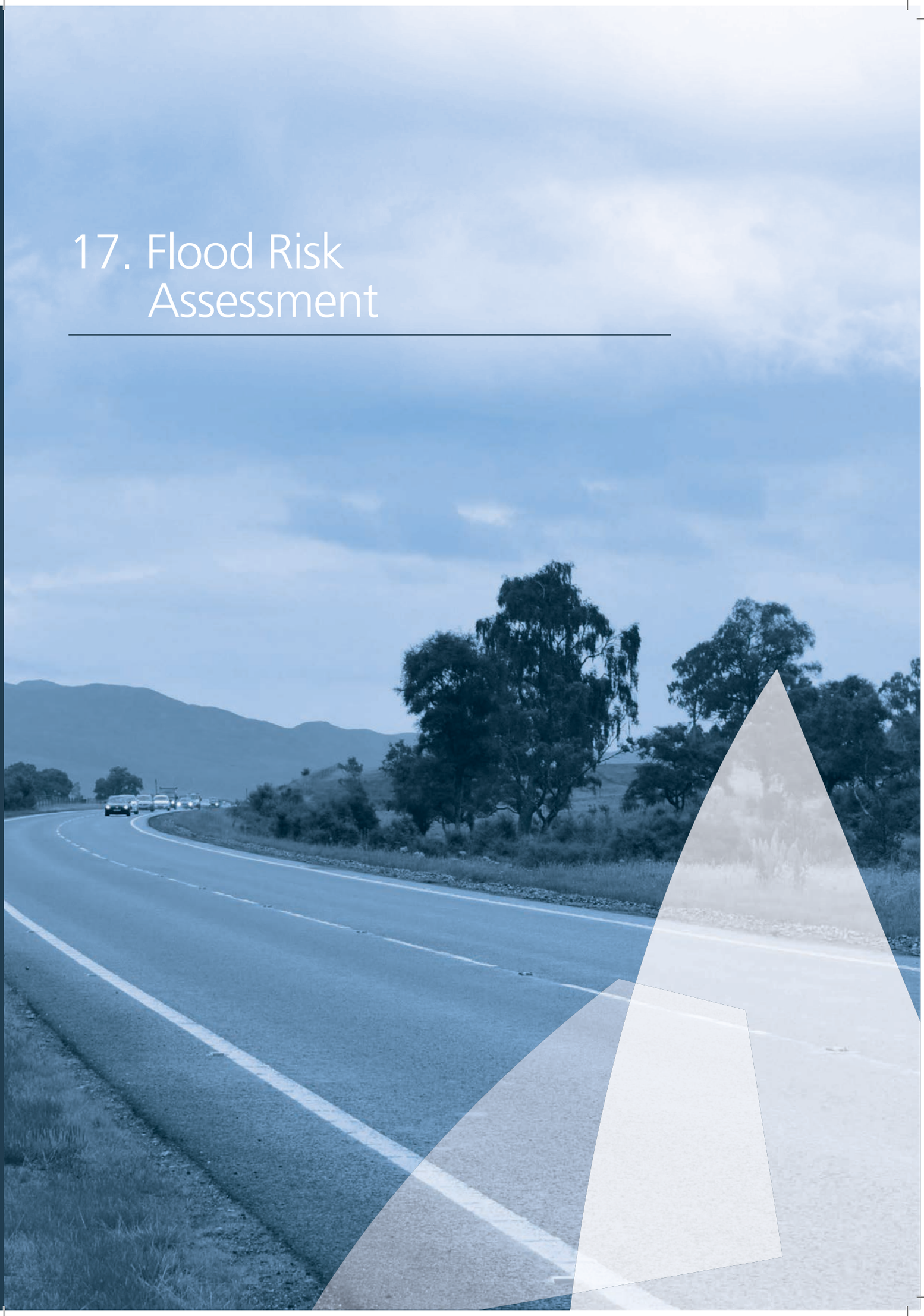
17. Flood Risk Assessment



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1. Introduction

1.1. Background

The A9 Trunk Road extends 177m forming a strategic trunk road link between Perth and Inverness. Between 2007 and 2008 Atkins developed a carriageway widening scheme for the Kincraig to Dalraddy stretch of the A9. In early 2009 a Public Local Inquiry took place following a number of objections to the Compulsory Purchase Orders.

In December 2011, the Scottish Government published its Infrastructure and Investment Plan which details spending until 2030. The Infrastructure and Investment Plan sets out that the A9 will be dualled between Perth and Inverness by 2025.

Following this announcement the previous Kincraig to Dalraddy carriageway scheme has been redesigned as a section of dual carriageway and will form part of the wider strategy to upgrade the A9 to dual carriageway standard.

The proposed scheme is located approximately 11km south west of Aviemore near the village of Kincraig within the district of Badenoch and Strathspey, between Ordnance Survey Grid references NH811037 and NH856095.

An Environmental Statement (ES) for the proposed Kincraig to Dalraddy dualling has been prepared by Atkins and published in November 2013. SEPA highlighted during consultation on the ES that the earthworks at the Allt an Fhearna and Dunachton Burn would potentially encroach onto the Indicative Flood Outlines and recommended a Flood Risk Assessment (FRA) was undertaken to assess any risk to the area.

In August 2013 there was an amendment to the scheme design following continuing discussion with statutory consultees. The revised design includes a cycleway running parallel to the road. This FRA assesses the impact of flooding to the revised design.

1.2. Approach

This FRA will follow SEPA's Technical Flood Risk Guidance for Stakeholders, version 4 (SEPA, 2009) and will therefore recognise, consider and address flooding from all potential sources. The requirements of a FRA are to:

- Assess the likely flooding mechanisms;
- Assess the potential impact of the proposed development on the risk of flooding to other properties;
- Review of historic flooding information;
- Review of current flooding information; and,

Provide recommendations as to whether further assessment of flood risk is required.

1.3. Legislative Background

For coastal and watercourse flooding Scottish Planning Policy (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% (1:1000));
- Low to medium risk area (annual probability of watercourse, tidal or coastal flooding in the range 0.1%-0.5% (1:1000-1:200));
- Medium to high risk area (annual probability of watercourse, tidal or coastal flooding greater than 0.5% (1:200)).

The central purpose of the risk framework is to prevent further development which would have a significant probability of being affected by flooding or which would increase the probability of flooding elsewhere. New development should not take place if it would be at significant risk of flooding from any source or would materially increase the probability of flooding elsewhere. The storage capacity of functional floodplains should be safeguarded, and works to elevate the level of a site by landraising should not lead to a loss of flood water storage capacity.

The probability of flooding must be taken into account on all planning applications. Where developments are shown to be within the 0.5% Annual Event Probability (AEP) flood outline shown on SEPA's Flood Map, it is usually necessary to undertake a formal FRA following guidelines set out by SEPA.

