			Junction Option A18		
				FP Vol (m^3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
Alt na Criche – Lynwilg (Section 2 & 3a Ch 3300 – 4500)	Agricultural land to the east of the Allt na Criche. LCA classification - moderate crop range and good yields.	288412 810661	Med	28 No 0	Neg	Neutral	0 No 0	Neg	Neutral	0 No 0	Neg	Neutral
	Lynwilg Farm to the west of the Allt na Criche. LCA classification - moderate crop range and good yields.	286645 891000	Med	18.3 No 0	Neg	Neutral	0 No 0	Neg	Neutral	0 No 0	Neg	Neutral
	Grassland area between the existing A9 and B9152.	288384 810593	Low	18.3 No 0	Neg	Neutral	0 No 0	Neg	Neutral	0 No 0	Neg	Neutral
	Agricultural land downstream of Highland Mainline Railway. LCA classification - moderate crop range and good yields.	288435 810541	Med	18.3 No 0	Neg	Neutral	0 No 0	Neg	Neutral	0 No 0	Neg	Neutral

Table 7.6: Impact of Magnitude Associated with Floodplain Loss for the Proposed Granish Junction Options Floodplain	Receptor	NGR	Sensitivity	Junction Option C18			Junction Option C21			Junction Option C31			Junction Option C34		
				FP Vol (m^3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
Allt na Criche (Granish) (Section 5 Ch8300-9600)*	Forestry Commission Land	289731 814913	Med	3473 m^3 Yes -70	Mod Ben	Moderate Benefit	3727 m^3 Yes -100	Mod Ben	Moderate Benefit	3843 m^3 Yes >-100	Maj	Large	3001 m^3 Yes >-100	Maj Ben	Large
	B9152 road to the east of Granish	289941 814737	High	3473 m^3 Yes -20	Min Ben	Slight / Moderate Benefit	3727 m^3 Yes -10	Min Ben	Slight / Moderate Benefit	3843 m^3 Yes -35	Min Ben	Slight / Moderate Benefit	3001 m^3 Yes -25	Min Ben	Slight / Moderate Benefit
	Residential & Non Residential Properties at Granish Farm (off General Wade's Road)	289896 815047	High	3473 m^3 Yes -20	Min Ben	Slight / Moderate Benefit	3727 m^3 No -50	Mod Ben	Moderate/ Large Benefit	3843 m^3 Yes >-100	Maj Ben	Large / Very Large Benefit	3001 m^3 No 40	Min	Slight / Moderate
	Grassland between the A9 and B9152	289569 814935	Low	3473 m^3 Yes 0	Neg	Neutral	3727 m^3 Yes -60	Mod Ben	Slight Benefit	3843 m^3 Yes >-100	Maj Ben	Slight / Moderate Benefit	3001 m^3 Yes 30	Min	Neutral

Table 7.6: Impact of Magnitude Associated with Floodplain Loss for the Proposed Granish Junction Options Floodplain	Receptor	NGR	Sensitivity	Junction Option C18			Junction Option C21			Junction Option C31			Junction Option C34		
				FP Vol (m^3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance	FP Vol (m3) Change in extent Change in depth (m)	Magnitude	Significance
	A9	289905 814999	High	3473 m^3 Yes 47	Min	Slight / Moderate	3727 Yes -60	Mod Ben	Moderate/ Large Benefit	3834 m^3 Yes >-100	Maj Ben	Large / Very Large Benefit	3001 m^3 Yes 70	Mod	Moderate / Large
	Forestry Commission land downstream of DS-WC-022	290140 815672	Med	3473 m^3 Yes >-100	Maj Ben	Large Benefit	3473 m^3 Yes -50	Mod Ben	Moderate Benefit	3834 m^3 Yes >100	Maj	Large	3001 m^3 Yes -30	Min Ben	Slight Benefit

7.1.32. At Allt an Fhearna scheme options 1 and 1A are considered to have a Major impact to the agricultural land located on the left banks with a local increase of 200mm in the peak flood levels. The significance is considered to be Large upstream of the A9. Downstream of the existing A9 there is no increase in peak flood levels as a result of the floodplain loss, and the impact is considered to be Negligible with a Neutral significance.

