# Appendix 11.4

## Hydromorphology Assessment
## Part 2

# Annex 11.4.4

## Hydromorphology Catchment Baselines

## Spey Catchment Overview

### *Introduction*

11.4.4.1 The works to dual the A9 between Crubenmore and Kincraig will involve crossing the River Spey at Kingussie, close to the existing crossing. The River Spey and its floodplain here has several European designations including a SSSI, SAC, SPA and Ramsar for a variety of river and floodplain species, many of which are sensitive to changes in fluvial processes within the channel and its floodplain. As part of the dualling project CFJV have been asked to provide fluvial geomorphological guidance to the location and design of the bridge and approach embankment. To do this an understanding of catchment and the current channel behaviour and process is required and this is provided in this report.

### *Methodology*

11.4.4.2 A desk study has been undertaken to review available reports and research on the Spey catchment, as well as aerial photographs and elevation data collected as part of the project. This has been used to provide an overview of the physical characteristics of the catchment as well as to outline the modifications that have been made within the catchment, and how this impact on the fluvial geomorphology to give the current from and processes we see today. At the crossing site historical analysis has also been undertaken based on a review of historical mapping.

11.4.4.3 A geomorphological walkover of the Spey near the existing bridge has been undertaken, as well as site visits to other tributaries along the A9 route has been undertaken (August 2015). This involved the collection of a series of site photographs and recording the current form and processes acting in the channel.

### *Catchment Overview*

#### Topography

11.4.4.4 The River Spey has its source below the Corrieyairack Pass approximately 30 km west of Newtonmore in the Monadhliath Mountains and flows for 157 km in a north-easterly direction towards the Moray Firth draining an area of 3367 $km^2$ (Cuthbertson & Partners, 1990; Gemmell *et al.* 2001). It has several major tributaries; the River Dulnain and River Calder draining the Monadhliath Mountains to the west and the Truim, Tromie and Feshie draining the Cairngorm Mountains from the east. The catchment has higher steeper areas in the headwaters of the catchment, flattening out towards the Spey, which flows within a flatter, more open valley, towards the coastal plain.

11.4.4.5 The longitudinal profile of the Spey can be divided into three distinct sections (**Figure 1**): the upper section has a steep, narrow, uneven gradient from its source in the Monadhliath Mountains which rise to approximately 1200 m AOD draining into Loch Spey at 350 m AOD and downstream to Spey Dam 350 m AOD (Upstream of the A9 Crossing(; the middle section between Laggan and Grantown is notably flatter, formally occupied by three palaeo-lakes, gently slopes from 250 – 200 m AOD with a wide floodplain that is c.500 m but up to 1500 m wide at Kingussie and Loch Insh (Grieve *et al.* 1995; SFB, 2015); and the lower section, downstream of Grantown which, due to isostatic uplift is unusually steep and therefore continues to cut into its channel as it flows toward the coast (SNH, 1997).

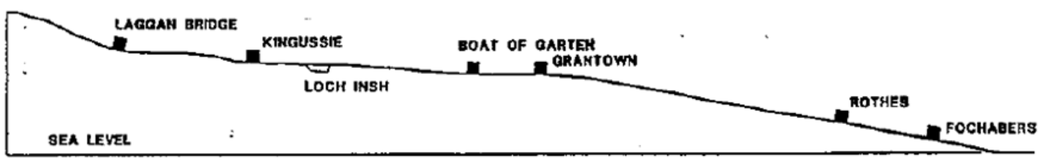



*Figure 1. Longitudinal profile of the River Spey (From Hinxman, (1901))*

### Geology

11.4.4.6 The solid geology of the River Spey catchment is dominated by slow-weathering crystalline schists and gneisses in the uplands. These are intruded in a number of places by granite and to the north, are overlain by Devonian Old Red sandstones in the Moray Firth coastal plain. Much of the superficial geology of the catchment consists of various glaciofluvial deposits, remnants of multiple periods of glacial erosion and meltwater deposition. These are comprised largely of gravel, sand, silt and clay. In the upper catchment hummocky glacial deposits, diamicton (sand and gravel), till, alluvial fan deposits (gravel, sand, silt and clay), and glaciofluvial deposits (gravel, sand and silt) are prevalent; in the middle section of the wide floodplain and Loch Insh alluvium, glaciofluvial sheet deposits and river terrace deposits are widespread, while lacustrine deposits are significant around Insh Marshes, vestiges of palaeo-lakes; and the lower section is largely glacial sand and gravel, alluvium and till.

11.4.4.7 The tributaries of the Spey transport large volumes of these glaciofluvial sediments and weathered bedrock into the main channel of the Spey, predominantly during flood events (Werritty & Ferguson, 1980), and thus, “many of the more recent geomorphological characteristics of the Spey valley reflect the inputs, particularly of sediment, from its tributaries” (Maizels, 1988 in Gemmell et al. 2001).

### Landuse

11.4.4.8 Over 60% of the land within the catchment is mountain and moorland, with much of the upper catchment comprising peat bog, acid grassland and heather grassland. Agriculture, principally grazing and production winter feed is confined to the valley floor of the Spey, with improved grasslands, rough grasslands, forest and woodland occupying a substantial part of lower areas. Cattle rearing, dairy and sheep farming, extensive commercial forestry and arable farming become more predominant into the middle section valley. Fen, marsh and swamp are found in the area in and around Insh Marshes (Cuthbertson & Partners, 1990; RSCMP, 2003; BGS, 2015). There are numerous small urban settlements and significant industrial and commercial developments within the Spey catchment, they include: large-scale recreational developments, sawmills, landfill sites, wind farms and land allocations for extension of food processing works and distilleries (RSCMP, 2003). These lead to a high level of water abstraction, which will have an impact on flow regime and sediment transport. In the ‘intermediate ground’ between the upper catchment and flat valley middle section, economic pressures are noted as being a factor likely to lead to land use change (between farming, forestry and sport) (RSCMP, 2003).

### Climate and hydrology

11.4.4.9 Precipitation within the catchment follows relief, with the highest volumes in the mountains and the lowest on the coastal plain. As well as these differences in the amount of precipitation across the catchment, the timing is also different with precipitation in the upper catchment predominantly between August-February, while in the lower catchment the highest rainfall occurs in July and August. Much of the precipitation in winter months can fall as snow at all levels, meaning that snow melt heavy impacts the hydrology of the catchment.

11.4.4.10 The hydrology of the catchment is also influenced by the lack of soil in the upper reaches of the catchment such as the Cairngorm plateau resulting in little water retention, direct runoff into watercourses and 'flashy' responses to rainfall events (RSCMP, 2003). In contrast, the flat topography and wide floodplain of the Spey Valley exhibits a gradient of 1:1200 has meant its flow regime "is more typical of a lowland river" (Gemmell et al. 2001).

11.4.4.11 Research shows that there has been an increase in the frequency and magnitude of annual floods within the catchment, since the 1950's based on the data from the Invertruim gauging station (**Figure 2**) caused by increased precipitation and snowmelt, a pattern shown in many catchments draining western areas of Scotland, (Gilvear, 2004). This fits with studies undertaken into client change in Scotland predicting a slight rise in the mean and annual temperature as well as an increase in average annual rainfall with autumn and winter seasons receiving the greatest increase (RSCMP, 2003).

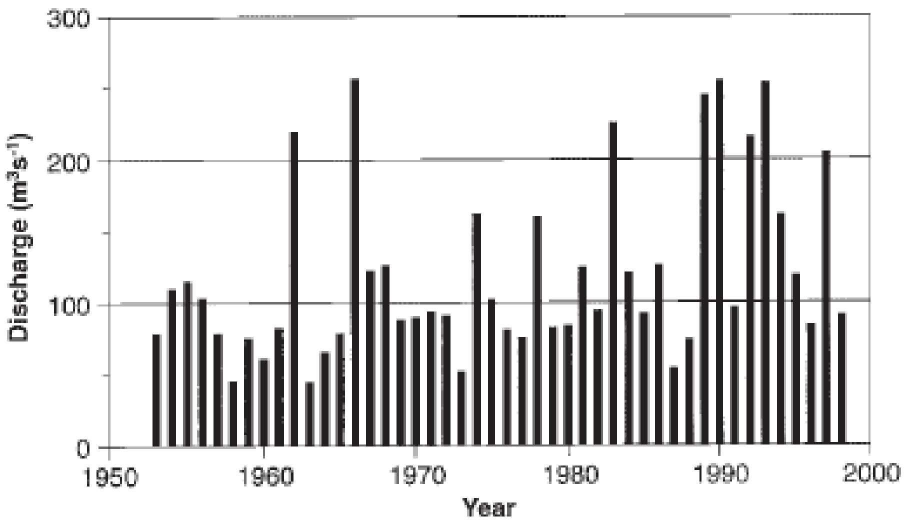



*Figure 2. A partial duration flood series for the River Spey at Invertruim for the period September 1953 to December 1998*

11.4.4.12 As well as the abstraction pressures from water supply, it is estimated that 70% of the water resources of the upper catchment are diverted for Hydro –electric schemes. Scottish & Southern Energy diverts water from the catchments of the rivers Tromie and Truim to Loch Ericht (in the Tummel/Tay catchment) and Alcan Smelting & Power UK diverts water from the River Spey itself (at Spey Dam), and from the River Mashie to the River Pattack (Loch Laggan/Spean) (RSCMP, 2003). The dams associated with these schemes have little storage capacity and act primarily as diversionary structures. However, they do assist in the reduction of some flood peak flows.

### *Catchment modifications*

#### Land-use change

11.4.4.13 The Spey catchment has been subject to anthropogenic changes that ultimately alter the form and processes of the Spey and its tributaries, by changing the hydrology and sediment supply.

Some of these changes can be identified through a review of historical mapping. Through this review a change in land use from moorland to forestry has been noted within the Spey catchment, with several localised areas around the upper Spey, as well as a large scale change in Glen Feshie, and the area above Insh. The mapping suggests that these changes occurred post 1928. Changes from moorland to forestry will alter the drainage of the area and the runoff to the channel depending on the draining installed. If this forestry is commercial it's felling is likely to result in an increase in sediment supply and runoff to the Spey.

### Drainage and flood defence

11.4.4.14 The 1870 mapping show evidence of small scale channel realignment and the installation of drainage ditches on the Spey floodplain at Balgowan, Ruthven Barracks and Inch marshes, where the floodplain is wider. This work was likely undertaken in the 1840's when grants were available from the government to improve land for agriculture thought improved drainage. Many of these drainage networks are still visible today and will be acting to lower the water table and increase the runoff rate into the Spey.

11.4.4.15 The review of the 1870 mapping historical mapping also shows a number of flood embankments along the Spey, that are likely to have been associated with the improved drainage and changing of the floodplain to land more suitable for agriculture. The river Calder also has a pair of embankments upstream of confluence with the Spey which are a more recent addition. These embankments reduce the connection between the channel and the floodplain which increases the conveyance of water downstream increases the velocity of the river and its ability to erode its bed and banks, and transport sediment downstream.

11.4.4.16 As well as the embankments visible on the OS mapping, it was noted from the site visit that several channels (Raitts Burn and the Gynack and potentially others) have been recently dredged for flood defence purposes, with arising's piled up on the bank tops, increasing bank height and behaving like an embankment, as well as creating a more uniform bed and potentially damaging habitats.

### Roads and railway

11.4.4.17 Much linear infrastructure has been constructed within the Spey catchment, and generally within the Truim and Spey floodplain. These include the Military roads of the 18$^{th}$ century (shown on the Roy maps of the 1750's), the Highland main line railway (1850's) and the A9 (1970's). This infrastructure impacts the geomorphology of the catchments in several ways.

11.4.4.18 The positioning of the roads and railway in the floodplain, often along embankments, running parallel to the channel act to reduce channel-floodplain coupling, resulting in increased conveyance and higher flood risk downstream. It will also increase the ability of the channel to erode and transport sediment from the bed and banks. In some cases, the channel is likely to have been realigned to fit between the embankments, and these now fix the channel position, reducing the ability of the channel to adjust in planform to changes in water and sediment supply, and reducing the sediment entering to the channel from erosion.

11.4.4.19 There are many locations where the infrastructure crosses the slope and channels perpendicular to channels. Here it in interrupts the movement of water and sediment downs the hill slope as well as in the channel. The crossings themselves in either culverts or via bridges also interrupt natural geomorphological process. Many of these are undersized for high flows, resulting in upstream impoundment of flows, deposition and scour in the vicinity of the crossing and deposition downstream, and in some cases blockage of the crossing. Some of these crossings have also changed (and fixed) the local bed level and bank positions of the channel, resulting in a change in energy gradient and often resulting in incision upstream (as the channel adjusts to this new slope) and deposition downstream and an inability of the channel to adjust to changes in water and sediment supply over time. Where there is an embankment crossing the floodplain, this acts as a dam in high flows, holding back the water and sediment upstream of the crossing, and forcing flows (causing erosion of the bed and banks) through the crossing, as well as reducing the area, depth and velocity of flooding downstream.

### Hydropower

11.4.4.20 72% of the Spey catchment is regulated by hydro power schemes (Gilvear, 2004), with schemes on the Spey and the Truim. These lead to a change in flow and sediment supply and transport regime both within the channels that are regulated and the Spey itself.

11.4.4.21 The Spey scheme was constructed in 1942, 15 km from the source of the Spey, as part of British Alcan's hydropower generation scheme to smelt aluminium. Water is stored behind the Spey dam and is released as a compensation flow of 1.42 $m^3/s$ with the rest diverted by canal and tunnel into Loch Laggan (Gilvear, 2004). Under very dry weather conditions the compensation flow is reduced to that of the inflow. Twenty-two days of "freshets" of 2.84 $m^3/s$ are also released to stimulate fish migration in September and October. In addition to the flows from the Spey, up to 11.33 $m^3/s$ can be taken from the Mashie tributary via the River Pattack (Gilvear, 2004). These diversions regulate, and reduce the discharge of the Spey, as well as reducing magnitude and frequency of high flow events. The Spey dam also acts to trap all of the bed load and much of the suspended sediment from the upstream catchment to this point. This sediment is removed periodically from behind the dam and stockpiled (Gilvear, 2004).

11.4.4.22 22% of the River Truim catchment is also regulated by a hydropower scheme run by SSE, initiated in the 1930's, and extended in the 1940's and 50's with most of the water abstracted going into Loch Ericht in the Tay catchment. The five main control features and the interactions are outlined **on Figure 3.** Loch an t-Seilich has a compensation flow of 1.263$m^3/s$ released continuously down through the fish pass on the dam, with flows above this diverted to Loch Cuaich or spilled, and a flow of 0.684$m^3/s$ is released continuously down the Truim at Dalwhinnie through the fish pass on the intake (Enviro Centre, 2008). However, there is no requirement to release any compensation flow to the Allt Cuaich downstream of Loch Cuaich (Enviro Centre, 2008). The entire bed load is trapped behind the diversion dams has historically been removed for the river system and stockpiled (Gilvear, 2004).