2. Site Description

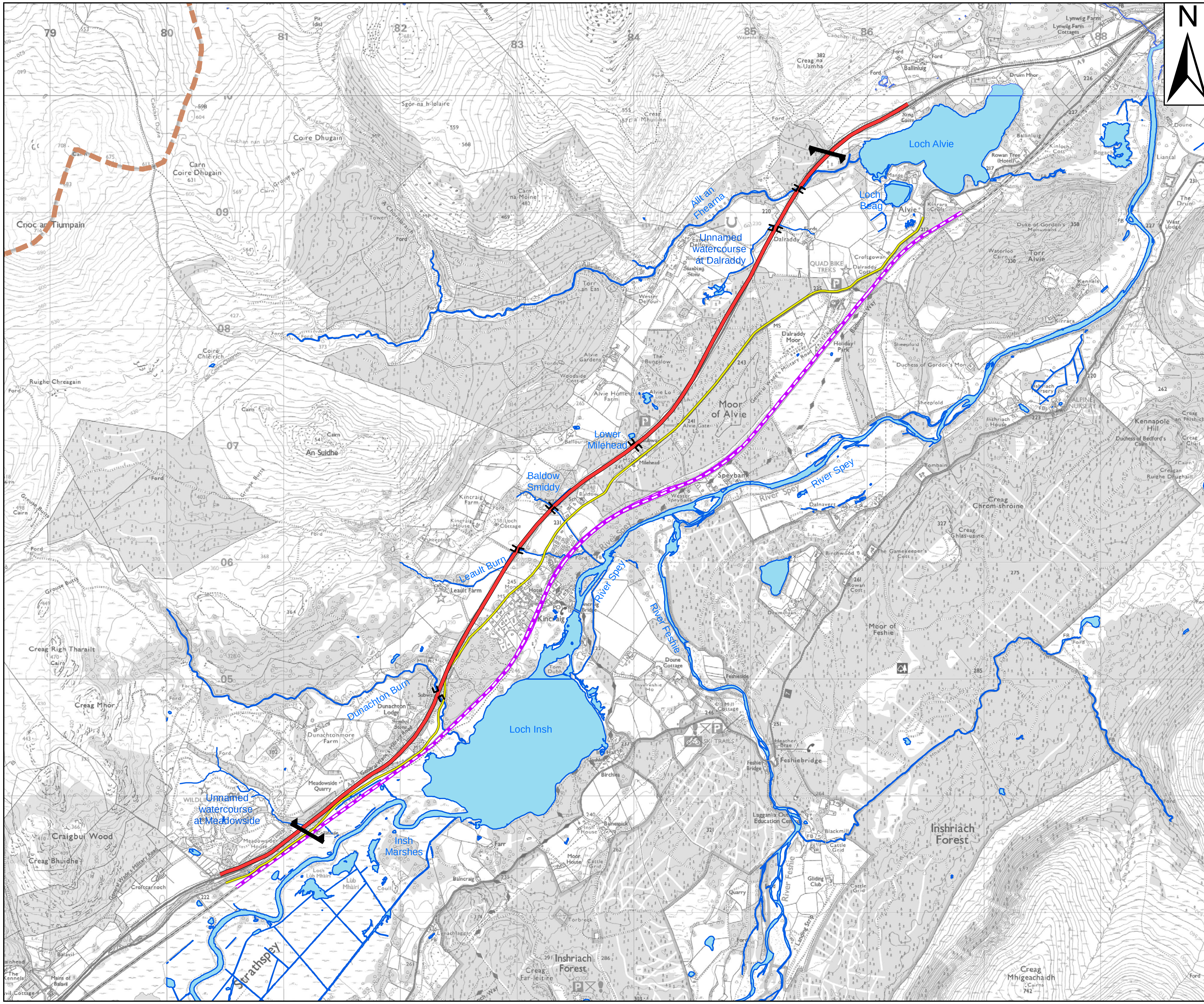
2.1 Location and Description of Site

The length of road to be upgraded runs parallel with the River Spey on its northern side. The preferred upgrade option is 7,455m in length, coming within approximately 250m of the River's Spey north bank at its closest point opposite Meadowside Quarry, near the southern end of the scheme. The proposed reach starts at 281191 803735 and ends at 285645 809506. This current section of road crosses six watercourses, all of which are tributaries to the River Spey. The River Spey is one of the largest rivers in Scotland and is designated as a Special Area of Conservation (SAC) and a Site of Special Scientific Interest (SSSI). Two site visits were undertaken, one on the 4.12.12 and the other on the 26.03.13.

The upper catchment of the River Spey is relatively steep, as is the lower river downstream from Grantown. However, the middle reach, which includes the study area, is characterised by a broad meandering channel, wide floodplain and is relativity slow flowing due to the low gradient. In this part of the river, which includes the Insh Marshes south east of Loch Insh, the river is more similar to a lowland river in form. The environmental and conservation significance of the Insh Marshes are recognised.

The Insh Marshes are an important feature of the River Spey catchment and are significant in terms of geology, wildlife and plant life. The site has been given SAC, SPA, SSSI and Ramsar status for its important populations of breeding and wintering wetland birds, nationally scarce mammals, plants and invertebrates.

The location of the proposed dualling section and the watercourses that are crossed by the proposed road are shown on Figure 2.1.



LEGEND

- Northern / Southern Extent of Scheme
- Existing A9
- B9152
- Railway
- Cairngorms National Park Authority Boundary
- Surface water feature
- Culvert

NB: STUDY AREA LIES WITHIN CAIRNGORMS NATIONAL PARK

Metres: 200 0 200 400 600 800 1,000

CLIENT NAME: TRANSPORT SCOTLAND

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Kincraig to Dalraddy

Title

FIGURE 2.1
SURFACE WATER FEATURES

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2.2. Structures

The Dunachton Burn, Leault Burn and the Allt an Fhearna crossings are being replaced with upgraded structures. The Baldow Smiddy will be replaced with a crossing that includes the watercourse and the underpass. The existing pipe at the unnamed watercourse at Dalraddy will be replaced with a like-for-like design. The length of the pipe will increase but the gradient and the size of the culvert will remain the same. The pipe at the unnamed watercourse at Meadowside will be extended by spanning a structure over the watercourse. All structures will maintain the original channel width as recommended in SEPA's letter dated 29th May 2013, which suggested that *'the burn through the culvert should maintain the same characteristics as the upstream and downstream sections'*.

The proposed structures are described below. The concept design drawings have been included in Appendix A (5109850/ATK/0717/SR/DR/S/101, 301, 401, 501, 601, 701).

Unnamed watercourse at Meadowside

There is an 800mm pipe conveying water under the A9 road crossing. It is proposed that the existing culvert under the A9 will remain and be extended through spanning the watercourse with abutments set back beyond the existing bank to minimise any impacts on the watercourse bed.

The following changes to the crossing may potentially affect conveyance and therefore flood risk at this location.

- The overall length of the structure will increase to 54m.

Dunachton Burn

The Dunachton Burn crossing is being replaced with an upgraded structure. The following changes to the structure may potentially affect conveyance and therefore flood risk at this location.

- The overall width of the structure will increase to 9.45m; however the channel width will remain the same.
- The overall length of the structure will increase to 45m.

The height of the proposed structure will increase to a minimum of 6.6m from the bed level of the channel.

Figure 2-2: Dunachton Burn Underpass/Culvert

Leault Burn

The Leault Burn crosses the A9 through a circular culvert. This has a small mammal ledge which can be accessed in low flows. A picture of the Leault Burn crossing, taken downstream, can be found in Figure 2.3.

Figure 2-3: Leault Burn Culvert

This culvert is being replaced with a rectangular box culvert. The following changes to the culvert may affect

conveyance and therefore flood risk at this location.

- The overall culvert width will be increased to 4.8m; however the channel width will remain the same.
- The culvert length will increase to 41m.
- The height of the structure will increase to 2.95m throughout the culvert.

Baldow Smiddy

The Baldow Smiddy crosses the A9 through a circular culvert. A picture of this culvert, taken downstream, can be found in Figure 2.4.

Figure 2-4: Baldow Smiddy Culvert

To the south of this culvert there is an access track through a separate culvert. The proposed design will replace the access track culvert and the watercourse culvert with one concrete box culvert.

The changes to the culvert that may affect conveyance and therefore flood risk at this location have been listed below.

- The overall width of the culvert will increase to 3.3m; however the channel width will stay the same.
- The culvert length will increase to 33m.
- The height of the structure will increase to a minimum of 6m throughout the culvert above the watercourse.

Unnamed Watercourse at Dalraddy

There is an unnamed watercourse that crosses the A9 at 258238, 808892. This crosses through a 1500mm diameter pipe. The general layout of the crossing is shown in the figure below.