7.1.33. At Loch Alvie all scheme options are considered to have Negligible impact on the floodplains with the increase in peak flood levels being less than 20mm across the loch. The overall significance at this location is considered to be Neutral.

7.1.34. At Lynwilg the flooding is considered to be surface water ponding, rather fluvial flooding from the Allt na Criche. All scheme options are considered to have a local impact on the flood depths, with an overall Large Significance at the point of volume loss. Downstream of the A9 between the B9152 the impact is considered to be Minor with peak flood levels increasing by 7mm. The significance at this location is Neutral.

7.1.35. Lynwilg is marginally impacted by junction option A02, with 18.3m^3 of the surface water flood storage area affected. This is considered to have a Neutral Significance, when considered on its own. When combined with the mainline route options the junction would have a Large Significance for all options.

7.1.36. At Aviemore all Mainline Options result in changes in modelled flood extents, changes in flood depth and increases in downstream peak level and flows. The former Aviemore Primary School, which was reported to have been flooded in February 1990, is located some 350m to the east of the burn and is not located on the 0.5% AEP floodplain. With respect to the residential properties on Strathspey Avenue the flood extents have increased such that additional properties have become vulnerable to flooding at the 0.5% AEP. Although the depth of flooding at these properties (4mm) only constitutes a negligible magnitude impact, it is felt that the introduction of any new vulnerable properties is an overriding factor, and as such the impact at Aviemore is considered to be of Major magnitude, with a significance of Large / Very Large for all Mainline Options. Further modelling will be required at Stage 3 to understand and mitigate against the impacts on floodplain within the Aviemore and Boat of Garten PVA. The Allt na Criche (Granish) is impacted by all mainline and junction options, which results in the displacement of flood water, altering both the flood extent and depth of flooding. The baseline modelling illustrates that the existing A9 is flooded between chainage 8200 and 8300 (NGR 2897 8149 and NGR 2897 8148). This is due to the existing ground level being at the same level as the A9, allowing an out of bank flow pathway to develop and flow over the A9 (Photograph 15A).

7.1.37. Although the model indicates potential reductions in water depths on the B9152 and the Forestry Commission land downstream of DS-WC-022, these have not been used to differentiate between the options due to limitations in the model. In particular the high sensitivity of the modelled flows to the assumed finished ground levels and dimensions of the replacement watercourse crossings and channel alignments. For all mainline options the A9 would continue to flood at this locality, with increases in water depth between 50-100mm and it is therefore considered to be a Moderate magnitude with Moderate/ Large significance.

7.1.38. All junction options intercept the 0.5% AMJV flood outline at NGR 2898 8151 and 2898 8153 and water would be routed towards the Junction. This results in an overall change in flood extents with large water depths being stored within the Granish Junction and water depths decreasing elsewhere. Although the model indicates potential reductions in water depths at most receptors including the B9152 and the residential & non-residential properties at Granish Farm, these have not been used to differentiate between the options due to limitations in the model as noted in 7.1.37. It is also not possible to separate the magnitude of the impacts associated with the junction or mainline options. It is therefore considered appropriate to conclude that, in common with the mainline options, the significance of all junction options is Moderate/Large.

7.1.39. The model will be developed at Stage 3, with specific focus on the design of the replacement crossings for the northern and southern bifurcations of Allt na Criche (Granish) (DS-WC-019 and DS-WC-022), channel alignment works and finished ground levels to ensure flood flows are contained within the existing floodplain, and are not displaced towards the proposed junction.

7.1.40. At Feith Mhor all scheme options result in localised changes to the modelled flood extents and flood depths, and are all considered to have an overall Large impact significance. However, the majority of the floodplains are contained between the existing A9 and the Highland Mainline Railway. The southbound widening options 1 and 1A would result in a greater impact with a total volume loss exceeding 10,000m^3. Option 2 northbound widening would impact a smaller extent of floodplain with the total volume of loss being 1,417m^3.