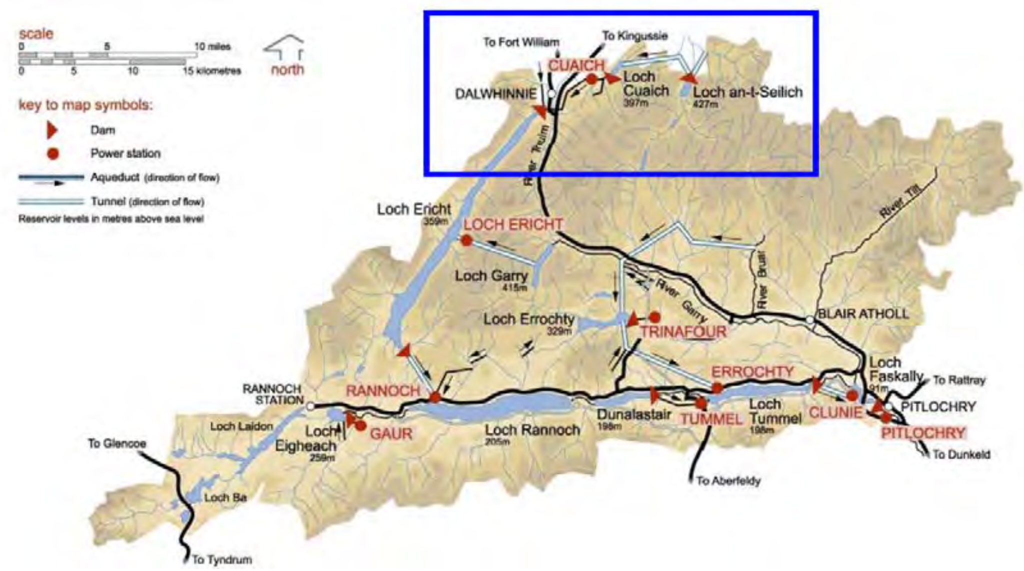



*Figure 3: The Tummel hydro-electric scheme (Enviro Centre, 2008)*

11.4.4.23 Much research has been undertaken into the morphological impacts associated with regulating rivers and finding suggest that in general downstream channel width reduces over time as the channel adjusts to the lower discharge. Gilvear (2004) has undertaken a study on the Spey between the dam at Laggan and has noted the following changes over the last 60 years;

- Reduced frequency of small floods (<50 $m^3/s$ - 1:2 year flow events)
- Increased frequency of large floods (over 100 $m^3/s$)
- Reduced channel width downstream, with the greatest reductions (between 50% and 80% of the channel width) at confluences.
- Where the channel has already been narrowed by flood embankments the reductions in width are less (20%)
- Downstream to Newtonmore the lower slope reduces the redistribution of sediment, and channel narrowing and adjustment is expended to take longer (Decades).

11.4.4.24 Despite these changes occurring close to the dam, similar reductions in width and channel capacity are still expected further downstream, just over a longer time period and there is evidence of channel narrow through the addition of sediment from the tributaries along the Spey (River Caulder, and Gynack Burn) from aerial imagery and historical mapping shows channel narrow along the upper Spey.

11.4.4.25 Channel width reduction occurs as the sediment inputs from the tributaries are unchanged, but the frequency of flows that can entrain and transport this sediment away from the confluences of the Spey has reduced, leading the deposition and stabilisation of the sediment and the formation of fans and bars at the confluences that vegetate over time. The narrower channel now has more energy during high flows so unvegetated material will mobilised downstream and deposit in the wider channel, narrowing this section of channel, and so material is slowly redistributed downstream, forming benches and narrowing the channel. The reduction in flood frequency-magnitude due to construction of the dam also reduces the 'self-cleansing' ability of the river to remove in-channel materials. As a result, there is increased sediment deposition and therefore reduced channel capacity (Cuthbertson & Partners, 1990), reducing the capacity of the channel to large flood events.

11.4.4.26 The rate of redistribution of sediment should be expected to increase as current climate change predictions suggest that flood magnitude will increase in the future and this in turn increases the rate of adjustment as the redistribution of the sediment input from the unregulated catchments. As the adjustment occurs it also creates a narrower, more efficient channel with greater potential to mobilise and transport sediment away from the confluence. This could mean an increase in the potential supply of sediment to the A9 River Spey Bridge crossing area and a narrowing of the channel over time as this adjustment continues. However, the low slope around Newtonmore will impede the redistribution of sediment, increasing the time period for adjustment, which is expected to be in the region of 100 years or more on UK rivers (Gilvear, 2004).

### *Spey crossing area baseline*

#### Current morphology

11.4.4.27 A geomorphological desk study and walkover of the area of the River Spey at Kingussie was undertaken in August 2015. During the site visit, the river system was characterised and areas of erosion and deposition in the vicinity of the bridge were mapped (**Figure 4).** Approximately 150m upstream and downstream of the A9 bridge were surveyed using an underwater Spyball camera, with surveys focussed in potentially suitable habitats for Fresh Water Pearl Mussel. However this has provided imagery of the bed of the Spey in this location that has been reviewed as part of this baseline.

11.4.4.28 In the vicinity of the A9, the Spey flows through a floodplain bounded by river terraces and the valley side (Figure 4). Within this floodplain is Kingussie on the left bank side and a series of historical low flood bunds on the right. Banks are steep to vertical and composed of fine sediment. Several gravel and cobble bars are present (first shown on 2014 OS mapping) that have started to vegetate and stabilise, locally narrowing the channel.

11.4.4.29 The Spyball imagery found sand substrate approximately 30m upstream of the bridge, with silt deposits and debris on top of the sand towards the left bank (north) of the channel. Mixed sized substrate was noted 20m upstream of crossing. Potentially suitable habitat was present in the middle and north bank of the river, downstream under the bridge until approximate 90m downstream of the bridge (approximately where north bank riparian trees stopped). Once the riparian tree cover along the north bank stops the channel shallows and is dominated by gravel substrate. The south bank substrates downstream of the bridge are characterised by silty deposits.

11.4.4.30 The channel in the area of the crossing actively meandering within its floodplain, eroding its banks adding sediment to the channel and transporting sediment along the channel. There is some evidence to suggest the channel is narrowing and this adjustment may be in response to the regulation of flows due to hydropower. The A9 bridge and embankment are also altering the natural behaviour of the channel in this area by fixing the left bank at the bridge , restricting planform change and erosion in this direction. The A9 embankment also crosses the floodplain, restricting flow downstream under flood conditions. This change in natural flow pattern alters velocities and sediment dynamics upstream and downstream and reduces downstream channel-floodplain coupling, again altering the interactions between water and sediment in the channel and on the floodplain.

11.4.4.31 The mapping and photographs show that the bridge is currently experiencing scour to the piers on the right bank side (when looking downstream) as the channel migrates in this direction (**Photograph 1**), and that bank erosion is occurring along the right bank (**Photographs 2 and 3**), which is moving towards the current A9 embankment. In this area the left bank rises steeply to form the valley side, and this has been protected with gabion baskets (**Photograph 4**), fixing the bank position on this side. It is also recorded that in the 1980's rock was placed in the channel to protect the piers along this side from scour.

11.4.4.32 From the initial desk study and walkover it appears that the bridge abutments and A9 embankment (which runs across the floodplain) constrict downstream high flows, which increases erosive energy under the bridge, causing scour to the bed and erosion of the right bank, where the channel is not fixed and able to adjust.

11.4.4.33 The current A9 Spey bridge is restricting natural geomorphological processes and will continue to do so as it alters flows and fixes the bank positions, and it therefore forms a morphological pressure within the Spey catchment.

11.4.4.34 If the rate of channel change in the area were to continue (as it is expected to do so) then over time it would be expected that future A9 maintenance would need to consider an intervention to protect the existing bridge embankment from erosion.

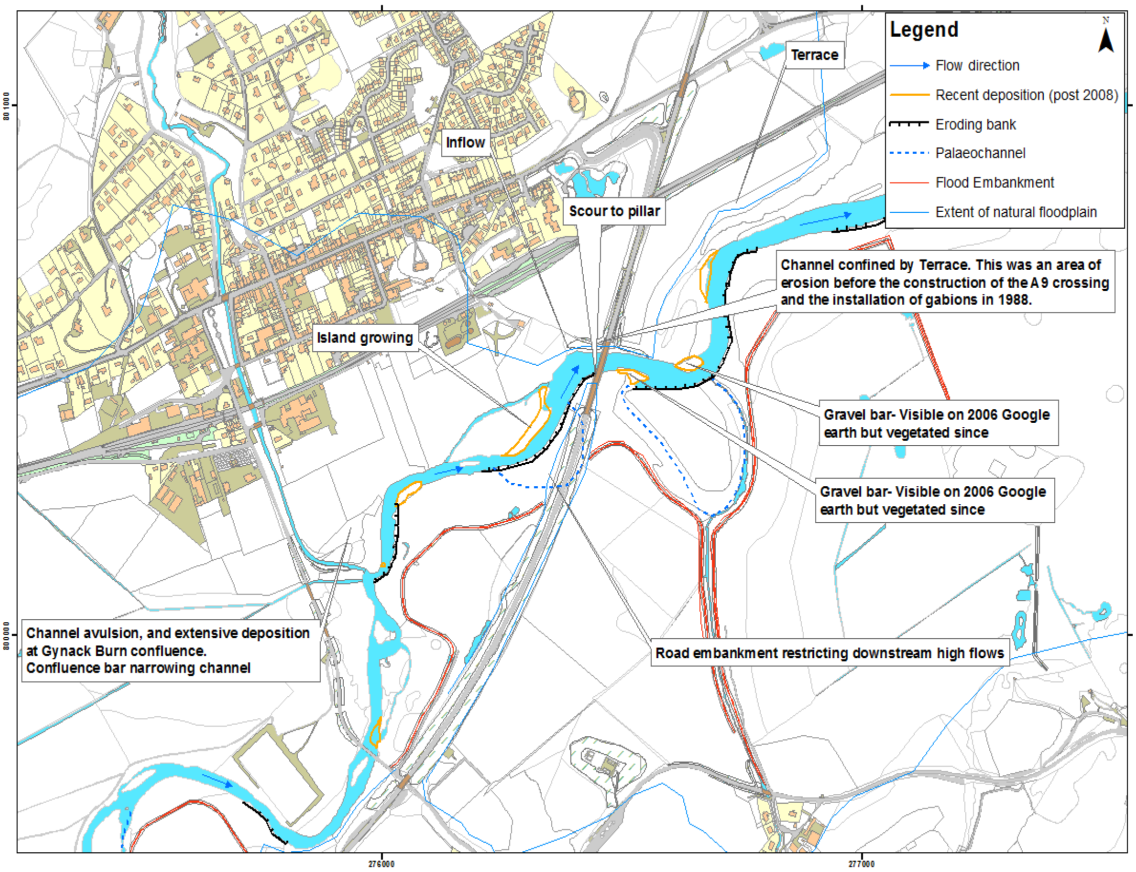
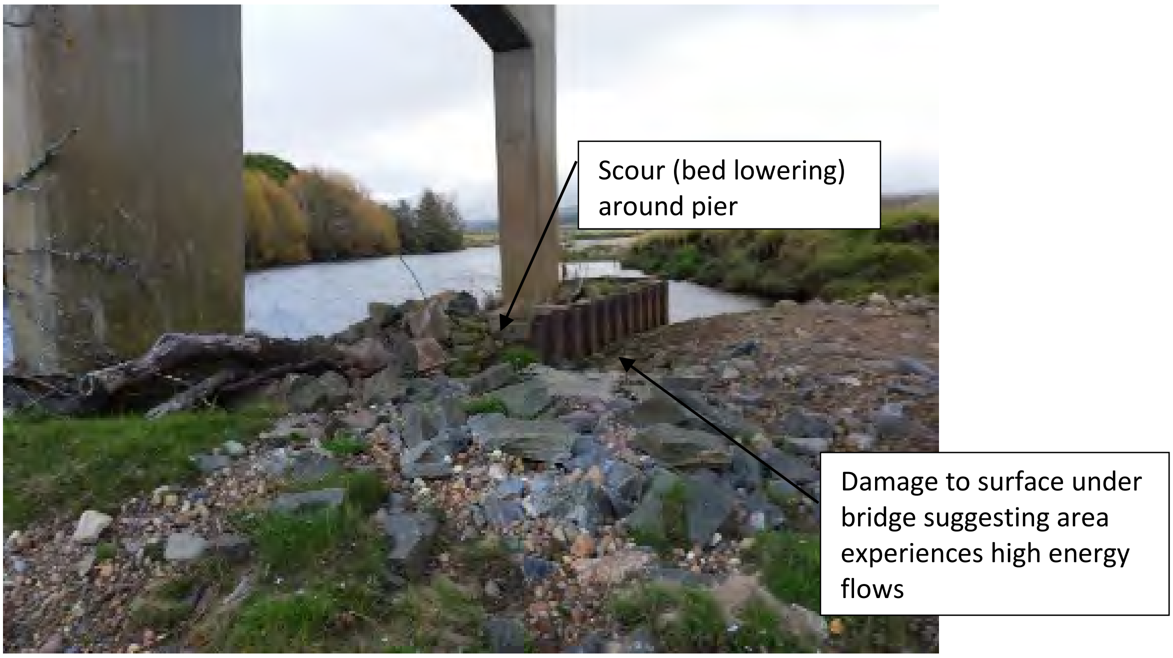
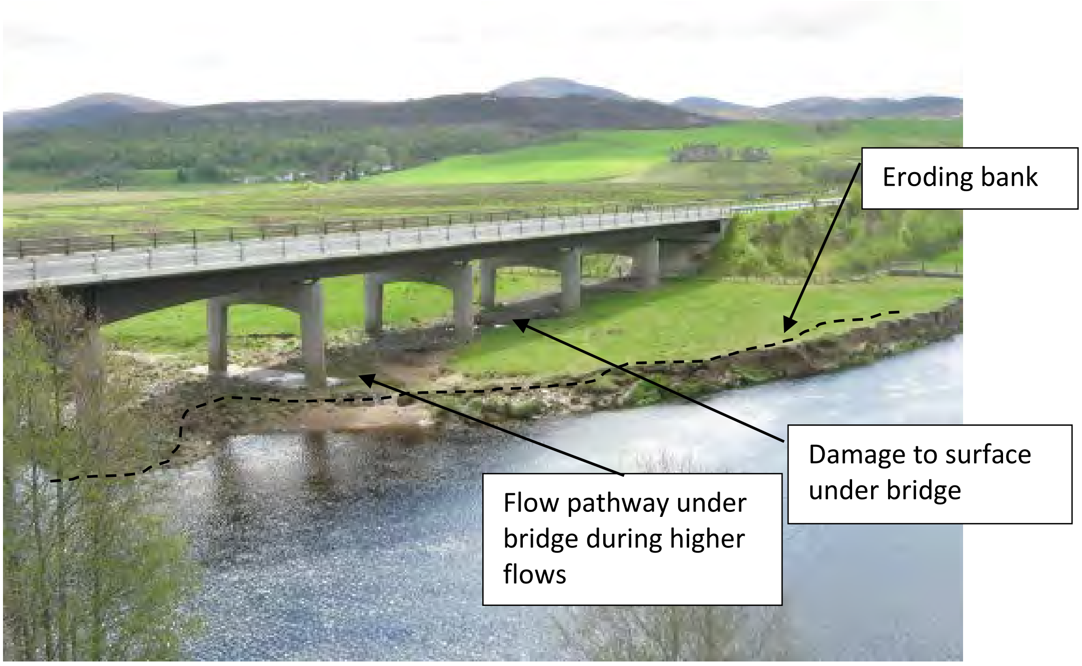



*Figure 4: Baseline geomorphological mapping*




*Photograph 1: Scour to bridge pier*




*Photograph 2: Erosion of the right bank*


Photograph 3: *Erosion of the right bank (looking upstream)*

Photograph 4: *Gabion basket bank protection along left bank*

### Modelling analysis

11.4.4.35 Flood modelling of the Spey has been undertaken for a 1:200 year flood event (the design flow for the project), during which stream flow occupies the whole floodplain. This has been undertaken to model the existing conditions and to explore the 'natural' conditions prior to construction of the A9, by fully removing the embankment and bridge structures. Velocity can also be used as an indication of sediment transport, with higher velocities suggesting more energy, and greater likelihood of sediment transport and entrainment than lower velocities.