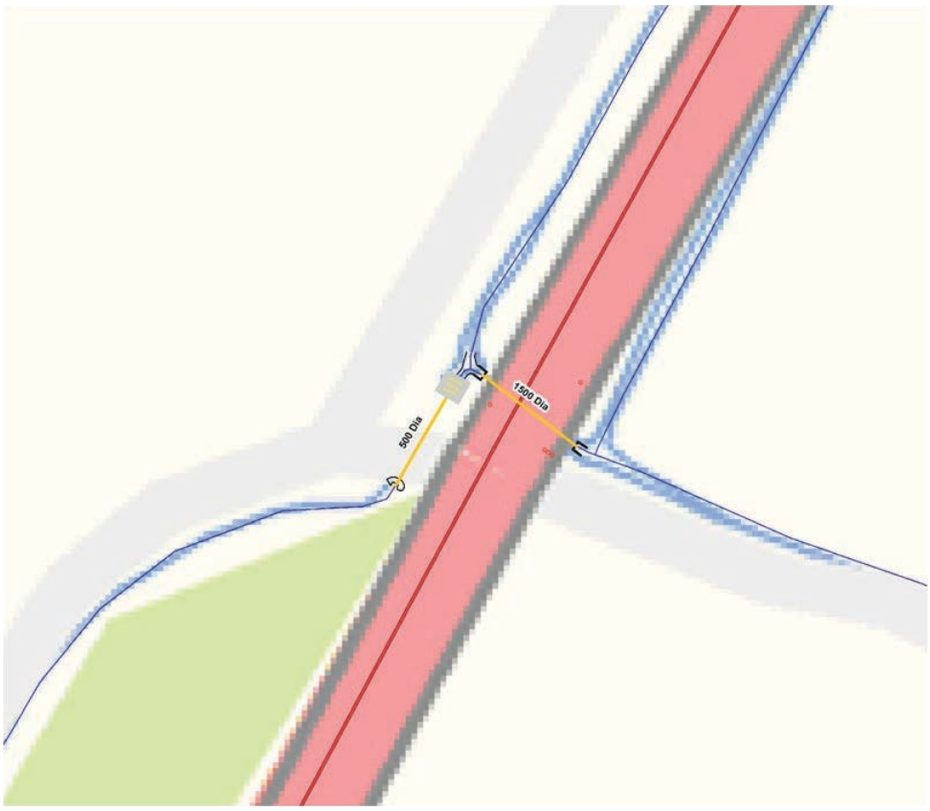

Figure 2-5: General Arrangement of unnamed watercourse at Dalraddy

To the north of the crossing, running parallel to the A9 is a drainage swale. This collects runoff from the road and routes it to the watercourse. To the south of the crossing is a field drain, which drains a small catchment adjacent to the A9. This flows under the access track to the A9 through a small 500mm pipe before joining with the northern swale and flowing under the A9 itself via the 1500mm pipe. The watercourse flows east towards the properties at Dalraddy and flows into Loch Beag.

It is proposed that the pipe conveying the unnamed watercourse at Dalraddy is replaced on a like-for-like basis. The size of the pipe will remain as 1500mm. The length of the pipe will increase to 44 m. The gradient of the pipe will remain similar to that of the watercourse. The drainage swale will be routed into the proposed SUDs before it outflows to the unnamed watercourse at Dalraddy. This will occur downstream of the crossing. The small 500mm pipe under the access track will no longer be required.

Allt an Fhearna

The Allt an Fhearna crosses the A9 through a concrete box culvert. This has an access track running parallel to the watercourse. A picture of the culvert taken downstream can be found in Figure 2.6.

Figure 2-6: Allt an Fhearna Culvert

The culvert is being replaced with a rectangular culvert. The changes to the culvert that may affect conveyance and therefore flood risk at the culvert location have been listed below.

- The overall culvert width will increase to 10m; however the channel width will remain the same.
- The length of the culvert will increase to 42m
- The height of the structure will increase to a minimum of 5.8m from the bed level.

2.3. Geology

A Ground Investigation for the A9 Kincraig to Dalraddy Carriageway Wideneing was undertaken in October 2006. The geology of the site was assessed in this report. It used the 1:10 000 and the 1:50 000 British Geological Survey (BGS) maps. These showed that the site consisted of the following:

Table 2-1: Geology of Proposed Site

Strata	Description
Made Ground	Unknown. Localised deposits only
Peat Deposits	Peat. Localised deposits only
Fluvioglacial Gravel	SAND and GRAVEL with some cobble and boulders locally very silty.
Glacial Till	Typically silty sandy gravelly CLAY with occasional cobbles.
Grampian Group	Typically schistose and locally gneissose psammites, pelites and semi pelites

Table from Atkins (2006)

The BGS maps indicated that the site is underlain by Fluvioglacial deposits and that there are small areas of peat above the Fluvioglacial deposits at the northern half of the route. The geological memoir for Geological Map Sheet 74 states that although Peat covers much of the Aviemore area it is uncommon to be more than 1m thick in lowland areas.

The BGS 1:50 000 scale and 1:10 560 scale geological maps indicate the drift deposits to be underlain by Precambrain aged Psammite, Gneiss and Schist. These are known as the Grampian Group. They are metasedimentary rocks which were previously clastic sedimentary rocks with a minor calcareous content.

2.4 Catchment Details and Study Extent

Seven catchments were assessed in this Flood Risk Assessment. These were all sub catchments to the River Spey. Figure 2.7 shows the catchment boundary and each catchment is described below.

Unnamed watercourse at Meadowside

The unnamed watercourse at Meadowside is a tributary to the River Spey and has a catchment area of 1.38 km^2 (FEH CD ROM, version 3). It flows from its source upstream of the wildlife park, under the A9 at 281150, 803710. It then flows under the B9152 and the railway line into the Insh Marshes.

The study extents for the unnamed watercourse at Meadowside extend from 280918,803813 to 281253, 803638. This is 246m upstream of A9 crossing and 79m downstream.

Dunachton Burn

The Dunachton Burn is a tributary to the River Spey and has a catchment area of 11.92 km^2 (FEH CD ROM, version 3). The Allt na Baranachd source is to the west of the Loch Insh. From Meali a' Chaochairn Duibh (604 metres in altitude), various tributaries join this mountainous stream which then becomes the Dunachton Burn. The Dunachton Burn flows under the A9 at 282370, 804850 and then under the railway line before it outflows into Loch Insh.

The study extent for the Dunachton Burn extends from 281895, 282386 to 282386, 804563). This is 670 m upstream of the A9 crossing and 360 m downstream.

Leault Burn

The Leault Burn is also a tributary to the River Spey and has a catchment area of 2.74 km^2 (FEH CD ROM, version 3). It has a predominantly rural catchment and flows under the A9 at 283090, 806040. The Burn continues to flow under the B9152 and the railway line and is joined by the Baldow Smiddy before flowing into the River Spey.

The study extent from the Leault Burn extends from 282646, 806062 to 283211, 806062. This is 690m upstream of the A9 crossing and 596 m downstream.

Baldow Smiddy

The Baldow Smiddy is a small tributary to the Leault Burn and has a catchment of 0.91 km^2 (FEH CD ROM, version 3). It flows under the A9 at 283298, 806470, then under the B9152 and the railway line before joining with the Leault Burn and outflowing into the River Spey.

The study extent for the Baldow Smiddy extends from 282918, 806501. This is 623 m upstream of the A9 crossing and 43 m downstream.