7.1.41. Flood Compensation measures will be required to be considered at Allt an Fhearna, Allt na Criche (Lynwilg), Aviemore, Allt na Criche (Granish) and Feith Mhor for all Scheme options, as the criteria of test 1 and 2 of the sequential test cannot be achieved. Table 7.7 details the requirements of the Stage 3 Assessment.

Table 7.7: Summary of Sequential Test and requirements for the Stage 3 Assessment

River Reach	Stage 2 DMRB Preliminary FRA		Requirements of Phase 3
	Test 1	Test 2	
Allt an Fhearna	Fail	Fail	Floodplain loss has been identified, therefore test 3 of the sequential test required.
Loch Alvie	Fail	Fail	Floodplain loss has been identified, therefore test 3 of the sequential test required.
Allt na Criche (Lynwilg)	Fail	Fail	Floodplain loss has been identified from all mainline options and junction option A02. Test 3 of the sequential test is therefore required.
Aviemore Burn	Fail	Fail	Floodplain loss has been identified, therefore test 3 of the sequential test is required. In addition to this 1D/2D linked model will be refined.
The Shieling/Easter Aviemore Burn	Pass	Pass	No further assessment required.
Allt na Criche (Granish)	Fail	Fail	Floodplain loss has been identified, therefore test 3 of the sequential test is required. In addition to this 1D/2D linked model will be refined.
Feith Mhor	Fail	Fail	Floodplain loss has been identified, therefore test 3 of the sequential test required.
River Dulnain	Pass	Pass	No further assessment required.

Summary

7.1.42. The Proposed Scheme will increase flood risk to downstream receptors for all route options. This is due to an increase in flow capacity of existing A9 structures and through the loss, and displacement of floodplains. The sensitivity of the receptors vary along the route of The Proposed Scheme, with the overall receiving watercourse being the River Spey. The increase in flood risk from increases in hydraulic capacity have been assessed based on the first main catchment.

7.1.43. The overall impacts are based on the precautionary approach, assuming the highest sensitivity for each reach, magnitude of impact and overall significance. Table 7.8 details the overall impact magnitude and significance from the increasing flow capacity and floodplain loss from the mainline options.

Table 7.8: Summary of Magnitude and Significance of Impact

Potential Impact	Receptor Location	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
		Sensitivity	Magnitude	Significance	Sensitivity	Magnitude	Significance	Sensitivity	Magnitude	Significance
Increase in flood risk from increases in existing hydraulic capacity.	Loch Alvie	Low	Mod	Slight	Low	Mod	Slight	Low	Mod	Slight
	River Spey	Med	Min	Slight	Med	Min	Slight	Med	Min	Slight
	Aviemore Burn	High	Maj	Very/Large	High	Maj	Very/ Large	High	Maj	Very/Large
	River Spey Aviemore North	Low	Maj	Slight/ Moderate	Low	Maj	Slight/ Moderate	Low	Maj	Slight/ Moderate
	Allt na Criche (Granish)	Med	Maj	Large	Med	Maj	Large	Med	Maj	Large
	Avie Lochan	Med	Mod	Moderate	Med	Mod	Moderate	Med	Mod	Moderate
	Loch Vaa	Low	Min	Neutral	Low	Min	Neutral	Low	Min	Neutral
	Loch Roid	High	Mod	Moderate/ Large	High	Mod	Moderate/ Large	High	Mod	Moderate/ Large
	Gormack Stripe	High	Min	Slight/ Moderate	High	Min	Slight/ Moderate	High	Min	Slight/ Moderate
	Feith Mhor	Med	Mod	Moderate	Med	Mod	Moderate	Med	Mod	Moderate
	River Dulnain	High	Min	Slight/ Moderate	High	Min	Slight/ Moderate	High	Min	Slight/ Moderate
	All nan Ceatharnach	Med	Min	Slight	Med	Min	Slight	Med	Min	Slight
	Bogbain Burn	Low	Mod	Slight	Low	Mod	Slight	Low	Mod	Slight
	Allt Slochd Mhuic	High	Maj	Large/ Very Large	High	Maj	Large/ Very Large	High	Maj	Large/ Very Large
Impact of Floodplain loss.	Allt an Fhearna (Section 1 Ch	Med	Maj	Large	Med	Maj	Large	Med	Min	Slight