11.4.4.36 The velocities output by the modelling have been compared to determine the probable erosion and deposition both with and without the embankment in place (**Figure 5 and 6**).

11.4.4.37 The results show that there is a large increase in velocity in the vicinity of the bridge with the current embankment in place compared to the pre A9 conditions. This substantiates the field observations that the bridge and embankment create high velocity flow under the bridge and downstream, which increases the rate of bed scour and bank erosion. The left bank and bed along the left side are fixed by previous engineering works and so are relatively stable, but the right side is subject to scour, leaving the pier that was on the right bank (when constructed) now close to becoming an island in the channel as the channel moves.

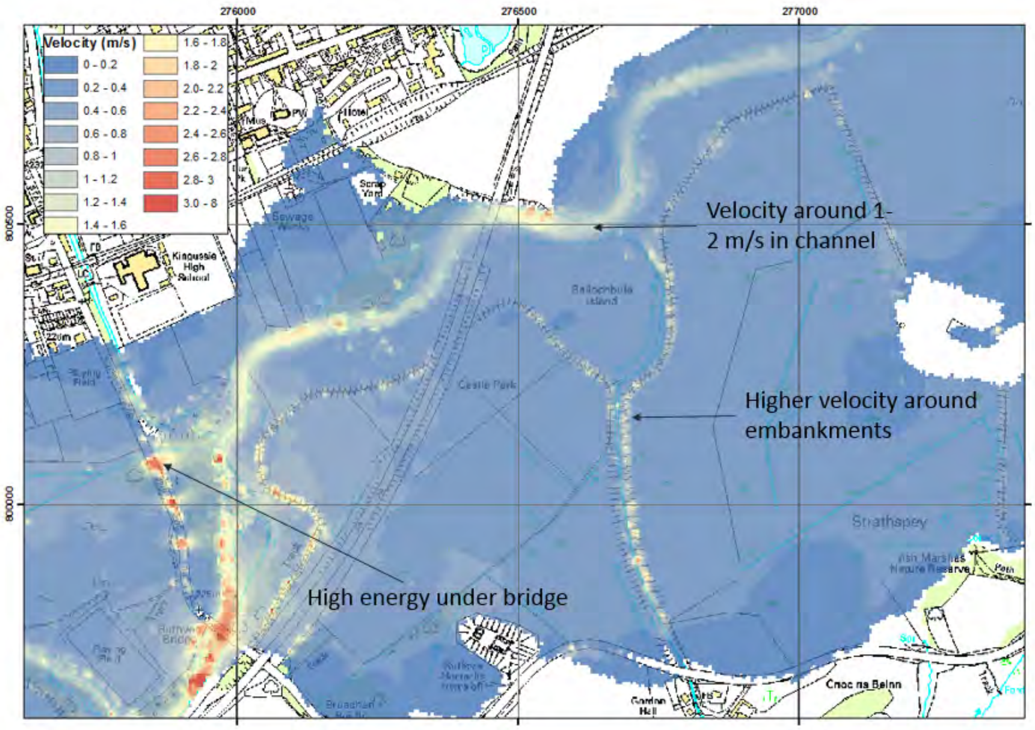



*Figure 5: 1:200 year velocity modelling under 'natural' floodplain conditions prior to A9 construction*

The rate of erosion of the right bank upstream of the bridge may also have been increased by the construction of the A9, as the velocity increases a small amount here, suggesting that the channel has more energy to erode material from its bed and banks.

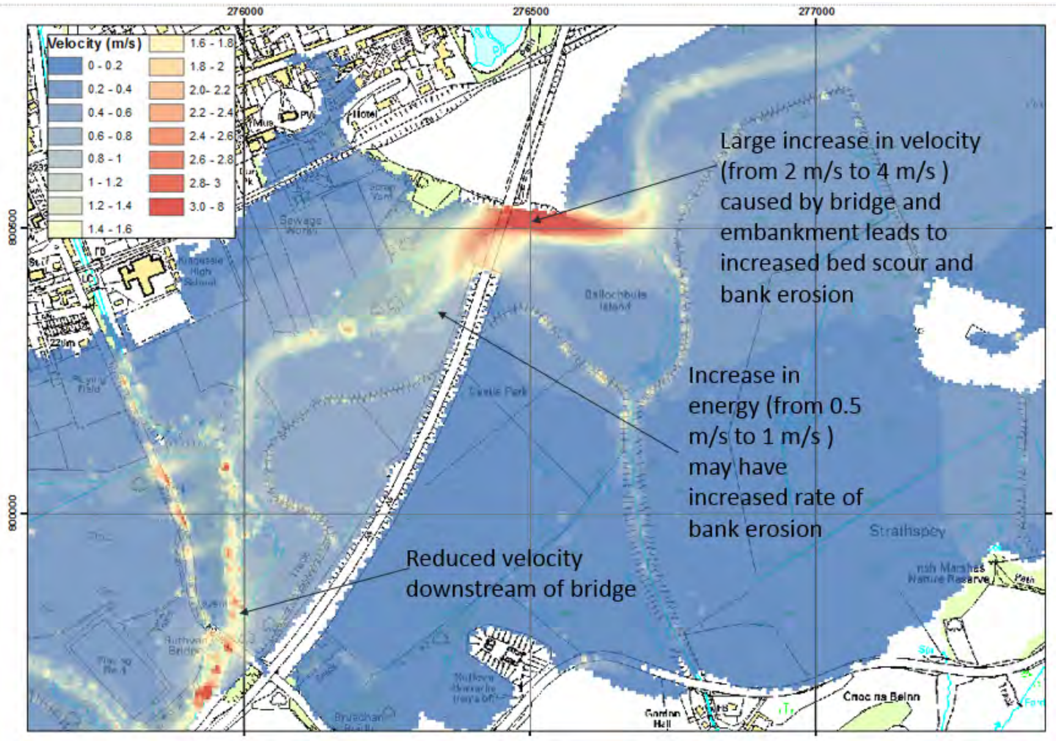



*Figure 6: 1:200 year velocity modelling under current conditions, with embankment and bridge abutments in place*

### Historical change

11.4.4.38 Analyses of historical OS maps and aerial imagery of the A9 Spey crossing, covering the period 1870 to 2014, has been undertaken in GIS to document changes in the river planform (Figures **7 and 8**). This demonstrates how the channel has migrated across its floodplain over time, where erosion and deposition have occurred and where any longer-term evolutionary patterns or trends have emerged.

11.4.4.39 The assessment of historical data shows:

- Between 1870 and 1899 the channel there was a general trend of straightening, with abandonment of meanders immediately u/s and d/s of the current bridge. There is also significant volumes of sediment in transport, indicated by several large mid-channel bars
- Between 1899 and 1965 the channel did not change significantly, with subtle re-development of meanders immediately u/s and d/s of the current bridge and slight change in the size and location of bars
- Between 1965 and 2008 the channel generally narrows as bars increase in size. The island upstream of the Spey crossing grows and the channel position continues to shift toward the south east
- Between 2008 and 2014 the channel narrows further, with the island continuing to grow. It should be noted that a general pattern of channel narrowing can be seen along much of Spey upstream of Kingussie, and this is attributed to the regulation in flow associated with the hydropower schemes in the catchment. The flow regulation reduces the frequency of smaller, channel forming flows (<50 $m^3/s$ or circa 1:2 year flow events) (Gilvear, 2004). The reduction in flood frequency-magnitude due to flow regulation also reduces the 'self-

cleansing' ability of the river to remove in-channel materials. As a result, there is increased sediment deposition and therefore reduced channel capacity.

11.4.4.40 The assessment shows that there has been a historical trend of channel narrowing, since 1870. It also shows that channel movement upstream of the Spey crossing location has had a net trend direction since 1899, with the channel moving towards the south east. This area of lateral channel movement is a concern as it has the potential to increase scour around the piers, as the bed of the channel moves across and these piers end up in the channel, as well as undercutting and eroding into the existing A9 embankment. This channel movement will also impact any future A9 crossing and embankment.

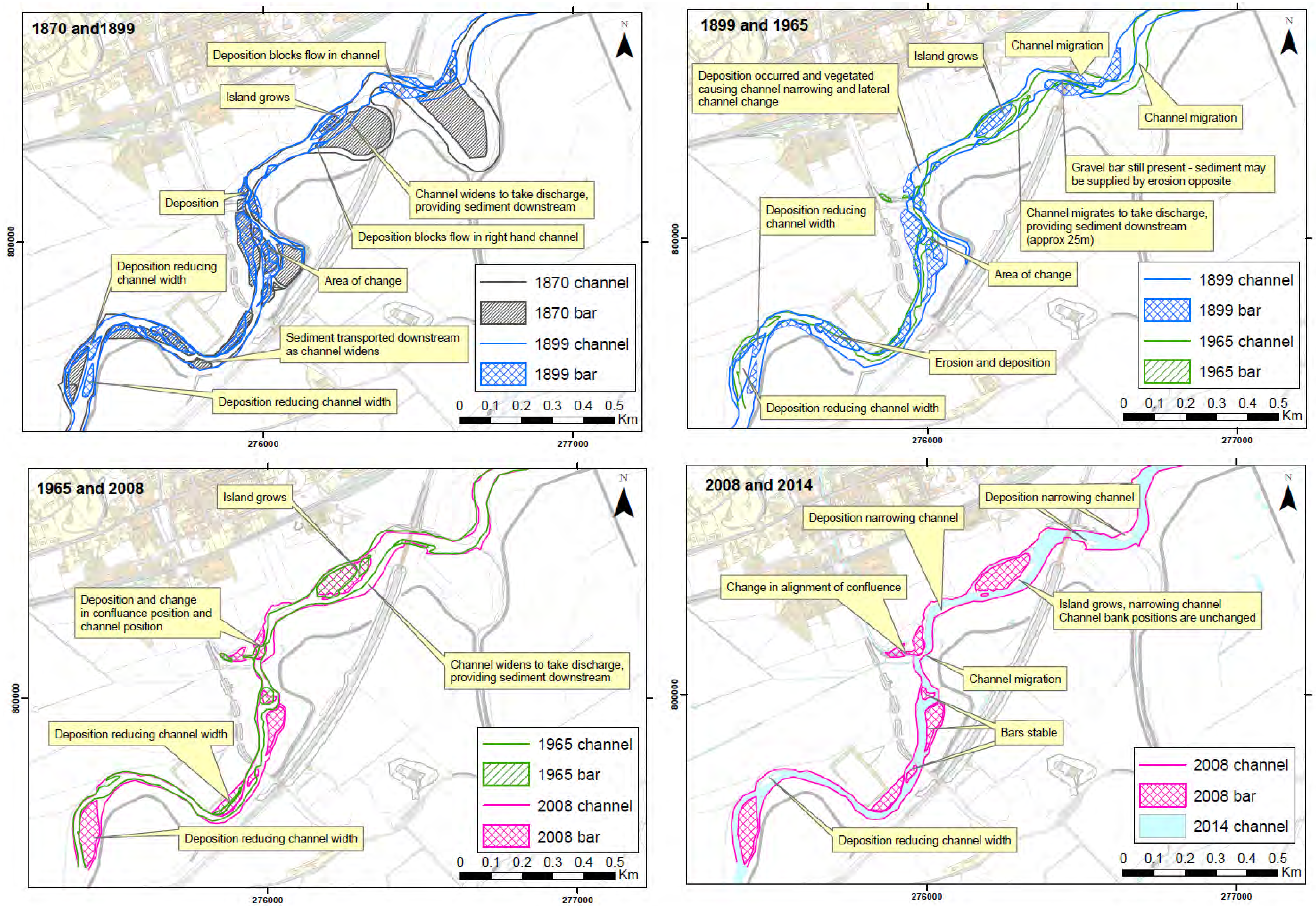



*Figure 7: Historical channel positions*


*Figure 8: Aerial photography form 1965 (pre-A9) and 2014*

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## Annex 11.4.4-Hydromorphological Catchment Assessment-133

| | |
|---|---|
| **Catchment No.** | 133 |
| **Catchment Name** | - |

| | | |
|---|---|---|
| **Channel Nature** | Nature of water course | Drain |
| | Size of water course | Other |

| | | |
|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.03 |
| | Average slope in catchment (°) | 11 |
| | % Catchment over 750m (for snow melt risk) | 0 |

| | | |
|---|---|---|
| **WFD classification** | Water, flows and levels | Good |
| | Physical condition | Good |
| | Overall ecological status | Moderate |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 133) | Gaick Psammite formation-Psammite | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 133)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |

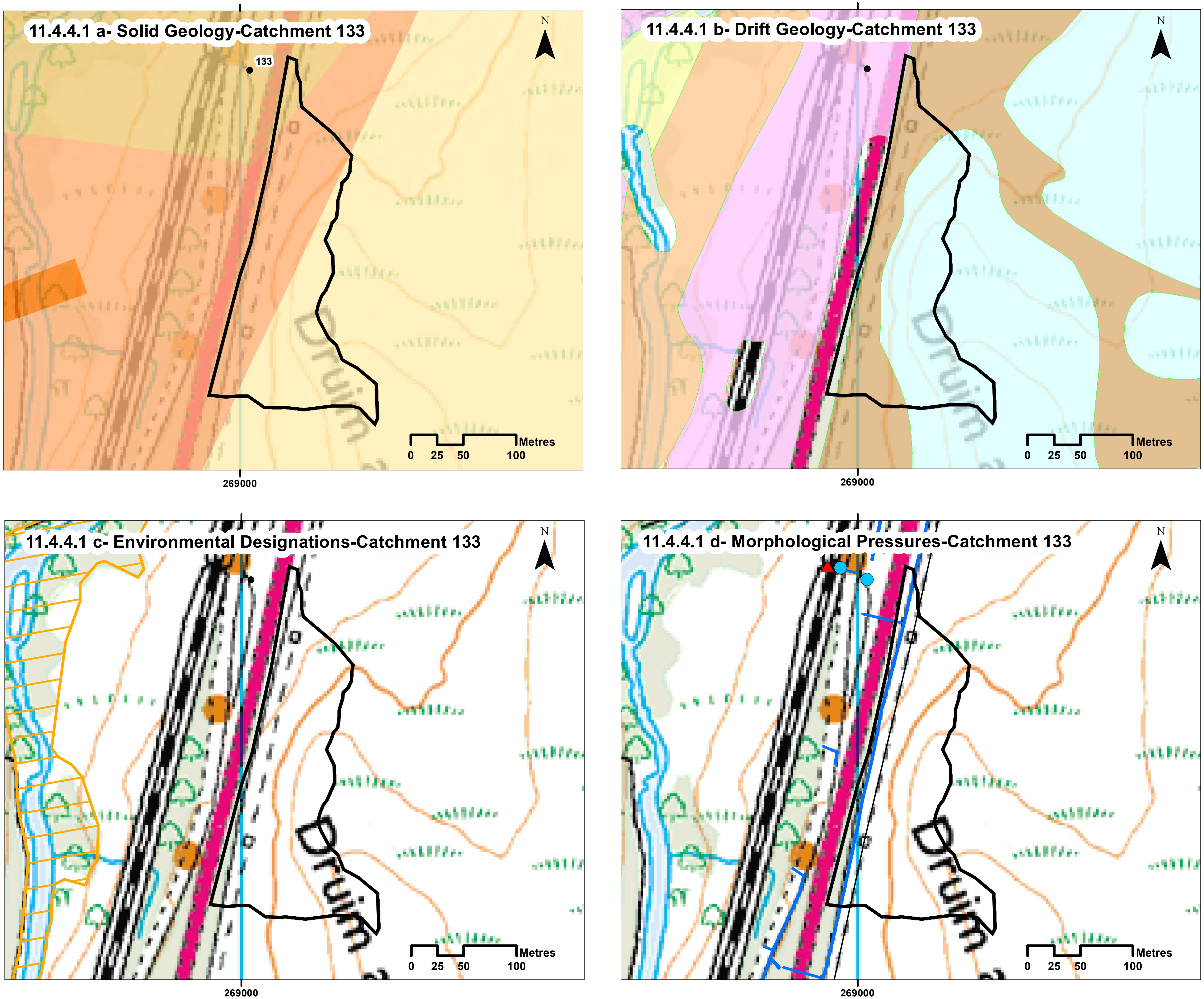
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 133 | |
| | Is peat present in the catchment? | Yes | |
| | Is there a bog burst risk? | No | Whilst there is peat u/s of the crossing, the crossing seems to only take road-parallel drainage and and u/s failure of peat very unlikely to be routed via this crossing. |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Wooded u/s, d/s and between road, railway and NMU route. |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 133) | No | |
| | Comment on sediment source potential in catchment | Likely to be limited to organics material. | |
| | Comment on sediment supply potential to crossing | Low - flat slopes | |

| | | | |
|---|---|---|---|
| **Morphology and Process-Reach upstream of crossing** | Channel morphology | Engineered | Cut drains, road parallel |
| | Predominant sediment size | Fine and organic | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | None | |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 133 | None | |
| | Impact of infrastructure | No | |
| | Channel realignment | No | |

| | | | |
|---|---|---|---|
| **Morphology and Process-At crossing** | Channel morphology | Engineered | |
| | Predominant sediment size | Fines and organics | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | None | |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | No | |

| | | | |
|---|---|---|---|
| **Morphology and Process-Reach downstream of crossing** | Channel morphology | Engineered | In culvert under NMU route |
| | Predominant sediment size | Fines/organics | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment | Yes | NMU route and railway. |
| | Impact of infrastructure | Yes | Fixed point at which drainage can pass |
| | Channel realignment | No | |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

**General**

- Crossing location

**Solid Geology**

- Gaick Psammite Formation - Psammite
- Loch Laggan Psammite Formation - Psammite, Micaceous
- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite - Microdiorite
- Pitmain Semipelite Member - Semipelite And Calcsilicate-Rock
- Pitmain Semipelite Member - Semipelite, Gneissose
- Scottish Highland Ordovician Minor Intrusion Suite - Leucogranite
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite- (Other Than Dykes) - Microdiorite

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Special Area of Conservation

**Morphological Pressures**

- Railway Bridge
- Culvert
- Drainage Ditch
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|

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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 133 Catchment Overview**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

| SHEET: | REVISION: | SUITABILITY: |
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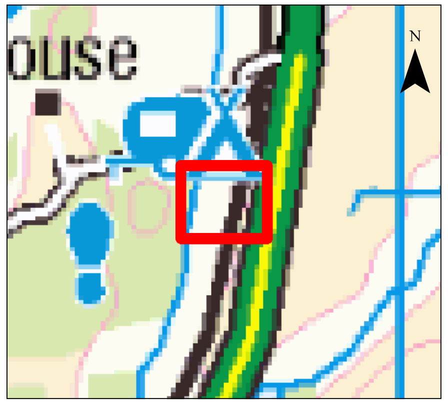

## Legend

- Other crossing
- Break in slope
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|


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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 133 Baseline Assessment**

| DESIGN: EL | DRAWN: AB | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 18/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: 1 OF 1 | REVISION: C01 | SUITABILITY: A3 |
|---|---|---|

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## Annex 11.4.4-Hydromorphological Catchment Assessment-134

| | | | |
|---|---|---|---|
| **Catchment No.** | 134 | | |
| **Catchment Name** | - | | |

| | | | |
|---|---|---|---|
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Minor | |

| | | | |
|---|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.2 | |
| | Average slope in catchment (°) | 5 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |

| | | | |
|---|---|---|---|
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Moderate | |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 134) | Gaick Psammite formation-Psammite | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 134)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |

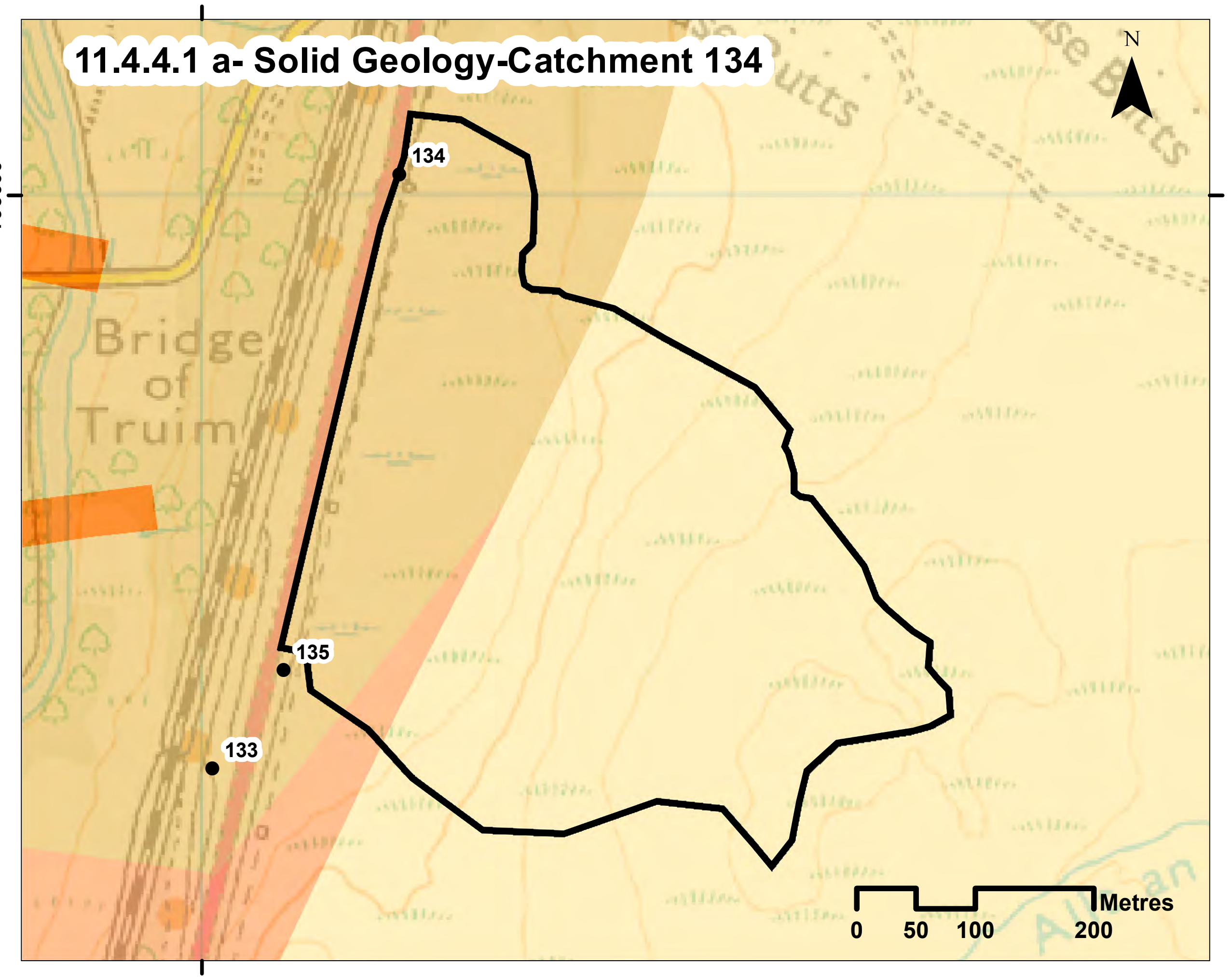
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 134 | |
| | Is peat present in the catchment? | Yes | On flat terrace slope east of road. |
| | Is there a bog burst risk? | No | Very unlikely |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Partial tree cover on older terrace and along watercourse |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 134) | Yes | ETL Tower |
| | Comment on sediment source potential in catchment | The extensive, almost flat river terrace u/s of the road means that even if sediment is generated from the uppermost slopes of the catchment, this is likely to be deposited on the terrace. | |
| | Comment on sediment supply potential to crossing | Limited for the reasons indicated above. | |

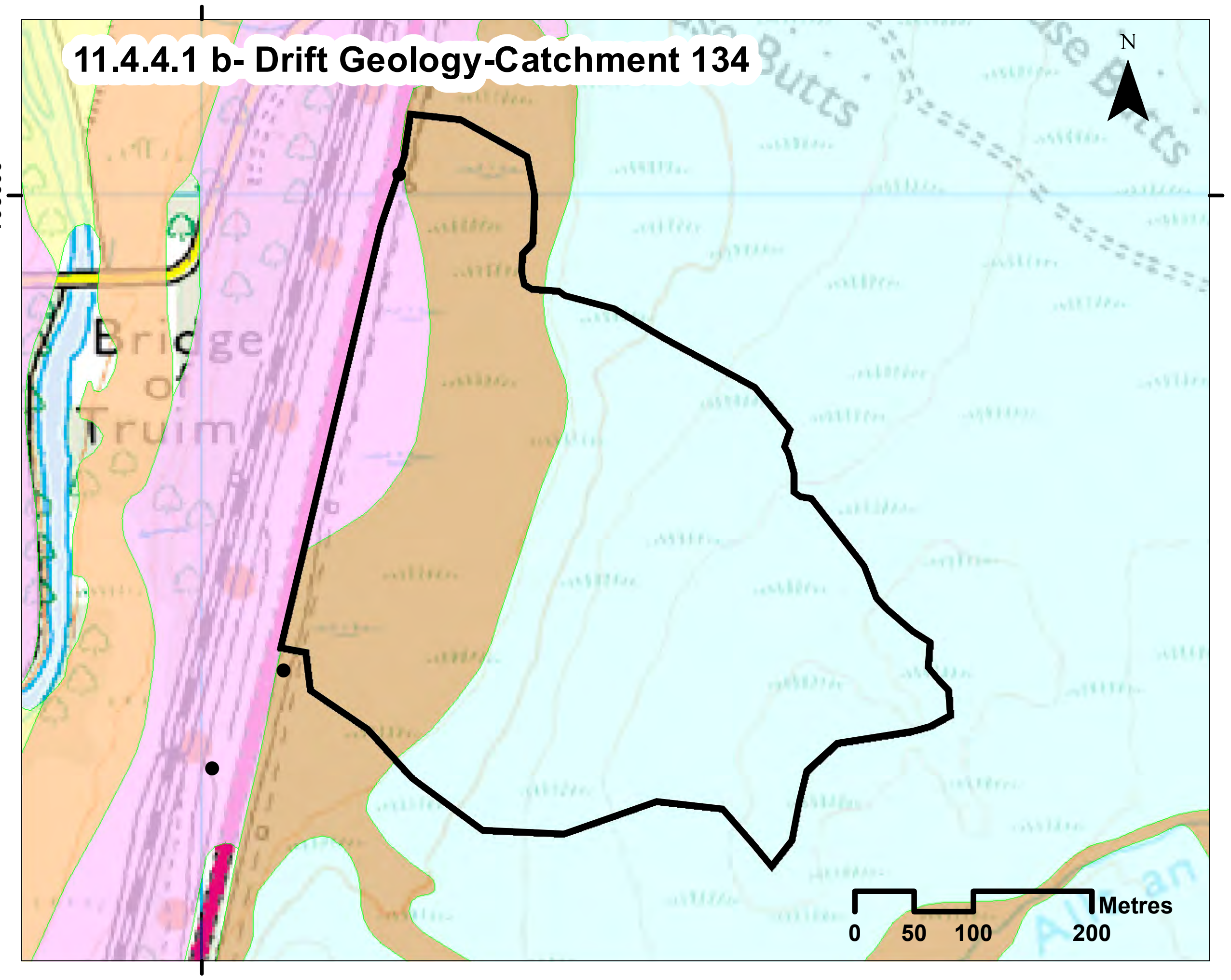
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach upstream of crossing** | Channel morphology | Engineered | Cut drains |
| | Predominant sediment size | Fine with some cobbles | Cobbles possibly generated from excavated river terrace material during road or ETL construction |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 134 | Yes | ETL |
| | Impact of infrastructure | Yes | consutruction? |
| | Channel realignment | Yes | |