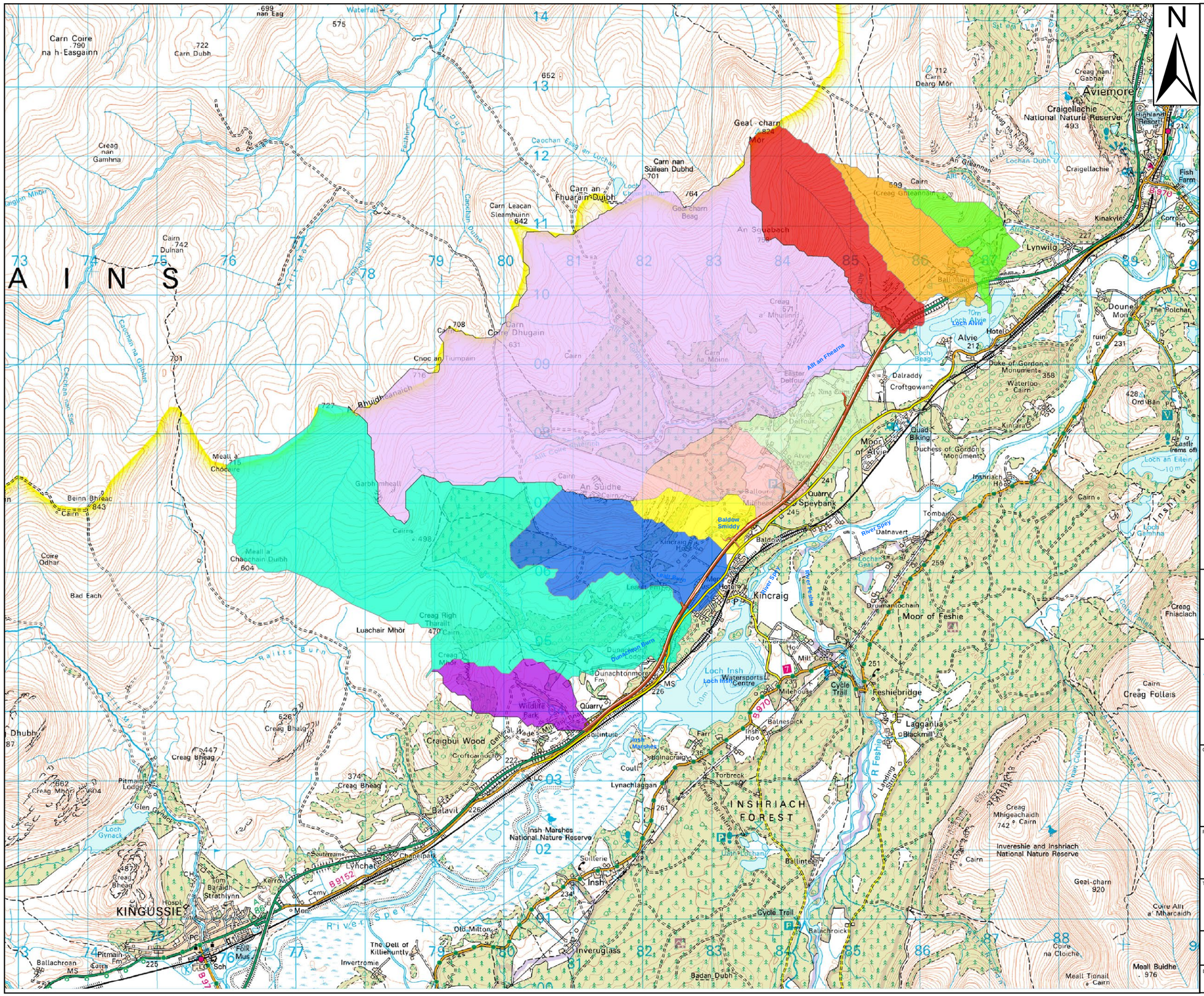

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FIGURE 2.7
CATCHMENT BOUNDARIES

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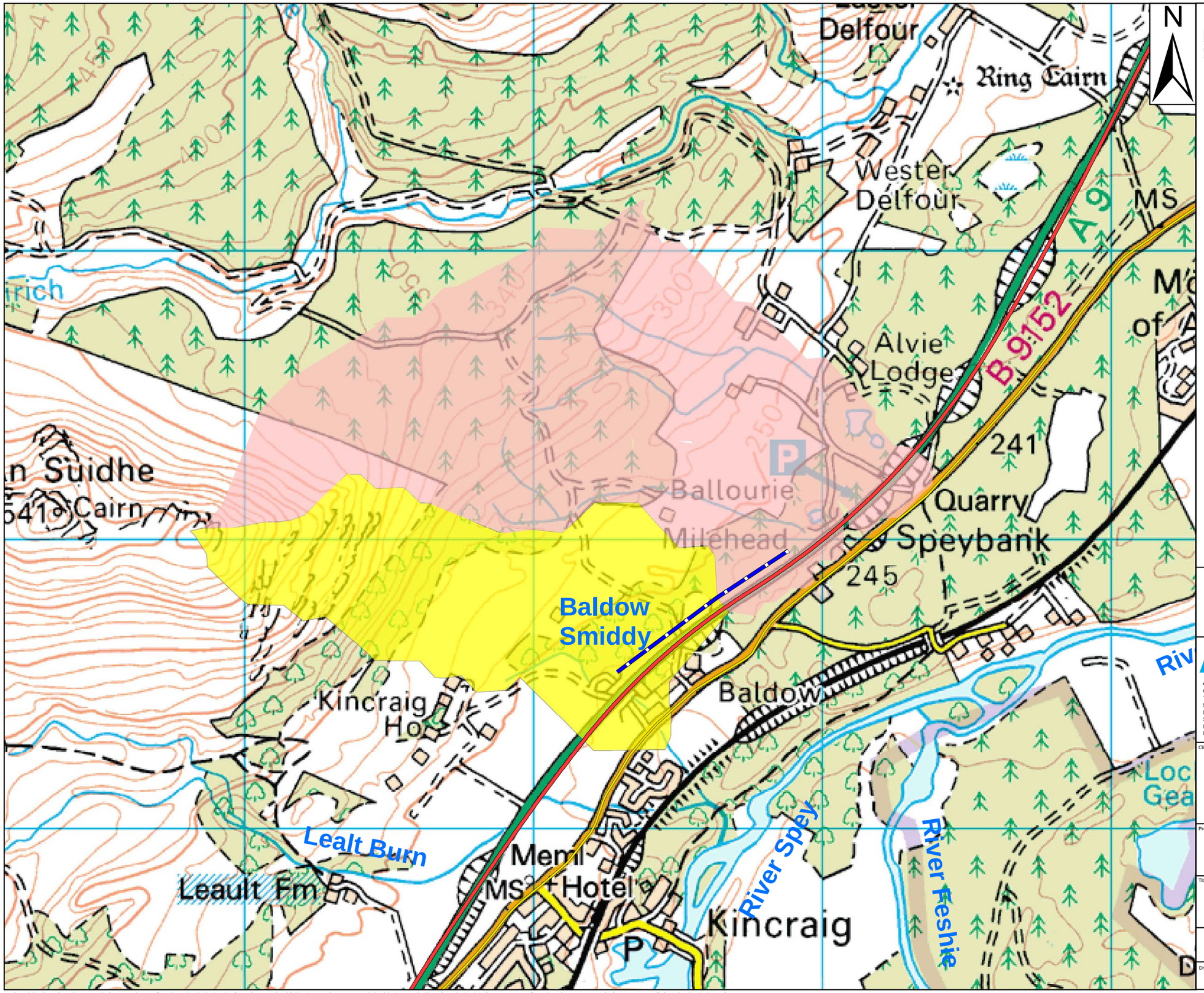

LEGEND

- Proposed New Embankment Works
- Lower Milehead Ditch
- Lower Milehead
- Baldow Smiddy

N

NB: STUDY AREA LIES WITHIN CAIRNGORMS NATIONAL PARK

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Title: FIGURE 2.8
LOWER MILEHEAD DITCH FLOW

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Lower Milehead

The Lower Milehead has a catchment area of 1.84 km^2 (FEH CD ROM, version 3). The Lower Milehead source is approximately 1.2 km west of the A9, where it crosses the Alvie Home Farm access track at NGR 284070, 807010. The channel flows into a small pond adjacent to the properties at Ballourie (283408, 807075). The flow infiltrates into the ground. The land immediately adjacent to the A9 at the Alvie Home Farm access track is fairly marshy and low lying. There is a ditch that runs alongside the existing A9 which picks up flow from this catchment. This flows into the Baldow Smiddy upstream of the A9 crossing. The indicative location of the ditch is shown in Figure 2-8.

Unnamed Watercourse at Dalraddy

The unnamed watercourse is a flood relief channel which crosses the A9 through a pipe at 285250, 808890. It has a catchment area of 1.78km^2. The watercourse flows east towards the properties at Dalraddy, and then flows into Loch Beag.

The study extent for the unnamed watercourse extends from 285029, 808724 to 285466, 808851. This is 278 m upstream of the A9 crossing and 358 m downstream.

Allt an Fhearna

The Allt an Fhearna has a catchment area of 20.08 km^2. It is a product of a number of larger tributaries, including the Allt na Cornlaraiche, Allt Each and Allt Coire Chleich. It has a predominantly rural catchment and flows under the A9 at NGR 285390, 809130. It then outflows into Loch Alvie, which has a surface area of 626m^2.

The study extent for the Allt Fhearna Burn extends from 285949, 809460 to 284779, 809021. This is 639 m upstream of the A9 crossing and 736 m downstream.

Loch Alvie has been included in the study extents as it is understood that the water levels of the Loch may impact the flood risk at the A9 crossing.

2.5. Historical Flooding

Historical flood information has been collected from several sources including:

- SEPA;
- Highland Council;
- British Hydrological Society (BHS) Chronology of British Hydrological Events.

2.5.1. SEPA

Consultation with SEPA found that there was some historical flooding within the vicinity of the proposed site. SEPA hold an indicative flood outline of a flood event that occurred in January 2004, based on a post flood survey. The flood outline showed the extent of the River Spey only, however the flood levels came within close proximity of the A9. The Insh Marshes were inundated and flood levels appear to have flooded the railway line just downstream of the proposed scheme. Furthermore, there was a report of flooding at a property on General Wade's Military Road. This area is approximately 20m from the first chainage in the proposed scheme.