Potential Impact	Receptor Location	Mainline Alignment Option 1			Mainline Alignment Option 1A			Mainline Alignment Option 2		
		Sensitivity	Magnitude	Significance	Sensitivity	Magnitude	Significance	Sensitivity	Magnitude	Significance
	Loch Alvie Section 1, Ch 1000 - 2700	High	Neg	Neutral	High	Neg	Neutral	High	Neg	Neutral
Impact of Floodplain loss.	Alt na Criche – Lynwilg (Section 2 & 3a Ch 3300 – 4500)	Med	Maj	Large	Med	Maj	Large	Med	Maj	High
	Aviemore (Section 4 Ch 7100 – 8000)	High	Maj	Very Large	High	Maj	Very Large	High	Maj	Very Large
	Allt na Criche (Granish) (Section 5 Ch8300-9600)	High	Mod	Moderate/ Large	High	Mod	Moderate/ Large	High	Mod	Moderate/ Large
	Feith Mhor (Section 7 Ch14700 - 15000)	High	Maj	Very Large	Med	High	Major	High	Mod	Large

7.2. Flooding from Groundwater

7.2.1. The SEPA Flood Map[x] for groundwater shows that there is no likelihood of direct flooding from groundwater. However, groundwater is often a contributing factor to flooding rather than a primary source. For example groundwater flows contribute to river baseflows. The surrounding geology is of a low permeability, with water strike levels from boreholes indicating that there is no significant groundwater flood risk.

7.2.2. The Proposed Scheme Options would have Negligible impact on groundwater flooding.

7.3. Flooding from Land (Pluvial/Surface Water)

7.3.1. The drainage design for The Proposed Scheme will consist of new gravity drainage networks, which will convey flow to suitable outfall points via sustainable drainage systems (SuDS). The discharge rates into the receiving watercourse will be limited to the existing runoff rates (Table 5.6 in Section 5.5).

7.3.2. The Stage 3 assessment will consider further limitation of runoff rate immediately upstream of the PVAs at Aviemore and Carrbridge.

7.3.3. The Proposed Scheme will be designed to be free from surface water flooding at the 20% AEP event and not result in flooding to third parties at the 0.5% AEP.

7.3.4. The impact from increasing the impermeable surface area is Negligible.

8. Mitigation

8.1. Fluvial Flooding

Construction

8.1.1. To protect the site and sensitive receptors from increased flood risk during the construction phase of The Proposed Scheme the following should be considered.

8.1.2. The Proposed Scheme development site should be listed on the SEPA flood warning register. The flood warning service monitors rainfall and river levels 24 hours a day and uses this information to forecast the possibility of flooding.

8.1.3. A flood warning and emergency evacuation plan will be prepared and submitted to Transport Scotland for approval before construction work commences. The emergency evacuation plan will include the following:

- how the flood warning should be provided and disseminated
- what will be done to protect the critical infrastructure of the development and how easily damaged items will be relocated
- the availability of staff and time taken to respond to a flood warning
- the use of high level refuges for staff within the plant
- the time needed to evacuate the site
- provision of safe access to and from the development

- the ability to maintain key operations during a flood event
- expected time taken to re-establish normal operation following a flood event

8.1.4. To ensure the effects of flood risk are minimised during construction, the work will be undertaken when flood events are unlikely and not predicted. Should a storm with flood potential be predicted then measures will be put in place to reduce the impacts of flooding, e.g. remove machinery from low-lying areas

8.1.5. All temporary channels and pumping operations to be sized in accordance with the flood risk for each location.

8.1.6. The excavation and construction works could lead to the blockage and severance of existing surface water drainage systems and watercourse crossing structures, which could result in low frequency localised flooding to the site. The Construction Environment Management Plan (CEMP) will outline the mechanisms to manage surface water flooding and will mitigate the risk from the blockage and severance of drainage pathways.