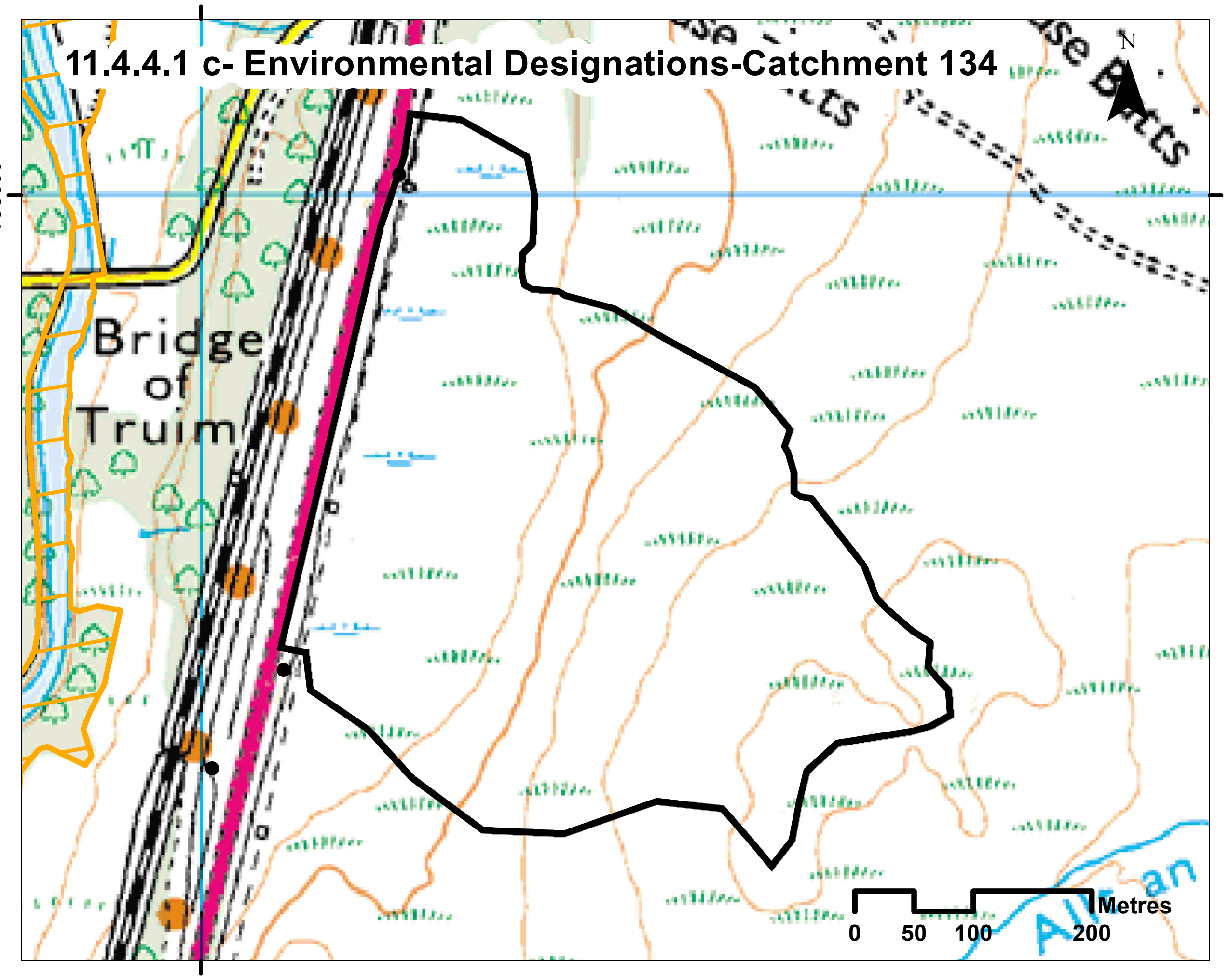
| | | | |
|---|---|---|---|
| **Morphology and Process-At crossing** | Channel morphology | Engineered | |
| | Predominant sediment size | Fines | |
| | Unvegetated bars | None | |
| | Vertical incision | None | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | Yes | Metalwork in photo 5034 (beneath NMU route?) looks fatigued. |

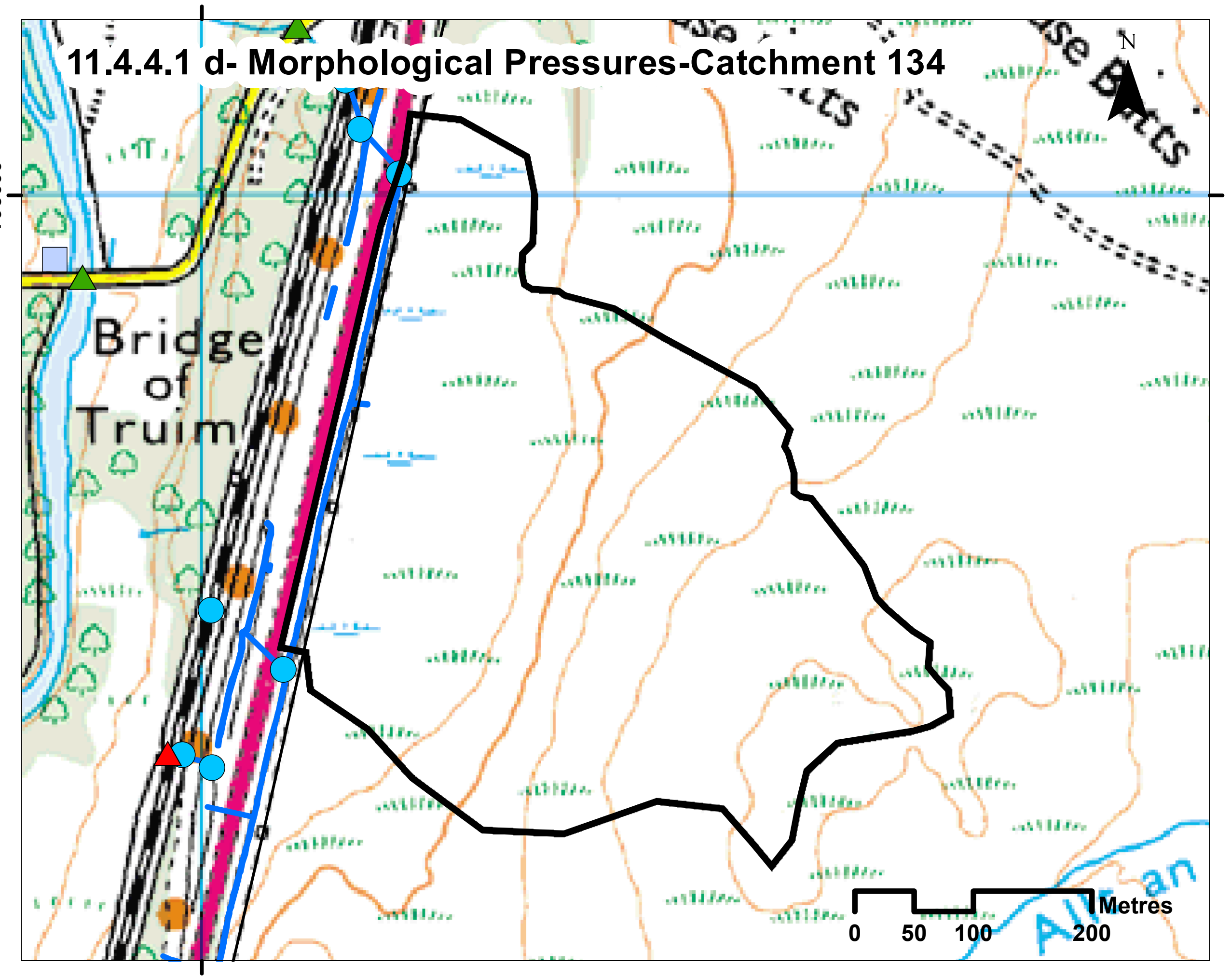
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach downstream of crossing** | Channel morphology | Engineered | to pass under NMU route and railway |
| | Predominant sediment size | Fine | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment | Yes | NMU route, railway and minor road to |
| | Impact of infrastructure | Yes | Restricts channel alignment |
| | Channel realignment | Yes | at least realigned when the railway was constructed as there is a right-angle bend in the channel shown in the 1903 map at the base of the eastern embankment slope and follows the base of this slope for c.20m before turning sharply to pass through the railway embankment. No further realignment appears to have occurred since then although it is not 100% clear from the photos whether the right- |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

**General**

- Crossing location

**Solid Geology**

- Gaick Psammite Formation - Psammite
- Loch Laggan Psammite Formation - Psammite, Micaceous
- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite - Microdiorite
- Pitmain Semipelite Member - Semipelite And Calcsilicate-Rock
- Pitmain Semipelite Member - Semipelite, Gneissose
- Scottish Highland Ordovician Minor Intrusion Suite - Leucogranite
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite- (Other Than Dykes) - Microdiorite

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Special Area of Conservation

**Morphological Pressures**

- Railway Bridge
- Road Bridge
- Culvert
- Abstraction Location
- Drainage Ditch
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 134 Catchment Overview**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

| SHEET: | REVISION: | SUITABILITY: |
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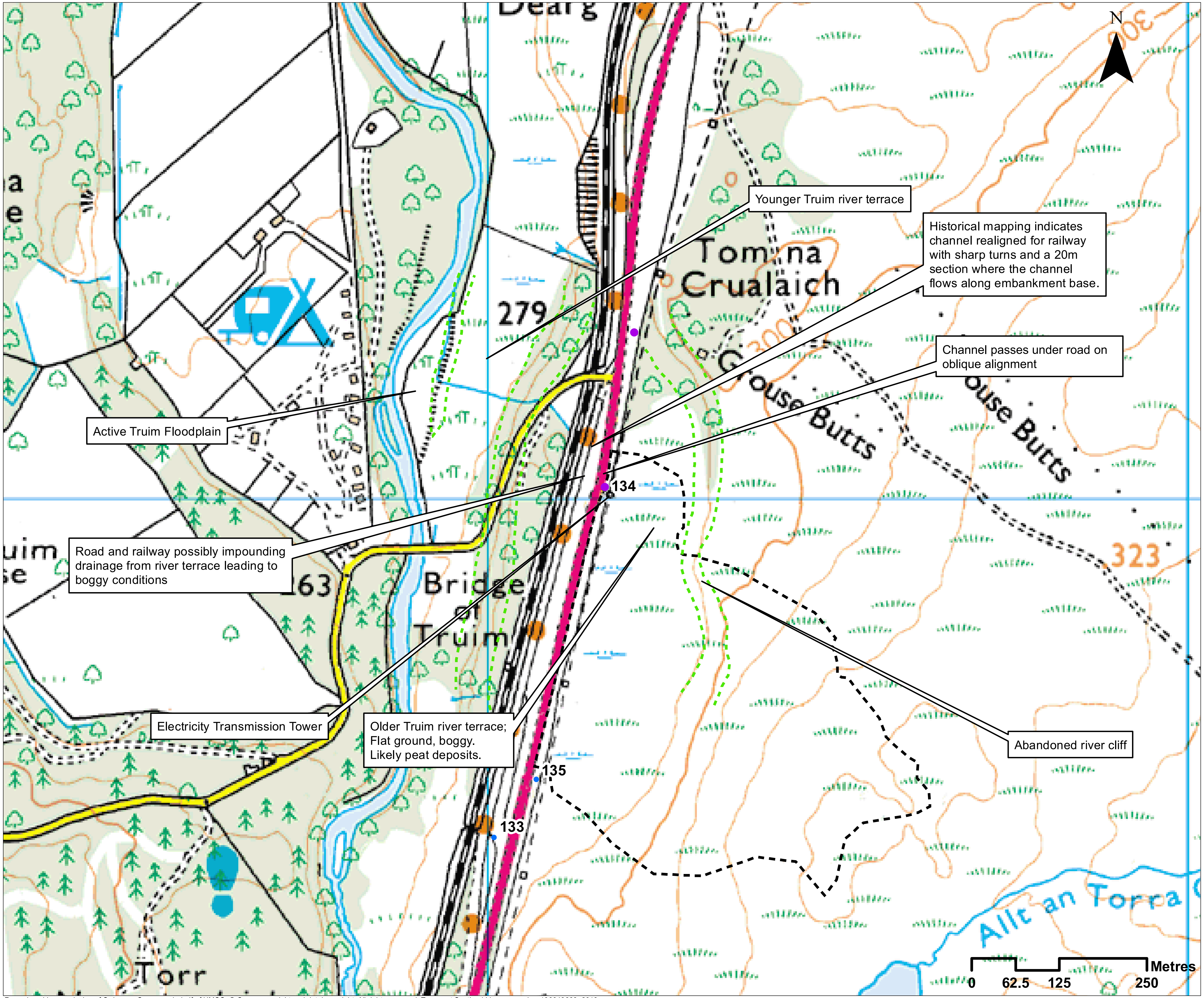


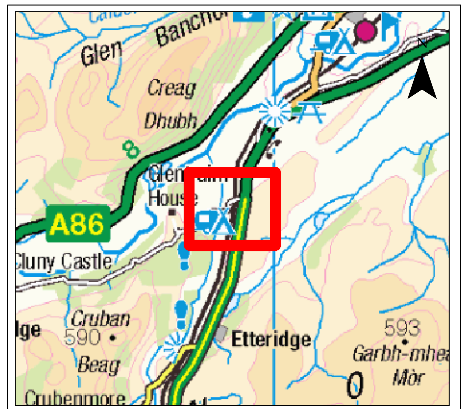


## Legend

- Minor crossing
- Other crossing
- Break in slope
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|

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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 134 Baseline Assessment**

| DESIGN: EL | DRAWN: AB | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 18/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: 1 OF 1 | REVISION: C01 | SUITABILITY: A3 |
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## Annex 11.4.4-Hydromorphological Catchment Assessment-136

| | | | |
|---|---|---|---|
| **Catchment No.** | 136 | | |
| **Catchment Name** | | | |

| | | | |
|---|---|---|---|
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Minor | |

| | | | |
|---|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.2 | |
| | Average slope in catchment (°) | 5 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |

| | | | |
|---|---|---|---|
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Moderate | |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 136) | Gaick Psammite formation-Psammite | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | - |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 136)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |

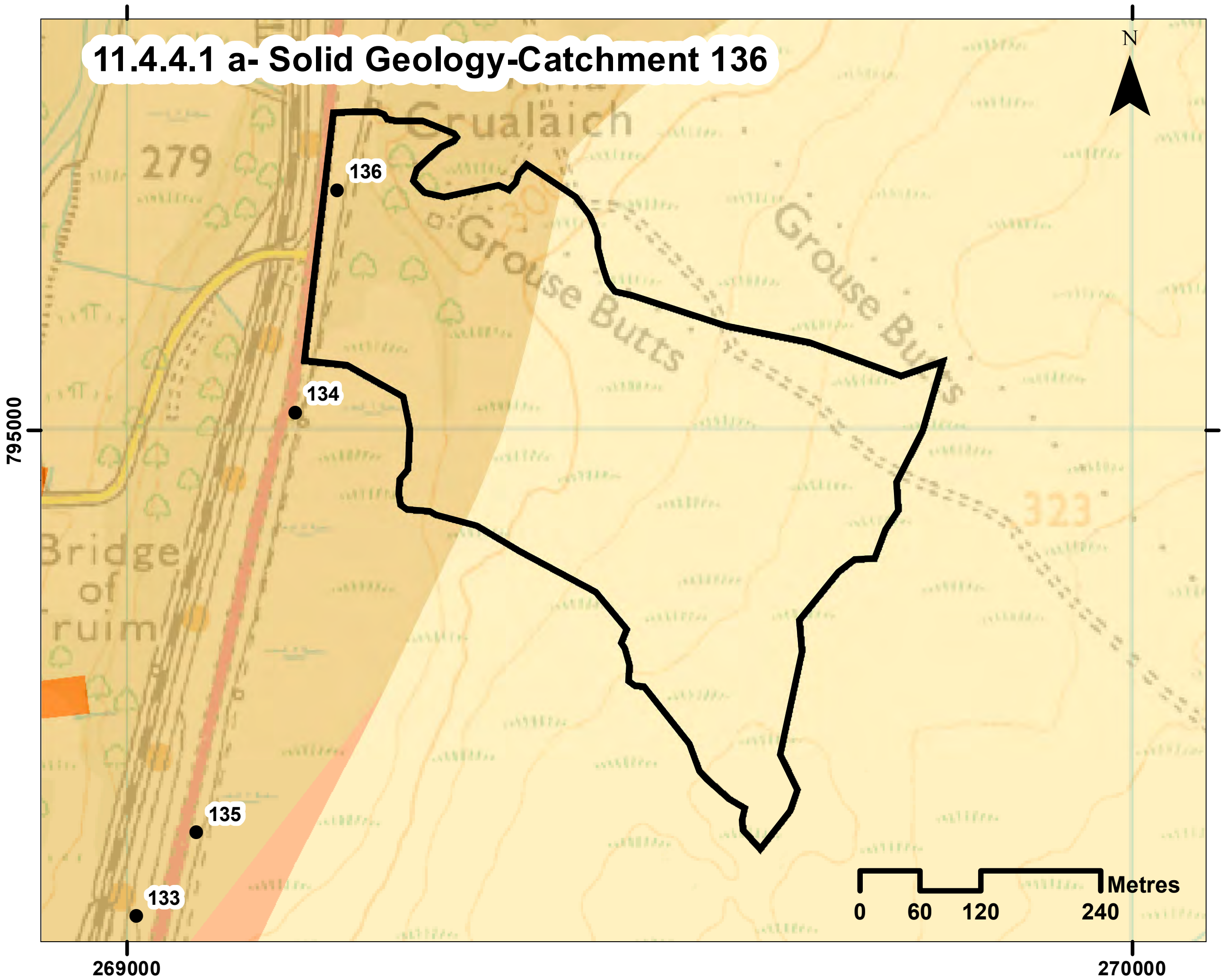
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 136 | |
| | Is peat present in the catchment? | Yes | Possible u/s of road |
| | Is there a bog burst risk? | No | |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | U/s, d/s and between road, NMU route and railway |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 136) | Yes | NMU route and railway d/s of road |
| | Comment on sediment source potential in catchment | Limited | |
| | Comment on sediment supply potential to crossing | Seemibly limited sediment supply, but culvert photos show culver c.30-40% obstructed by deposited gravel. | |

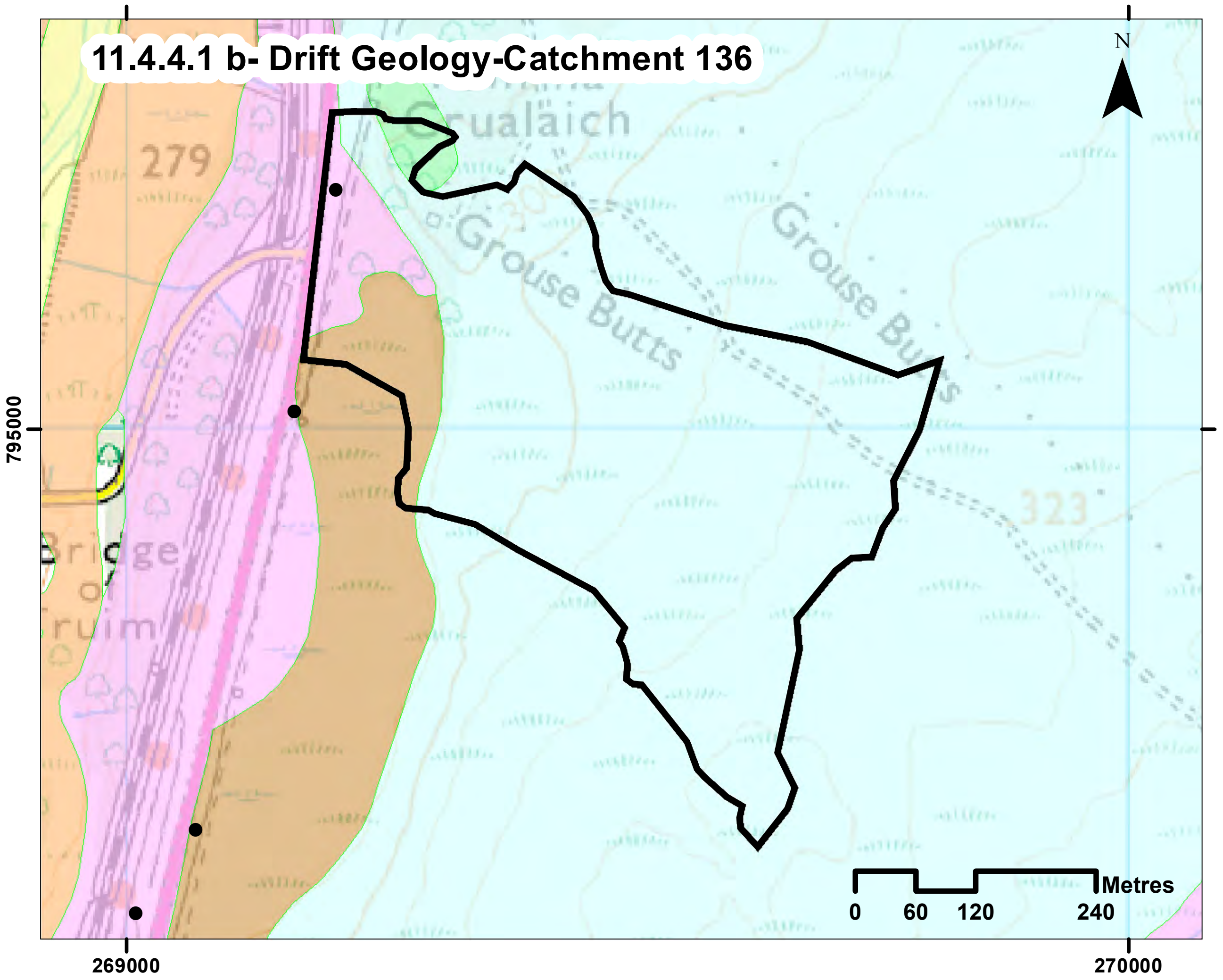
| | | | |
|---|---|---|---|
| **Morphology and Process- Reach upstream of crossing** | Channel morphology | Engineered | Cut drain |
| | Predominant sediment size | - | No photos |
| | Unvegetated bars | NO | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 136 | No | |
| | Impact of infrastructure | No | |
| | Channel realignment | Yes | Previously channel turned to west c.30m u/s of culvert entrance. |

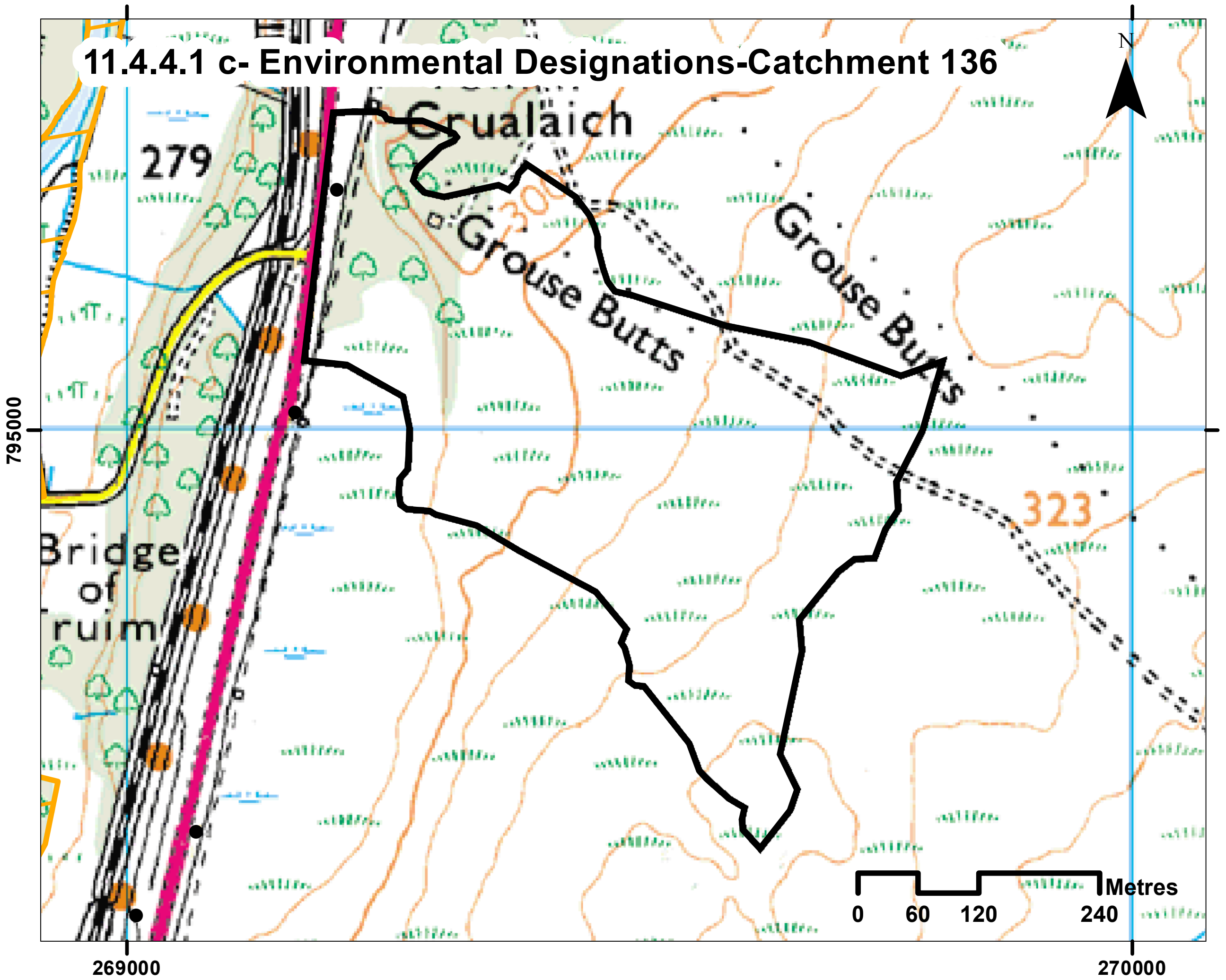
| | | | |
|---|---|---|---|
| **Morphology and Process- At crossing** | Channel morphology | Engineered | |
| | Predominant sediment size | Gravel | deposited in culvert |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Medium | |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | Yes | Outflow d/s of NMU route has developed step from scour |