2.5.2. The Highland Council

As part of The Highland Council's duties under the Flood Prevention and Land Drainage (Scotland) Act 1997, Biennial Flood Reports are produced. These document the following:

- The measures The Highland Council consider are required to be taken to prevent or mitigate flooding of non-agricultural land;
- The measures which have been taken since the date of publication of the previous report to prevent or mitigate such flooding; and
- All occurrences of flooding since that date.

The Biennial Flood Reports from The Highland Council are available on their website (http://www.highland.gov.uk/yourenvironment/flooding/biennialreports/, accessed 3.6.13). The following Biennial Flood Reports have been reviewed as part of this FRA:

- Report No. 1 – 1997;
- Report No. 2 – 1999;
- Report No. 3 – 2001;
- Report No. 4 – 2003;
- Report No. 5 – 2005;
- Report No. 6 – 2007; and
- Report No. 7 – 2009.

The review of the reports indicated that there were no recorded incidents of flooding on or in the vicinity of the A9 between Kincraig and Dalraddy. There was mention of flooding in Aviemore and Kingussie and the reports details the Aviemore Flood Prevention Scheme. These have been summarised in a table in Appendix C.

2.5.3. BHS Chronology of British Hydrological Events

The British Hydrological Events website is a public repository database for hydrological information for the years up to 1935 only. The database contained one entry for the River Spey at Kincraig and three entries for flooding on the Spey, which are considered to be near Kincraig and Dalraddy. The entries have been listed in a table in Appendix D.

3. Flood Risk to the Proposed Scheme

3.1. Introduction

The flood risk to the proposed scheme is outlined below. It refers to all sources of flood risk considered. Hydrological and hydraulic modelling was carried out to inform flood risk analysis. The hydrological models were built in accordance with UK industry procedures set out in the Flood Estimation Handbook and subsequent related research. The hydraulic models were built using InfoWorks RS 1D and 2D hydraulic modelling software. Details of the hydrological and hydraulic modelling methodology are described in an accompanying technical note (Appendix B and E).

3.2. SEPA Indicative Flood Map

SEPA has produced an Indicative Flood Map which provides a strategic national overview of the area estimated to be at risk of flooding from river and/or sea. The map shows areas which have a 0.5% chance of flooding in any single year. The maps have limitations as these are based on broad scale hydrological and hydraulic modelling techniques along with coarse digital terrain model and they do not take account of flood prevention schemes, or the effects of hydraulic structures. These maps do not accurately estimate the flood risk associated with individual properties or specific locations.

A review of the Indicative River and Coastal Flood Map (Scotland) 200 year flood outline (i.e. the flood with a 0.5% chance of occurring in any single year) showed that there was a risk of flooding at the proposed development. The indicative flood outlines showed that the Dunachton Burn and the Allt an Fhearna flooded at the A9 crossings. During consultation with SEPA (dated 19.12.12) (Appendix F), there were concerns that the proposed embankments associated with the A9 dualling may impinge on the flood extents for the Allt an Fhearna and Loch Alvie. The SEPA indicative flood map does not represent watercourses with a catchment area less than 3km^2, therefore the Leault Burn, Baldow Smiddy and the unnamed watercourses at Meadowside and Dalraddy do not appear on the map.

3.3. Flooding From Rivers (Fluvial Flooding)

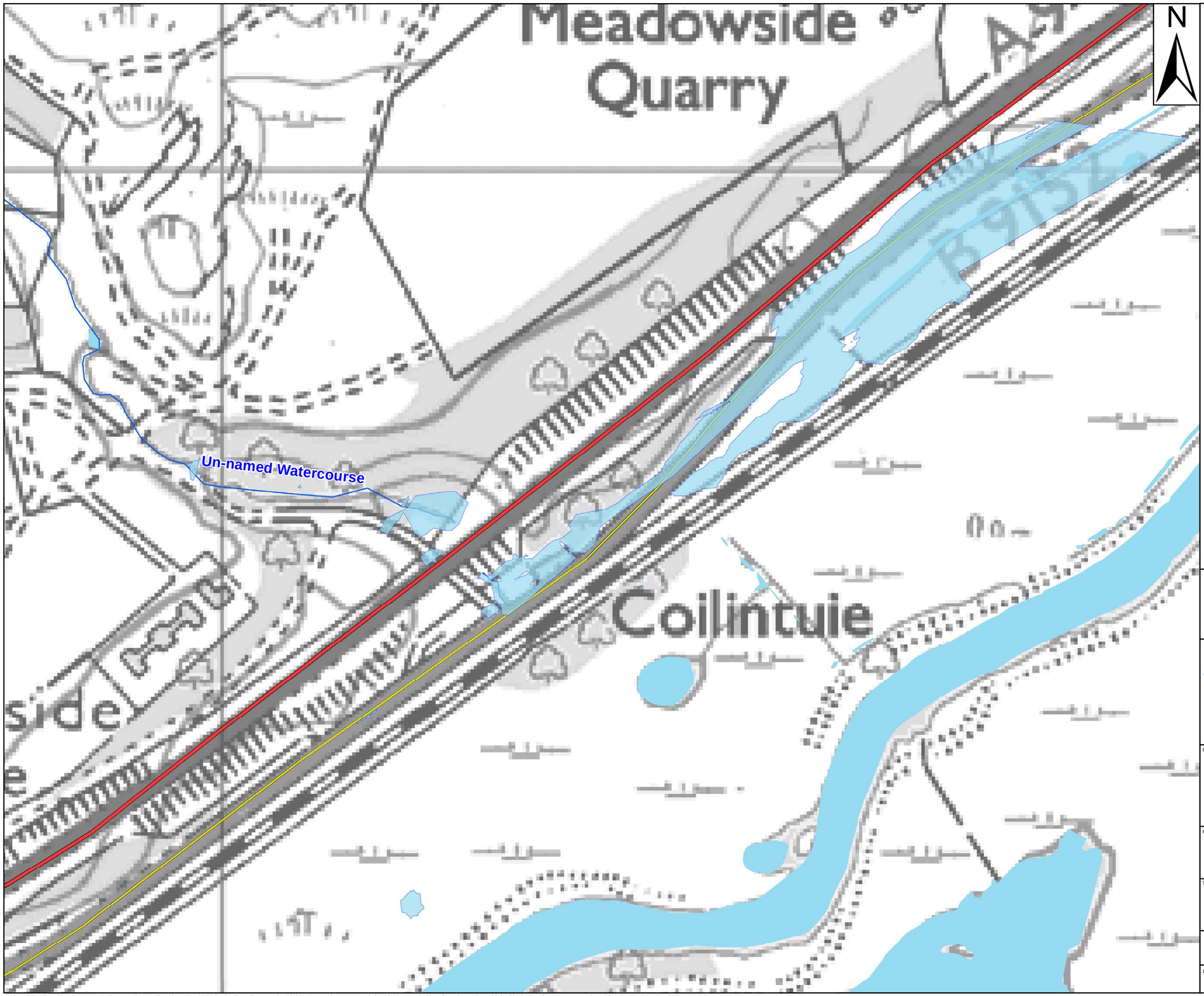
Details of the hydraulic modelling for this section can be found in the Hydraulic Modelling Technical Note in Appendix E. This also includes a full set of results.

3.3.1. Unnamed Watercourse at Meadowside

The main risk of flooding to the proposed design at this location is from the unnamed watercourse at Meadowside. The hydraulic model simulated the 0.5% AEP (with 20% increase as allowance for climate change) for the existing scenario. The flood outlines produced indicated that there was extensive flooding on low lying ground between the A9 and the B9152. This included the property north-east of the watercourse. The hydraulic model showed that the flow from the watercourse did not flow out of bank. Flooding to the area is likely to be a result of the low lying ground and its proximity to the Insh Marshes; surface water runoff ponds in this area, resulting in flooding to the residential property. There is potential for the culvert downstream of the A9 to block, which would increase the risk of flooding to the property. This has not been assessed in this FRA.

The flood extents for the 0.5% AEP (with 20% increase as allowance for climate change), existing scenario, are shown in Figure 3.1.

The proposed crossing was modelled for the 0.5% AEP (with 20% increase as allowance for climate change). The model found that there was no change in water level and flow as a result of the proposed design.