8.1.7. Stockpiles and site compounds should all be located out with the 0.5% AEP flood envelop.

8.1.8. During construction, the operation of machinery may result in compaction of the soil which will reduce the infiltration capacity. This could result in an increase in surface water runoff and could lead to localised flooding and runoff into the watercourses and rivers. As part of the CEMP, surface water runoff will be managed such that it will not increase the risk of flooding at the proposed development site, or to land within the surrounding area.

Operation

8.1.9. There are twelve locations where The Proposed Scheme could result in an increase in flood risk to local and regional receptors. The increase in flood risk can be attributed to:

- Increase in flow conveyance from upgrades/and or replacement of watercourse crossing
- Loss of floodplain storage
- Changes to overland flow pathways

8.1.10. The Proposed Scheme will be designed to avoid increasing flood risk to the proposed scheme and third parties.

8.1.11. There are twenty three existing watercourse crossings, which would potentially increase peak flows downstream and six locations where floodplains are intercepted and/or displaced by the proposed scheme. As part of the Stage 3 design consideration will be given to the optimisation of earthworks, and the hydraulic capacity to further reduced the flood risk impacts identified.

8.1.12. For the structures identified as having the potential to result in increased downstream flood risk the following will be considered:

- Maintaining the existing structure capacity
- Upsizing the structure but enabling the channel to spill upstream of the culvert , if the surrounding land was suitable and maintain the existing conveyance

8.1.13. Where the above is not possible/feasible/realistic, then sensitivity testing will be undertaken for each of the identified culverts to understand both the local and regional impact on downstream peak flows and water levels.

8.1.14. In order to meet the requirements of the DMRB, to avoid floodplains, or meet the requirements of DMRB HD45/09(Para 2.37 black box) the following should be adhered to:

- The road must remain operational and safe for use in times of flood.
- The Proposed Scheme should result in no net loss of floodplain storage.
- The Proposed Scheme should not impede water flows.
- There should be no increase in flood risk elsewhere.

8.1.15. The strategy will be to use a sequential test for storage compensation (similar to the approach used in Planning Policy Statement 25 (PPS25) to flood risk and development). This strategy aligns with SEPA's guidance to stakeholders. Table 2.7 -Table 2.9 shows the sequential test for compensation.

8.1.16. It is not possible to entirely avoid floodplains from The Proposed Scheme and the impact is considered to be:

- Large Adverse Allt an Fhearna
- Large Adverse at Allt na Criche (Lynwilg)
- Very Large Adverse at Aviemore;
- Moderate / Large at Allt na Criche (Granish) and
- Large Adverse Feith Mhor

8.1.17. At these locations where floodplain impact cannot be avoided the sequential test shown in Table 2.9 will apply.

8.1.18. Where flood compensation storage is required this can be achieved through a number of options including:

- landscaped features, through the re-profiling of the ground to replace the level for level volume loss. Consideration will be given to the floodplain conveyance, storage, land use and connectivity
- creation of enlarged channels, whereby increasing the storage available in channels that cross a floodplain (direct storage) or that connect a floodplain (in-direct storage)
- offline depressions or basins, which provide additional storage areas that can be linked to the 0.5% AEP floodplain with hydraulic structures to ensure level for level storage. It might be feasible to use culvert structures to control the flow through the embankment to neutralise the effect of the scheme. However, if all culverts are to be enlarged then it's unlikely that this approach will be an option. It may be that culverts through existing side roads and the railway already serve this purpose

8.1.19. The floodplain loss associated with the Allt an Fhearna is localised upstream of the existing A9, with Neutral significance downstream. However at the point of loss the impact is considered Large Adverse, and compensation flood storage should be considered.

8.1.20. Although the loss of floodplain storage associated with Loch Alvie is considered to be Negligible. It is considered best practice to provide flood compensation storage, in accordance with the SEPA flood risk guidance for stakeholders.