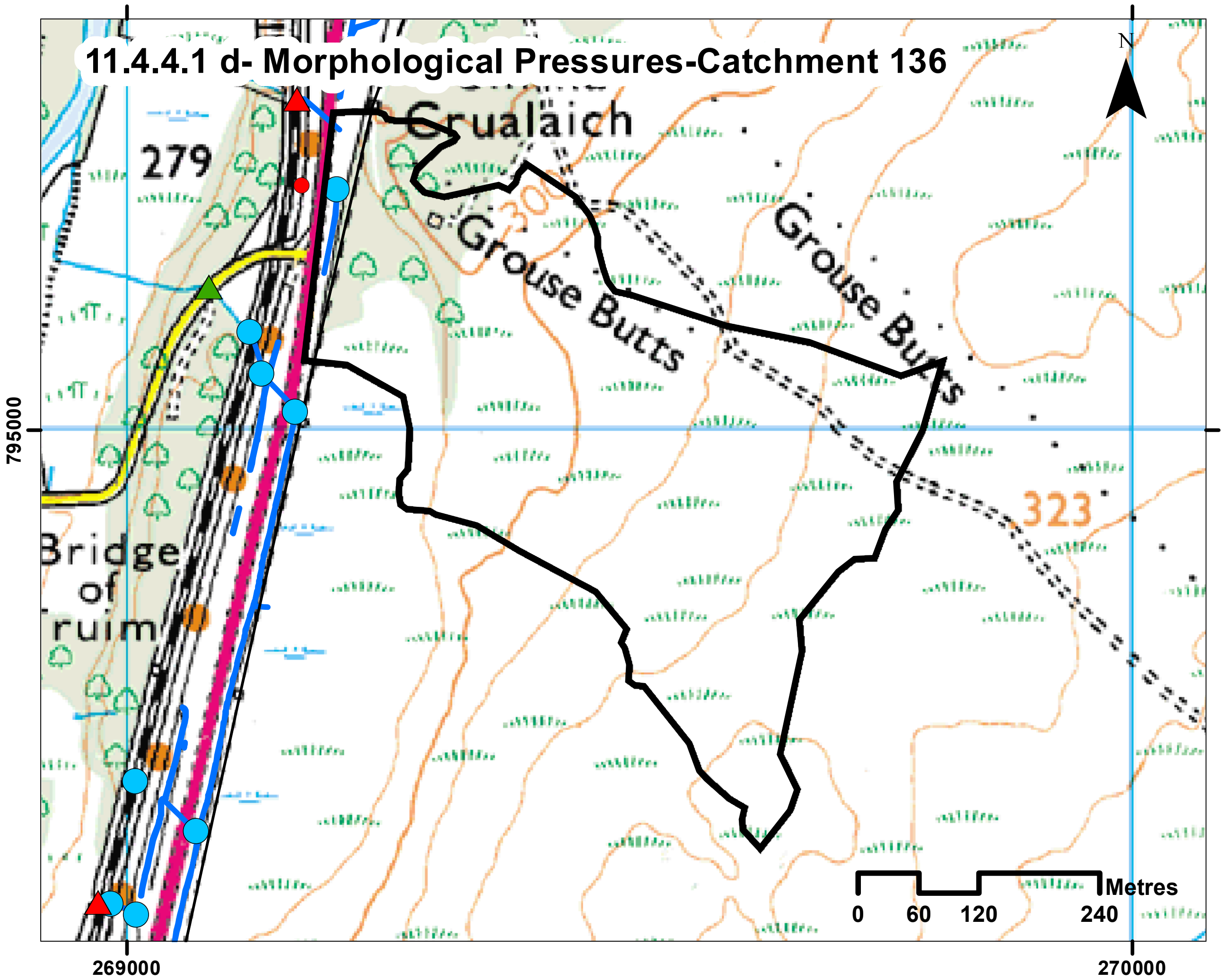
| | | | |
|---|---|---|---|
| **Morphology and Process- Reach downstream of crossing** | Channel morphology | Cascade | Falls steeply through railway underbridge |
| | Predominant sediment size | cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment | Yes | Railway |
| | Impact of infrastructure | Yes | Limits opportunity for realignment d/s |
| | Channel realignment | Yes | Historical mapping 1902 shows the channel used to follow the alignment of the current road, but now takes a more direct route (oblique to the A9 alignment) to the railway underbridge. |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

**General**

- Crossing location

**Solid Geology**

- Gaick Psammite Formation - Psammite
- Loch Laggan Psammite Formation - Psammite, Micaceous
- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite - Microdiorite
- Pitmain Semipelite Member - Semipelite And Calcsilicate-Rock
- Pitmain Semipelite Member - Semipelite, Gneissose
- Scottish Highland Ordovician Minor Intrusion Suite - Leucogranite
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite- (Other Than Dykes) - Microdiorite

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Special Area of Conservation

**Morphological Pressures**

- Railway Bridge
- Road Bridge
- Culvert
- Step in Bed
- Drainage Ditch
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 136 Catchment Overview**

| DESIGN: EL | DRAWN: EV | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

| SHEET: 1 of 1 | REVISION: C01 | SUITABILITY: A3 |
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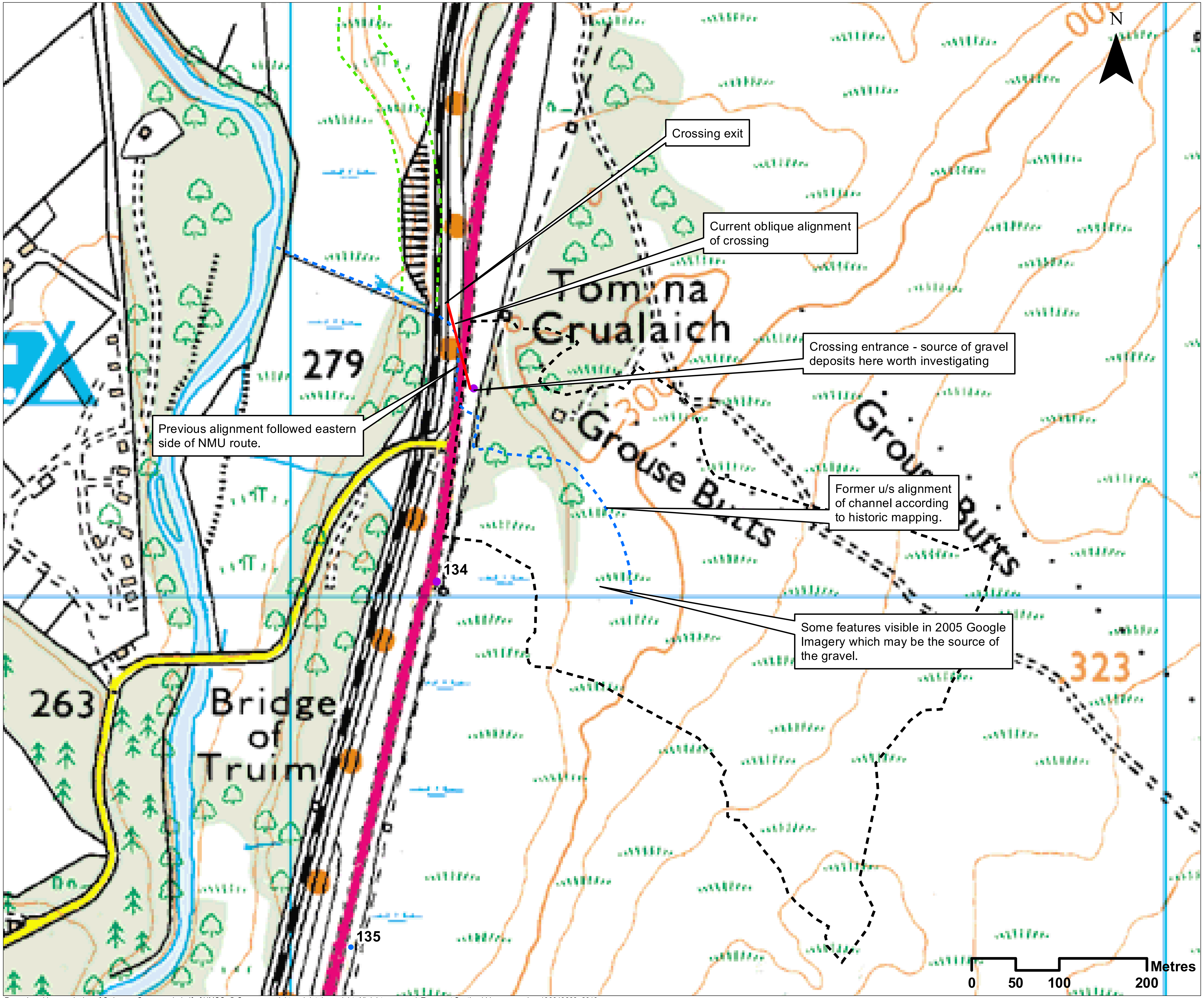


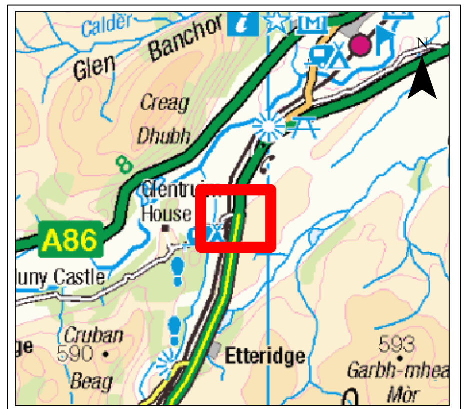


## Legend

- Minor crossing
- Other crossing
- Break in slope
- Original channel
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|

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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 136 Baseline Assessment**