LEGEND

- 0.5% AEP (with 20% increase in flow as allowance for climate change)
- Existing A9
- B9152
- Surface water feature

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Title:
FIGURE 3.1
Flood Extents for Meadowside
0.5% AEP (with 20% increase for Climate Change)

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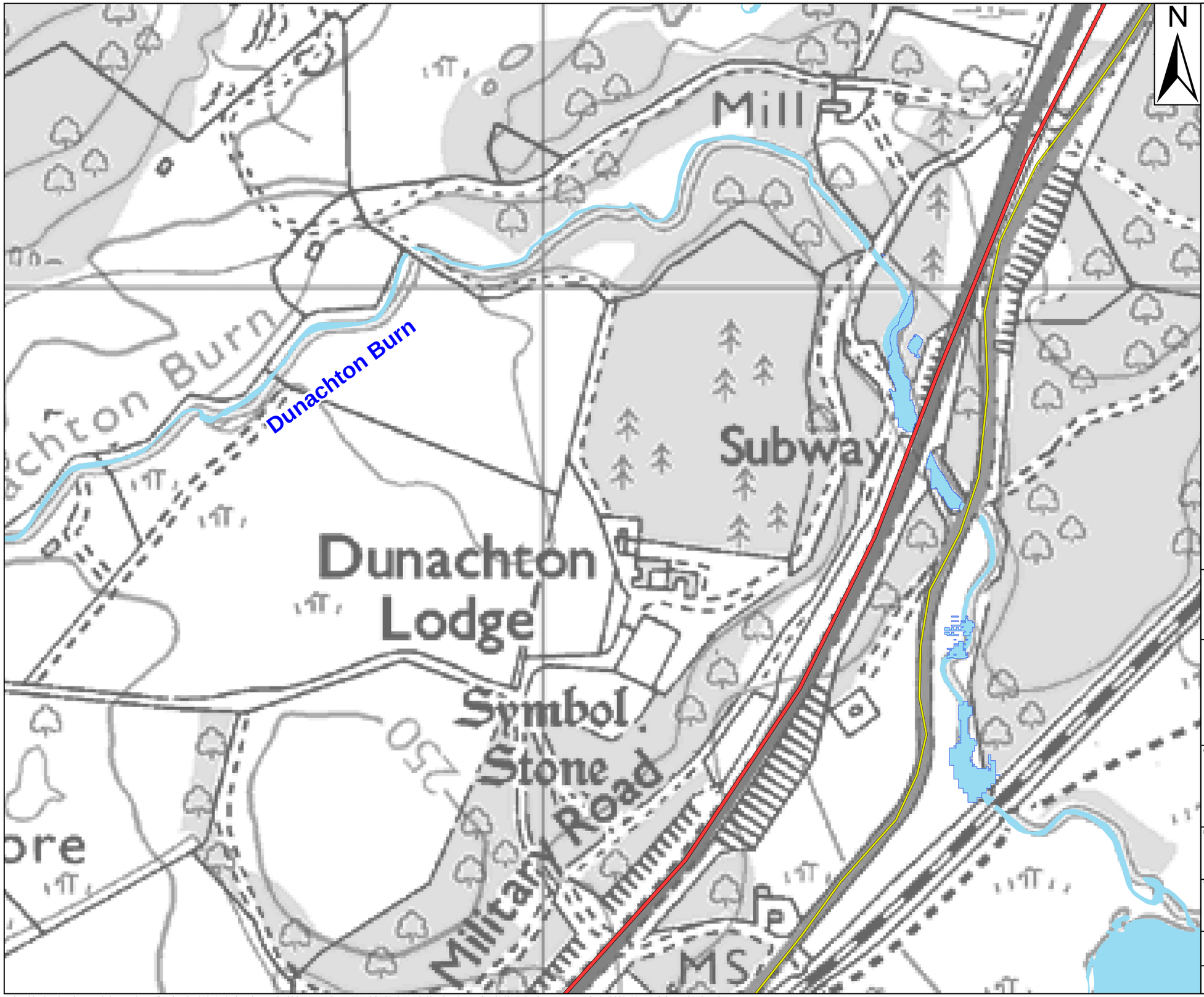

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LEGEND

- 0.5% AEP (with 20% increase in flow as allowance for climate change)
- Existing A9
- B9152
- Surface water feature

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Title: FIGURE 3.2
0.5% AEP (with 20% increase for CC) Flood Outline, Dunachton Burn, Existing Scenario

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3.3.2. Dunachton Burn

The main risk of flooding to the proposed design is from the Dunachton Burn. The hydraulic model simulated the 0.5% AEP (+20% increase as allowance for climate change) for the existing scenario. This showed that the river channel under the culvert floods the access track but does not extend onto the flood plains. The water depth on the access track is estimated as 1.3m and therefore impassable. There is, also flooding at the downstream extent of the model, upstream of the railway crossing. This is shown on Figure 3.2 which shows the flood extents for the existing scenario.

The effect of the proposed structure was simulated using the hydraulic model. The model found that the proposed design slightly reduced the water level at the crossing for the 0.5% AEP (+20% increase in flow as an allowance for climate change) event. There is a small decrease in water levels in the proposed scenario simulation as the access track is wider; therefore the out-of-bank flow from the channel under the crossing is spread out along a bigger area. The model found that there was no change in downstream flow as a result of the proposed design.

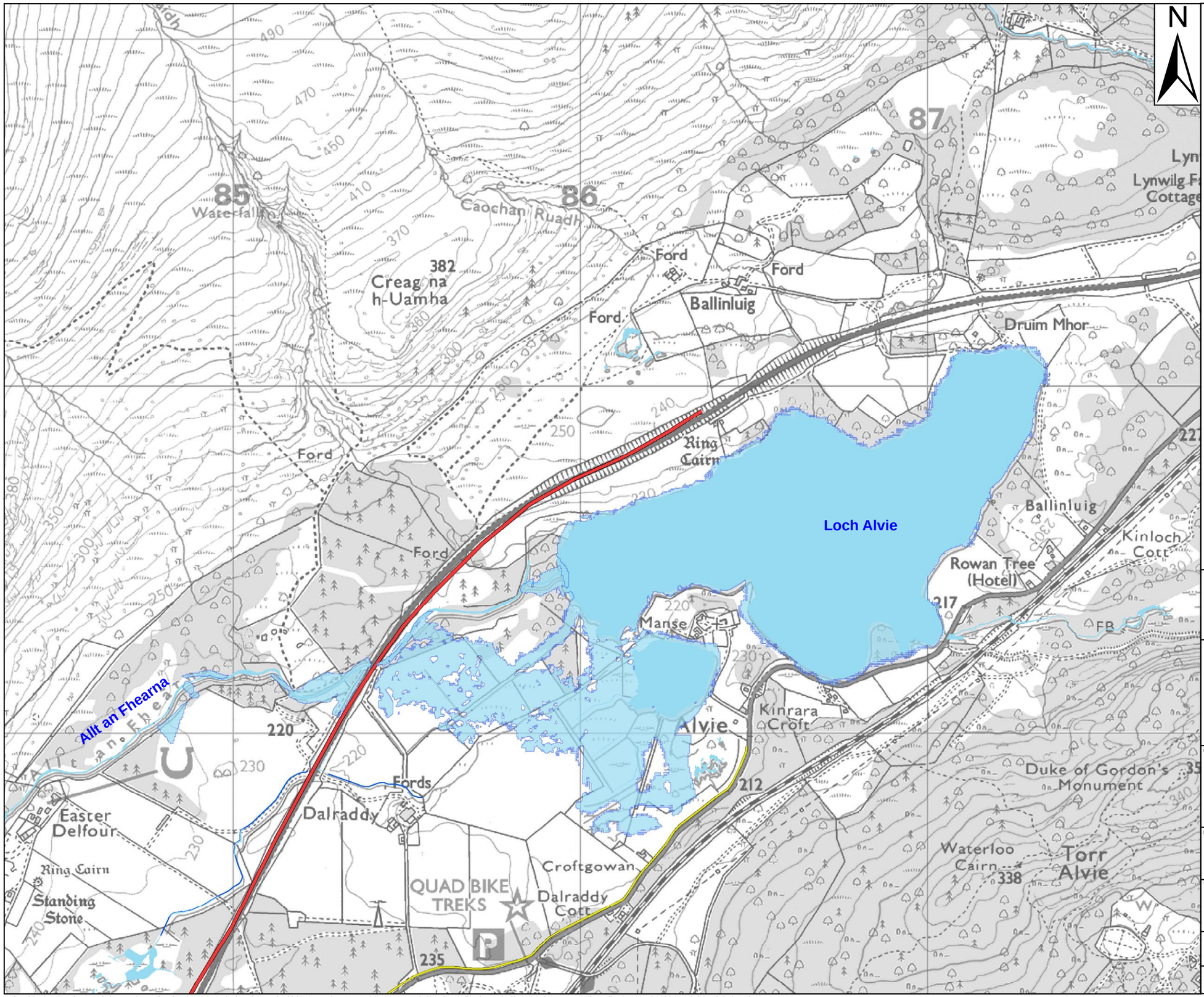
The hydraulic model was run for the 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.5% AEP (with a 20% climate change allowance). The access track to Dunachton Lodge was found to flood at the 50% AEP flood event, for both the existing and proposed scenario. It should be noted that this is not the only access to the Dunachton Lodge.