8.1.21. The surface water flood storage associated with the Lynwilg farmland is considered of Medium importance, due to the high value agricultural land use. The loss of flood water storage is localised, with Minor impacts on peak levels downstream.

8.1.22. The floodplains associated with the Aviemore Burn and Aviemore are considered of High importance, providing protection to a range of receptors including residential and non-residential properties. The impact from changing the flood outline and increases in flood depth, means avoidance or full mitigation of the 5467m^3 lost storage volume will be required to mitigate the impact.

8.1.23. The floodplains associated with the Allt na Criche (Granish) currently present a flood risk to the existing A9, with the Proposed Scheme altering the flood risk to the A9 and downstream receptors. The impact from the changing flood outline and flood depths means avoidance and/or full mitigation of the 3000-4000m3 lost storage will be required to mitigate the impact.

8.1.24. The floodplains of Feith Mhor are primarily located between the existing A9 and Highland Mainline Railway. The impacts from the floodplain loss are locally contained in this area. Although peak flows increase in the immediate area next to this displacement, the preliminary testing indicated Negligible change in the peak levels downstream of the railway and the effect of the floodplain loss is local at the point of loss.

8.1.25. At the following locations the impacts of floodplain losses are locally contained and the downstream impact is considered to be Slight or Neutral significance.

- Allt an Fhearna
- Loch Alvie
- Allt na Criche (Lynwilg)
- Feith Mhor

8.1.26. It may be possible at these locations that partial compensation is suitable if full compensation is not practically achievable. The hydraulic models will be used to inform the design and impact, to provide adequate mitigation.

8.1.27. The Aviemore Burn and Allt na Criche (Granish) are considered to have a downstream impacts, which will require further consideration. As part of the Stage 3 design, consideration will be given to the optimisation of earthworks, and the proposed hydraulic capacity to further reduced the flood risk impacts identified, and the extent of mitigation required. The hydraulic models will be used to inform the design review, and the design of mitigations measures and impact to provide adequate mitigation.

9. Managing Residual Risk

9.1.1. Residual risk will be assessed as part of the Stage 3 Assessment, once mitigation measures and strategies have been developed.

10. Conclusions

10.1.1. The Proposed Scheme between Dalraddy and Slochd will cross a number of watercourses and their associated floodplains. It will increase the amount of impermeable surface area, and there is the potential for some groundwater interaction (albeit groundwater levels are likely to correlate to river baseflows).

10.1.2. The DMRB Stage 2 FRA identified that The Proposed Scheme would have an overall Large/Very Large significance to the existing fluvial flood risk locally and to downstream receptors, as a result of increasing culvert capacity and the displacement and or loss of floodplain volume.

10.1.3. The 1D hydraulic capacity models confirmed that there are five structures which would be considered to have Major impact on downstream flood risk. These are at DS-WC-014, DS-WC-017, DS-WC-022, DS-WC-061 and DS-WC-062.

10.1.4. It is recommended that DS-WC-014, DS-WC-017 and DS-WC-022 are assessed within the 1D/2D linked models.

10.1.5. In addition to Major impacts there are twelve watercourse crossings with a Moderate impact and a further six with Minor impacts.

10.1.6. There are two structures which are considered to have a Large/Very large significance these are DS-WC-014 and DS-WC-061. One structure with a Large significance (DS-WC-022) two with Moderate/Large significance (DS-WC-026 and DS-WC-032) and seven with a Moderate or Slight /Moderate significance.

10.1.7. For all structures where the existing capacity is less than the 0.5% AEP event and the significance is greater than Slight, mitigation and/or further assessment will be required at Stage 3.

10.1.8. Hydraulic modelling was used to confirm the floodplain extents at Loch Alvie, Allt na Criche (Lynwilg), Aviemore, Allt na Criche (Granish), Feith Mhor and Carrbridge.

10.1.9. At Loch Alive, Allt na Criche (Lynwilg), Aviemore, Allt na Criche (Granish) and Feith Mhor all The Proposed Scheme options result in a loss or displacement in floodplain.