It is concluded that the proposed design of the Dunachton Burn does not increase the risk of fluvial flooding from the Dunachton Burn.

3.3.3. Allt an Fhearna

The main potential fluvial flood risk impact associated with the proposed design is from the Allt an Fhearna. The hydraulic model simulated the 0.5% AEP (with a 20% increase as allowance for climate change) for the existing scenario. This showed that there is out of bank flow directly upstream and directly downstream of the crossing. There is flooding to the access track located next to the watercourse. This is estimated as approximately 2m deep and therefore impassable. There is further flooding to the east of the A9, in agricultural fields. This is from Loch Alvie and Loch Beag, although there is a low-lying area of land on the right bank of the Allt an Fhearna that allows flood water to flow into this flood plain. The flood outlines for this event is shown in Figure 3.3. Figure 3.4, shows the flood extents and the proposed embankment locations. This shows that the embankments to the proposed A9 will encroach onto the flood outlines.

The proposed design for the Allt an Fhearna increases the overall span of the existing structure, widening the access track. The proposed design was simulated using the hydraulic model. The results found there was a decrease in flow and water level for the 0.5% AEP (with 20% increase as allowance for climate change) at the Allt an Fhearna crossing and further downstream. As the overall span of the crossing is increased there is more conveyance for out–of-bank flow. This results in a decrease of water levels downstream. The low point, on the right bank, downstream of the crossing is unaffected by the embankments, therefore flood flows from the channel are still able to spill out into the flood plain area, therefore the embankments are having no net affect on the water levels and flows in the channel. Flood outlines for the proposed model are in Figure 3.4.



LEGEND

- 0.5% AEP (with 20% increase in flow as allowance for climate change)
- Existing A9
- B9152
- Surface water feature

NB: STUDY AREA LIES WITHIN CAIRNGORMS NATIONAL PARK

200 0 200 M

CLIENT NAME: TRANSPORT SCOTLAND

LICENCE NUMBER: SE 100046668 2012

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Project: A9 DUALLING PERTH TO INVERNESS Kincraig to Dalraddy

Title: FIGURE 3.3
Allt an Fhearna, Existing Flood Extent
0.5% AEP (with 20% increase for Climate Change)
and Proposed Embankment layout

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A3	1:10,000	LG Date 18/10/13	EM Date 18/10/13	XX Date 18/10/13

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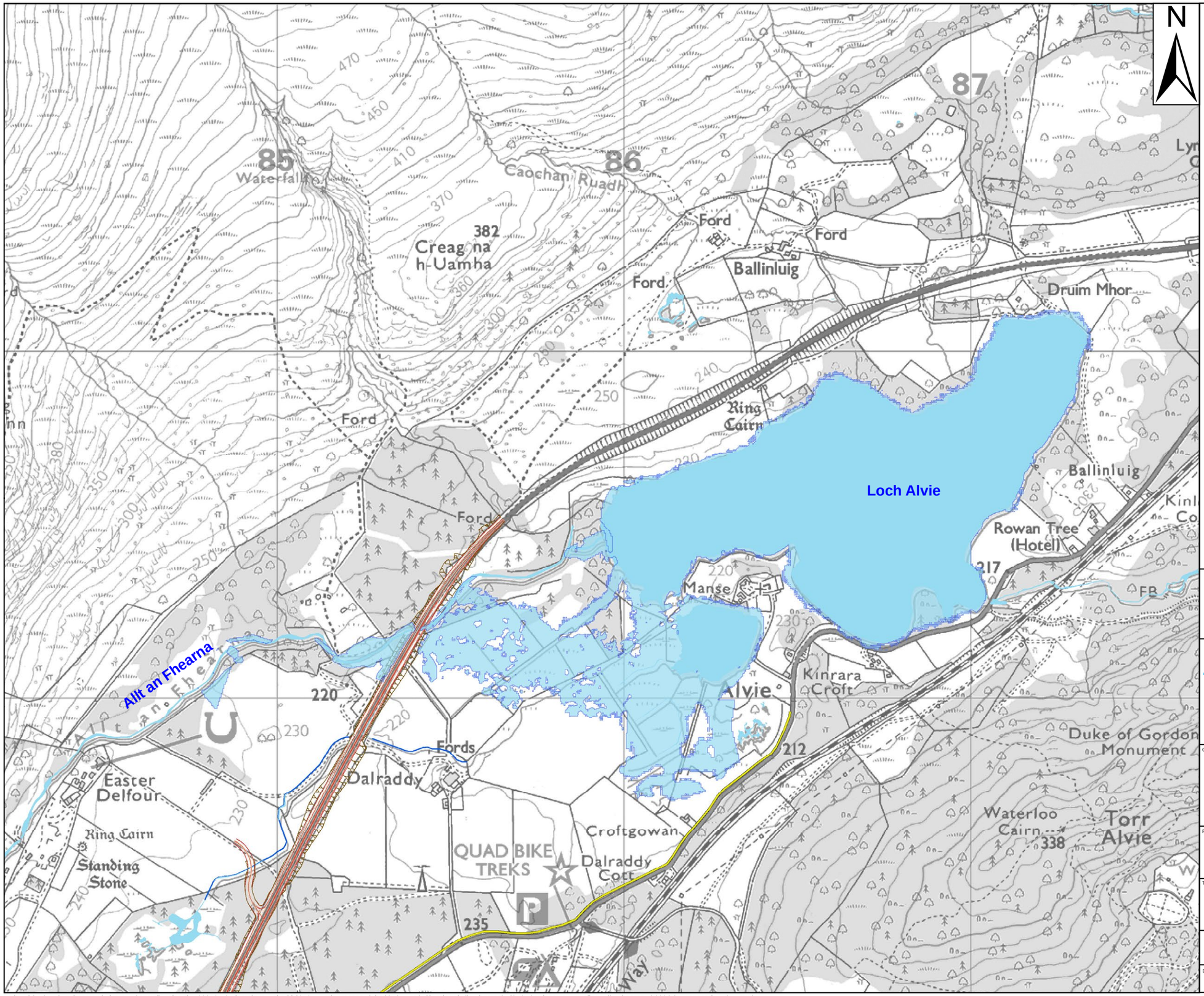

LEGEND

- 0.5% AEP (with 20% increase in flow as allowance for climate change)
- Existing A9
- B9152
- Surface water feature
- Proposed New Embankment Works

NB: STUDY AREA LIES WITHIN CAIRNGORMS NATIONAL PARK

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Project: A9 DUALLING PERTH TO INVERNESS Kincraig to Dalraddy

Title: FIGURE 3.4
Allt an Fhearna,
0.5% AEP (with 20% increase as allowance for climate change) Proposed Scenario

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Drawing Number: 5109850_WAT_FIG3_4 Rev 01

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3.3.4. Smaller watercourse assessment

The capacity of the existing and proposed structures for the Leault Burn, Baldow Smiddy and the Unnamed watercourse were assessed to find whether the proposed changes to the structures would reduce the capacity to convey the 0.5% AEP (with a 20% increase as allowance for climate change). Further details of this can be found in the Hydraulic Modelling Technical Note (Appendix E).

Leault Burn

The hydraulic model found that the water level for the 0.5% AEP (with a 20% increase as allowance for climate change) does not exceed the soffit level in the existing scenario. The model found that there was no change in flow or water level due to the proposed structure. The overall span of the structure will widen but the proposed channel will remain the same. The Leault Burn flow is in bank at the 0.5% AEP (with a 20% increase as allowance for climate change), therefore widening the access track has no affect on flow or stage.

Baldow Smiddy

The hydraulic model found that the water level for the 0.5% AEP (with 20% increase in flow as allowance for climate change) does not exceed the soffit level in the existing or proposed scenario. They also showed that the water level decreased for the proposed design simulation. The simulations showed that there is no change in flow downstream. This was based on increasing the culvert length from 27.7m to 31.5 but keeping the same gradient as the existing, throughout the culvert.

Unnamed Watercourse at Dalraddy

The hydraulic model found that the water level for the 0.5% AEP (with 20% increase in flow as allowance for climate change) does not exceed the soffit level in the existing or proposed scenario. They also showed that the water level decreases for the proposed design simulation. The simulations showed that there is no change in flow downstream. This was based on increasing the culvert length from 16.2m to 44m but keeping the same gradient as the existing, throughout the culvert.

3.4. Coastal Flooding

Due to the locality of the site there is no risk of coastal flooding to the proposed Scheme.

3.5. Flooding from Groundwater

The Vulnerability of Groundwater in the Uppermost Aquifer maps are available on SEPA's website (http://www.sepa.org.uk/water/groundwater/idoc.ashx?docid=c830572f-0856-4350-991f-0f5e881c869b&version=-1, accessed 3.6.13). This shows that the site is likely to have a moderate to high vulnerability. It is also likely that the superficial aquifer flow will be intergranular and of high productivity.

Groundwater vulnerability across the whole site can be classified as a 'minor or moderately permeable aquifer – Fractured of potentially fractured rocks which do not have primary permeability of other formations of variable permeability.' Within the southern section of the site the groundwater vulnerability can also be classified as a 'non or weakly permeable aquifer – These formations with negligible permeability that are generally regarded as containing insignificant quantities of groundwater'. At the southern extent of the site there is the Insh Marshes, therefore it is possible that the groundwater level will be shallow or the underlying deposits have a lower permeability.

The information above indicates that there is a risk of groundwater flooding particularly to the southern extent of the site.

3.6. Flooding from Land (Pluvial/Surface Water)

The existing A9 from Kincraig to Dalraddy is mainly impermeable. Surface water drains to gully pots which discharge to carrier drains that run along the verges adjacent to the A9 carriageway. These then drain into the nearest watercourse. The proposed drainage design has six networks, each draining to a filter drain and a SUDs pond before discharging to the nearest watercourse.

The A9 Dualling: Kincraig to Dalraddy will increase the road surface area and therefore, without mitigation, will increase volume of water draining into the watercourses. The existing and proposed runoff rates were estimated using The Wallingford Procedure. The Modified Rational method was used to estimate the rainfall intensity over the site for the 1 in 200 year flood event. A 20% increase was added to the rainfall estimate as an allowance for climate change. Rainfall intensities for the storm durations of 5, 10, 15, 30 minutes and 1, 2, 4, 6, 10, 24, 48 hours were calculated. The critical storm duration of 5 minutes was used for the comparison of existing and proposed estimates of runoff. Runoff rates for the proposed networks were calculated using the existing impermeable area and the proposed impermeable area to give a comparison of the increase in runoff estimated due to the proposed development. The runoff rates for each network have been presented in the table below.

Table 3-1 Estimated Runoff Rates for Existing and Proposed A9 Development

Network	Existing Runoff Rate (m^3/s)	Proposed Runoff Rate (m^3/s)	Difference (m^3/s)
1	0.6	1.1	0.5
2A	0.3	0.6	0.3
2B	0.4	1.0	0.6
3	0.4	1.0	0.6
4	0.4	1.0	0.6
5	1.1	2.8	1.7
6	0.1	0.3	0.2

The results show that there is a significant increase in runoff due to the proposed development. The results above have been based on the most intensive rainfall event at the 200 year return period with a 20% increase as allowance for climate change. They have also been based on the assumption that the existing and proposed development is 100% impermeable.

4 Mitigation of Flood Risk

4.1. Managing Actual Flood Risk

Section 3 identified potential flood risk to the proposed A9 Dualling: Kincraig to Dalraddy. This section sets out the principles of how these risks will be mitigated, if necessary through appropriate design and operation of the development.

4.2. Flooding from Rivers (Fluvial Flooding)

4.2.1. Dunachton Burn

There is an existing risk of flooding downstream of the A9 crossing at the 0.5% AEP (+20% increase as climate change allowance). This is downstream of the rail crossing, as the river flows into Loch Insh. There is also an existing risk of flooding to the access track which runs through the culvert adjacent to the river channel. The proposed design does not increase the risk of flooding to the culvert or to the existing flooding downstream. Mitigation measures are therefore not required.

4.2.2. Allt an Fhearna

There is an existing risk of flooding in relation to the Allt an Fhearna at the 0.5% AEP (+20% increase as climate change allowance). The proposed design allows for a decrease in flood risk at the culvert as it is estimated that the access track will be inundated at the 10% AEP instead of the 50% AEP as it is currently.

The proposed embankments are located within the flood extends of the 0.5% (+20% increase as allowance for climate change), however there was no increase to water level or flow in the watercourse downstream demonstrating that there is no loss of attenuation or increase in flood risk associated with this. No mitigation is therefore required.

4.2.3. Smaller Watercourses

The proposed design for the new structures on the Baldow Smiddy, Leault Burn and the unnamed watercourse at Dalraddy have been assessed to show no increase in flood risk, therefore no mitigation is required.

4.3. Flooding from Groundwater

Section 3 reports that there is a risk of groundwater flooding at the southern extents of the scheme. Any SUDs design will need to account for groundwater flooding as elevated groundwater levels will decrease the efficiency of a SUD. Mitigation measures for groundwater flooding may include lining the SUDs features to they are not inundated with groundwater and to ensure they do not float. Observations of high groundwater levels will be recorded in the Ground Investigation for the A9 Dualling: Kincraig to Dalraddy: programmed to take place in April 2014. This investigation will include boreholes, soakaway and trial pits tests at the proposed SUD locations. If the ground investigation shows that there is standing water at these locations, the SUD design will be refined to address any groundwater flooding issues that are identified. .

4.4. Flooding from Land (Pluvial Flooding)

Section 3 reports an increase to pluvial flooding as the impermeable area of the A9 section increased due to the proposed dualling. It is recommended that the increase in runoff is mitigated through the design and implementation of an effective SUDs strategy. The SUDs infrastructure will be sized to allow attenuation of the increased flow volumes to output Greenfield runoff rates and in continued consultation with The Highland Council. The SUDs features identified and sized for the outline design are all located outwith the 0.5% AEP (with 20% increase as allowance for climate change) flood outlines and therefore risk from fluvial flooding is not an issue for the drainage design.

5. Managing Residual Risk

Residual flood risk is the risk of flooding that remains once the mitigation measures have been implemented. Mitigation described in section 4.4 related to the flooding from land. The mitigation measures adequately mitigate the risk of flood from all assessed sources to the proposed A9 Dualling: Kincraig to Dalraddy. However, there remains a risk of flooding to the access tracks adjacent to the Allt an Fhearna and the Dunachton Burn. The water depth estimated on these access tracks for the 0.5% AEP (with 20% increase in flow as allowance for climate change) were 1m for the Dunachton Burn and 0.6m for the Allt an Fhearna. There is alternative access to the land either side of the A9 that can be used when these access tracks flood. Therefore additional mitigation measures are not required.

6. Conclusions and Recommendations

6.1. Conclusions

- The proposed design does not increase the risk of fluvial flooding from all watercourses either to the A9 or to third-party land.
- There is a possible risk of groundwater flooding at the southern extent of the scheme. This will be confirmed by the Ground Investigation due to commence in April 2014.
- There is a risk of flooding from land as the proposed dualling increases the area of impermeable road surface, however this will be mitigated as the proposed SUDs will attenuate addition flow.

6.2. Recommendations

- It is recommended SUDs are used to attenuate the increase in flow from runoff from the road. A drainage strategy should be put in place to set out the approach to mitigating the risks associated with the increased surface runoff.
- It is recommended that the SUD designs are revised if they are located in areas which have high standing water level. Further information on groundwater levels will be available in the Ground Investigation.

7. References

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