10.1.10. The impacts for The Proposed Scheme were simulated in the hydraulic model using a hypothetical “glass wall” of the scheme footprint to determine the impacts on flood risk, both at the point of floodplain loss/displacement and downstream. This is a conservative approach to volume loss and may overstate the impacts.

10.1.11. The impacts from the displacement of the floodplain at Loch Alvie are considered to be Negligible with a Neutral significance.

10.1.12. The floodplain at Allt na Criche (Lynwilg) are considered to be from surface water flooding, rather than the watercourse. The loss of volume here results in localised increased in peak levels in the Allt na Criche and is considered to be of Large Adverse significance.

10.1.13. The impacts from floodplain loss at Aviemore are considered to have a Very Large Significance from all Proposed Scheme options and measures will be required to mitigate against the impacts. This will be undertaken as part of the Stage 3 Assessment and will likely require a combination of options to achieve an optimum solutions.

10.1.14. The impacts from the Proposed Scheme at Granish, will result in the displacement of the flood water, altering both the flood extent and depth of flooding for all mainline and junction options.

10.1.15. The modelling results indicate that the displacement of flood waters, could generate both positive and negative impacts with reductions and increases in flood depth to number of sensitive receptors.

10.1.16. Any reductions in flood levels at specific receptors have not been used to distinguish between the options as the change in flood depths can only be confirmed once the final ground levels, the nature of the proposed culvert crossing and the road drainage design is progressed at Stage 3.

10.1.17. All mainline and junction options impacts, in terms of loss of floodplain, for the Allt na Criche (Granish) are considered to have a Moderate /Large significance.

10.1.18. With regard to Feith Mhor, The Proposed Scheme options all result in a localised change in floodplain extents and depth, which are considered to be of Large Significance. Mainline alignment Option 2, will result in less floodplain volume loss, albeit the attribute significance remains the same. The Stage 3 Assessment will consider mitigation measures.

10.1.19. Increases in surface water runoff from increased impermeable areas will be managed through the drainage design with the proposed discharge rates limited to the existing discharge rate. The Stage 3 Assessment will consider further limitation on discharge at Aviemore which has been identified as a High sensitive receptor.

11. Scope of the DMRB Stage 3 FRA

11.1.1. The DMRB Stage 3 FRA will to be undertaken to support the DMRB Stage 3 Assessment. It will compare the pre and post development scenarios, based on the Preferred Route alignment. The following key tasks and considerations will be undertaken as part of the Stage 3 Assessment:

- the baseline hydraulic capacity will be determined for structures DS-WC-013, and DS-WC-031.
- all new watercourse crossings and existing crossings which will be replaced and/or extend will be assessed based on a proposed design for each structure.
- for all watercourse crossing structures which have a significance impact greater than Slight mitigation and further assessment will be considered.
- the baseline model for Aviemore will be refined to include additional topographical survey information. Cattle creeps and road underpasses are conveying flood waters and their representation in the hydraulic model needs to be confirmed
- verification of the flood model extents compared with local flood history in Aviemore; additional information may be required from The Highland Council and SEPA.
- detailed consideration will be given to the possible mitigation measures at Aviemore and tandem with the developing design at Stage 3
- DS-WC-014 to be incorporated into the Aviemore model and considered as part of any mitigation strategy
- Detailed consideration will be given to the possible mitigation measures at Allt na Criche (Granish) and consultation will be undertake with the highways and structures design teams.
- the sequential test will be applied to determine what Flood Compensatory Storage will be required at each locations (Table 2.7 to Table 2.9 provides details on the sequential test)
- suitable locations for storage will be identified, as close to the source of loss as possible, providing and maintaining connectivity of the floodplains and will seek to achieve level for level storage
- additional topographical survey may be obtained to improve the accuracy of modelling assessments of flood storage loss and mitigation
- it may be that a combination of storage options and other flood defence measures are considered to mitigate any impacts to third party receptors.

- sensitivity testing will be undertaken to assess the impact at the scheme on downstream receptors
- the impacts on flood risk of blockage at the proposed new or replacement watercourse crossing structures will be assessed