| DESIGN: EL | DRAWN: AB | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 18/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: 1 OF 1 | REVISION: C01 | SUITABILITY: A3 |
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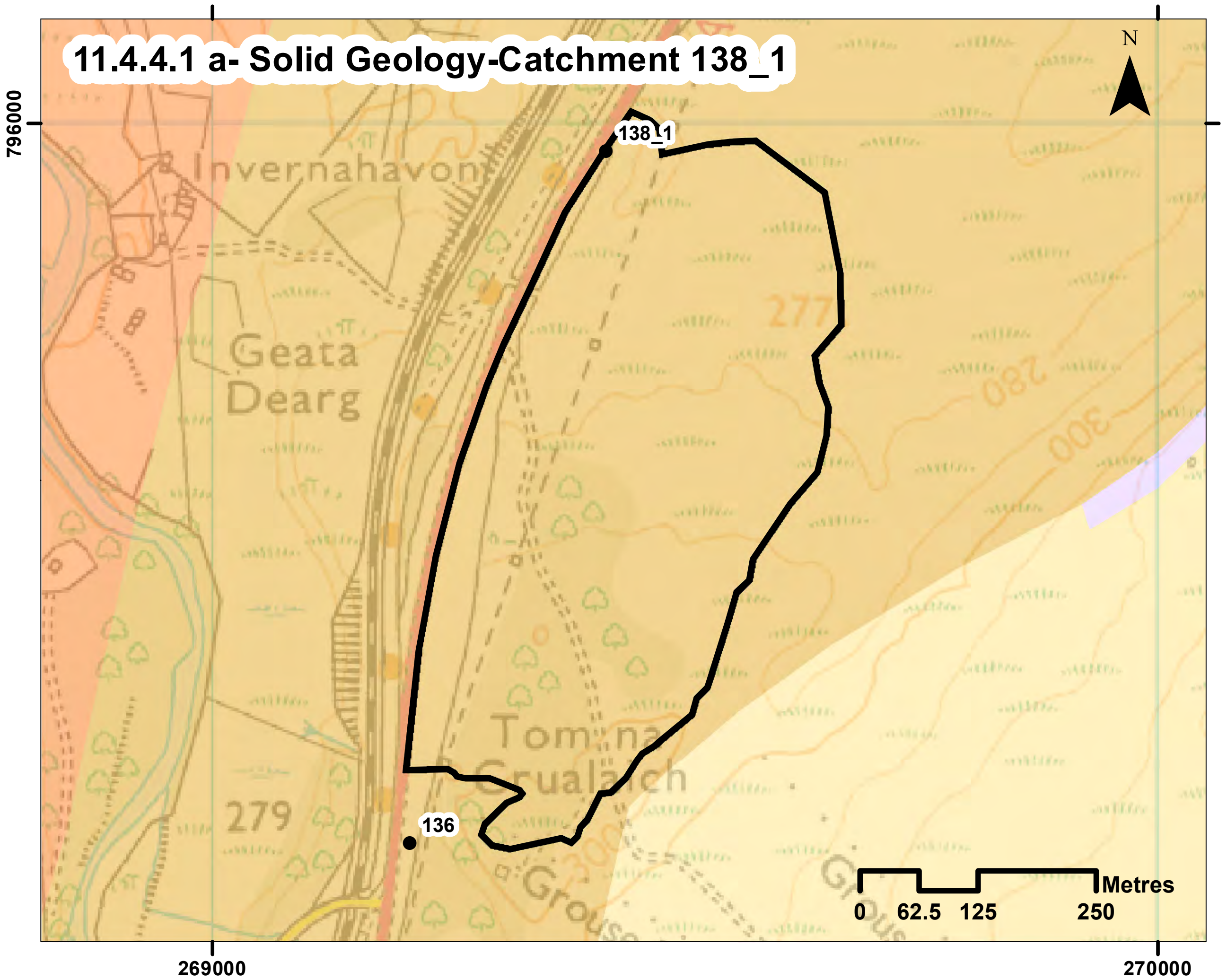
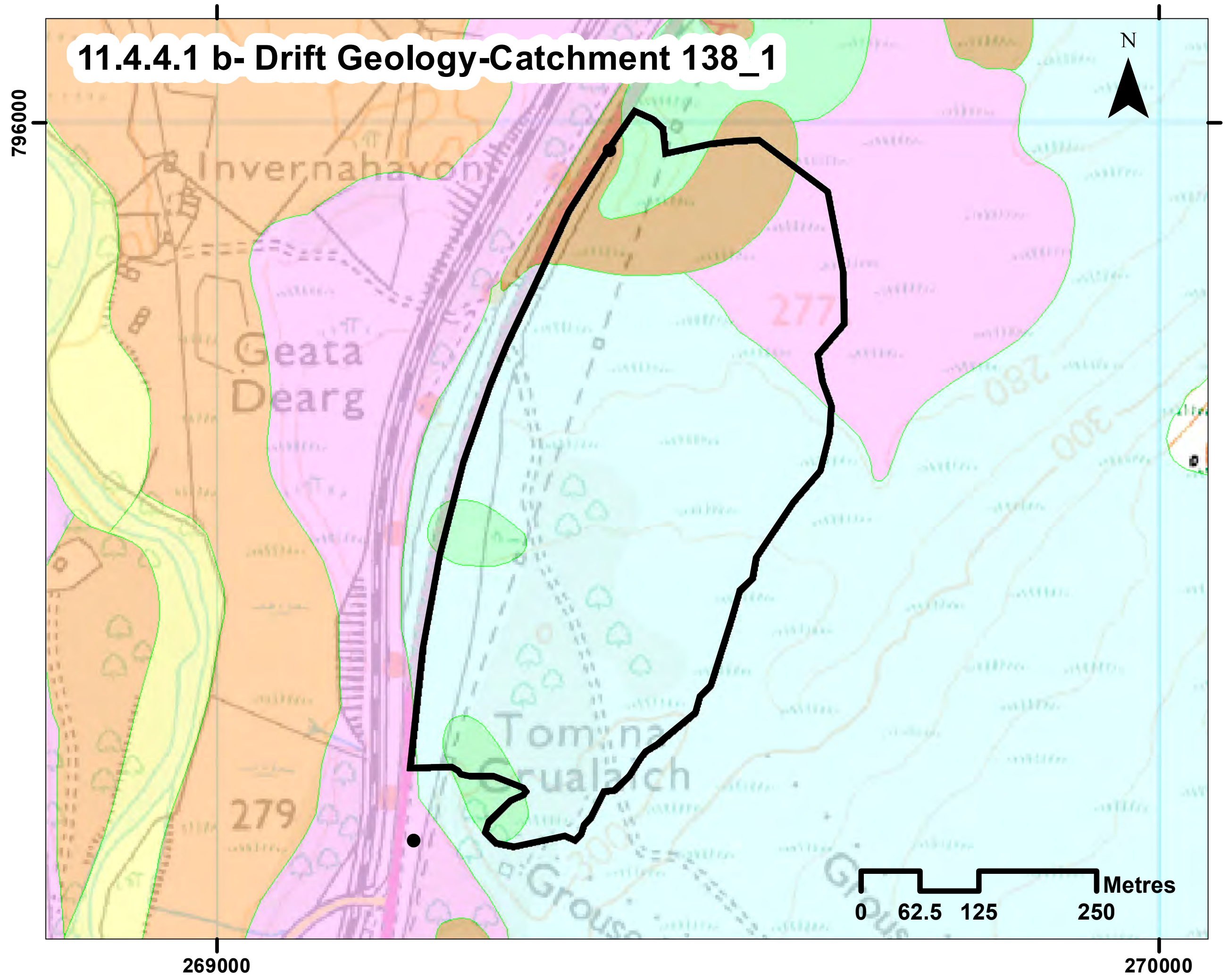
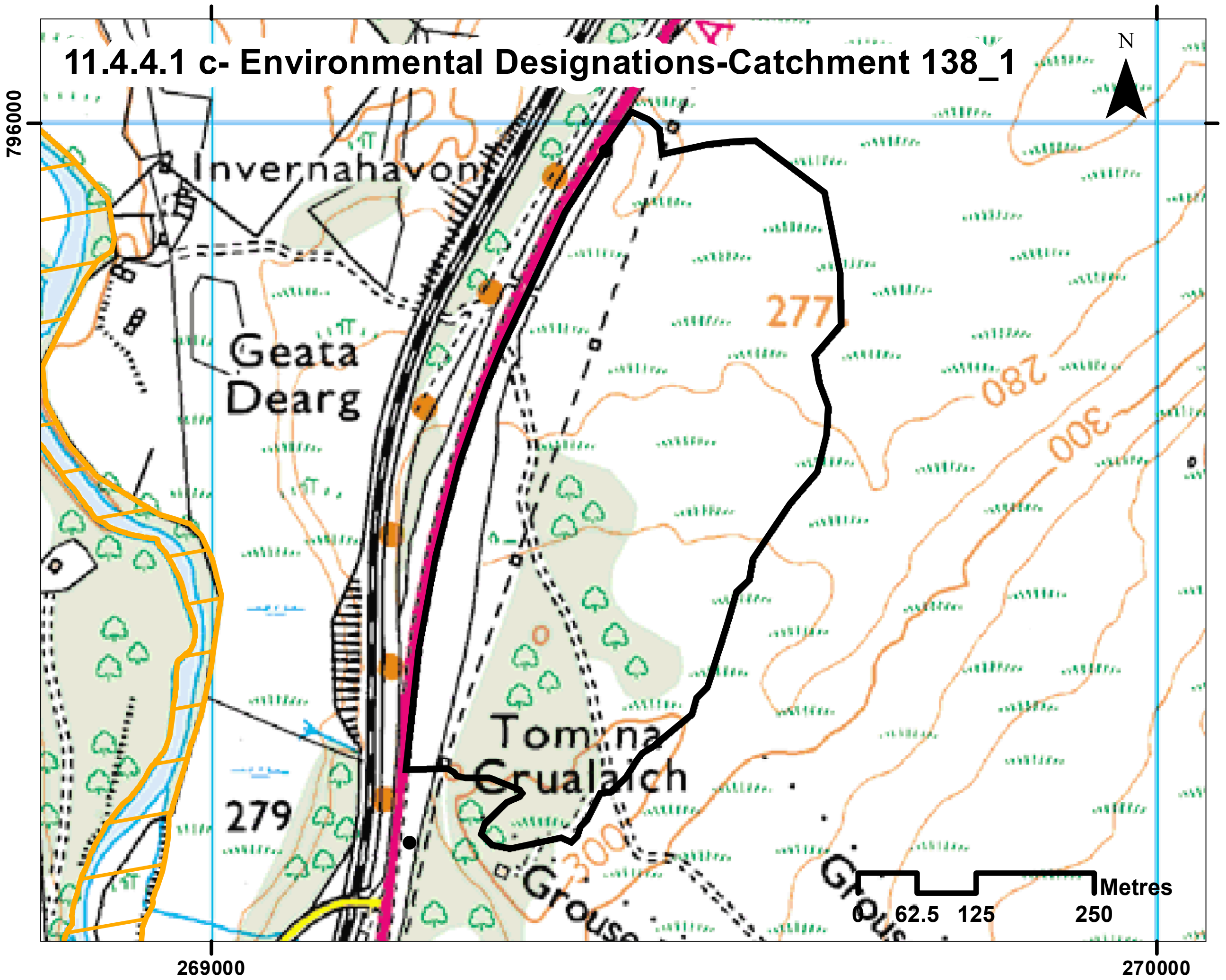
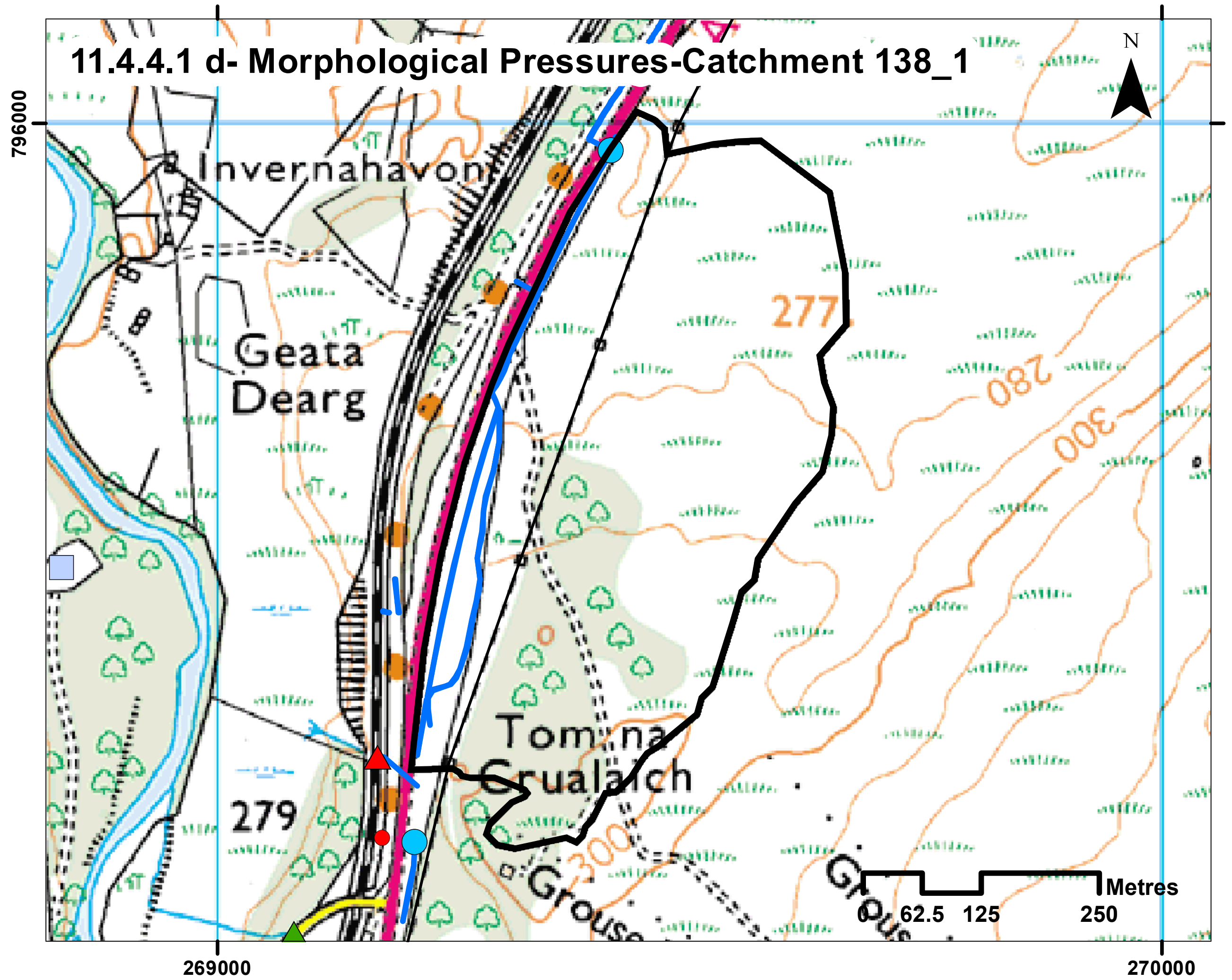
# Annex 11.4.4-Hydromorphological Catchment Assessment-138_1

| | | | |
|---|---|---|---|
| **Catchment No.** | **138_1** | | |
| **Catchment Name** | **-** | | |
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Other | |
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | | |
| | Average slope in catchment (°) | | |
| | % Catchment over 750m (for snow melt risk) | | |
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Good | |
| **Geology (Map 1a - Bedrock) (Map 1b - Superficial)** | Majority bedrock (%) | Loch Laggan Psammite formation- Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |
| **Environmental Designations (Map 1c)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Map 2 | |
| | Is peat present in the catchment? | Yes | Crossing drains peatland area u/s of road indicated by aerial photo and BGS 1:50k mapping |
| | Is there a bog burst risk? | No | Highly unlikely bog is drained, gradients very low and bog doesn't appear to be |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Limited scrub woodland. Unlikely to generate much woody debris |
| | Presence and nature of infrastructure (Map 1d) | Yes | ETL and towers. |
| | Comment on sediment source potential in catchment | Likely just to be fines and organics. | |
| | Comment on sediment supply potential to crossing | Low gradients and limited sediment sources. Doesn't appear to be an issue from | |
| **Morphology and Process- Reach upstream of crossing** | Channel morphology | Engineered | |
| | Predominant sediment size | Fine | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (Map 1d) | Yes | ETL |
| | Impact of infrastructure | No | |
| | Channel realignment | No | No channel shown on 1899 mapping |
| **Morphology and Process- At crossing** | Channel morphology | Engineered | |
| | Predominant sediment size | Fines | |
| | Estimated discharge at 1:200 event ($m^3/s$) | 2.1 | |
| | Crossing currently undersized? | | |
| | Unvegetated bars | None | |
| | Vertical incision | None | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | None | |
| **Morphology and Process- Reach downstream of crossing** | Channel morphology | Engineered | |
| | Predominant sediment size | Fine | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (Map 1d) | Yes | NMU route |
| | Impact of infrastructure | Yes | Assumed drain passes beneath NMU |
| | Channel realignment | No | None evident on 1899 mapping |
| **Summary behaviour** | Very small crossing which appears to drain an area of peatland u/s of the road. No evidence of erosion or deposition issues.<br>If this is draining the area of peatland significantly, there may be an opportunity for an environmental improvement if that drainage isn't natural. | | |




## Legend

**General**

- Crossing location

**Solid Geology**

- Loch Laggan Psammite Formation - Psammite, Micaceous

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Special Area of Conservation

**Morphological Pressures**

- Railway Bridge
- Road Bridge
- Culvert
- Step in Bed
- Abstraction Location
- Drainage Ditch
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 138_1 Catchment Overview**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

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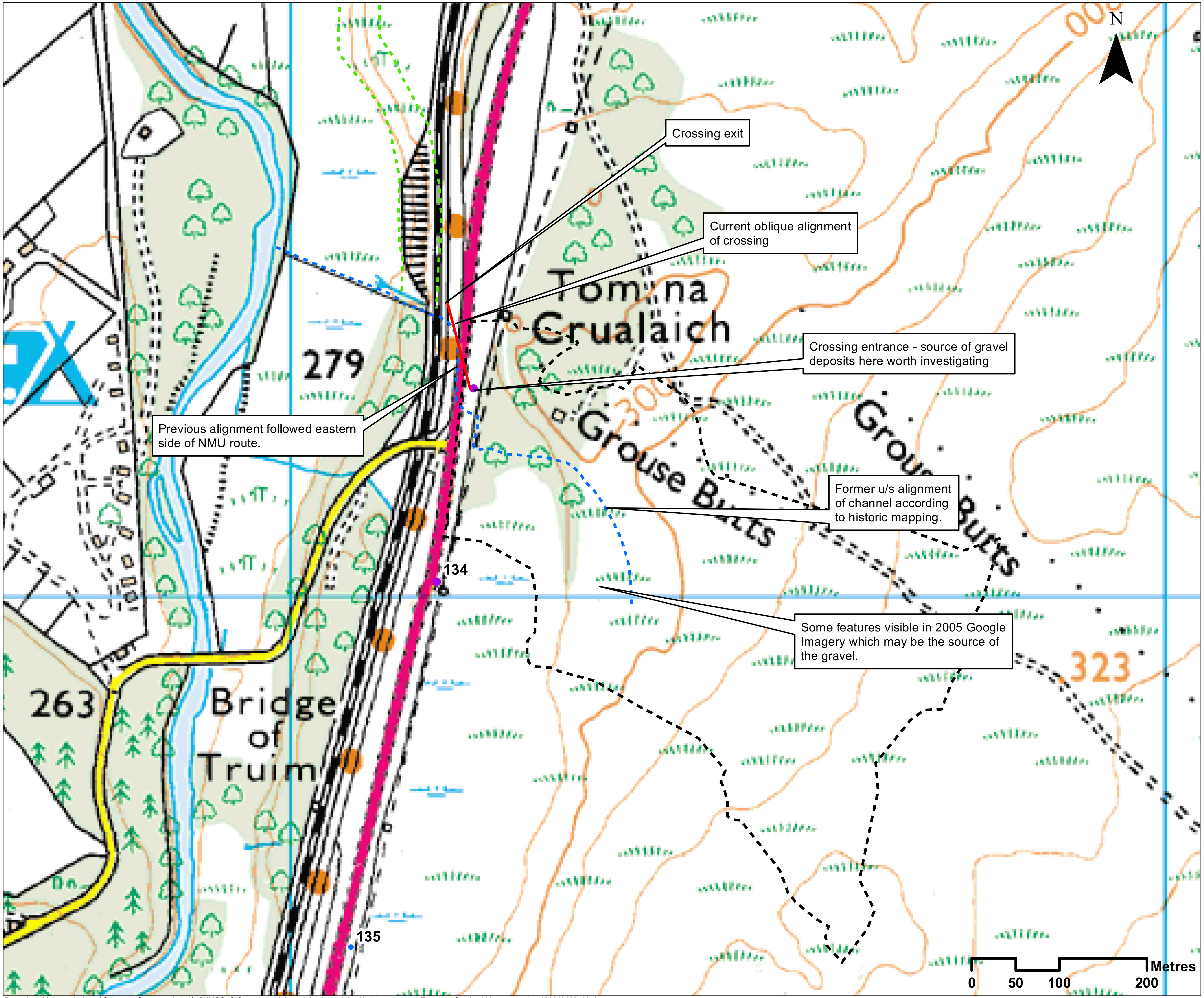
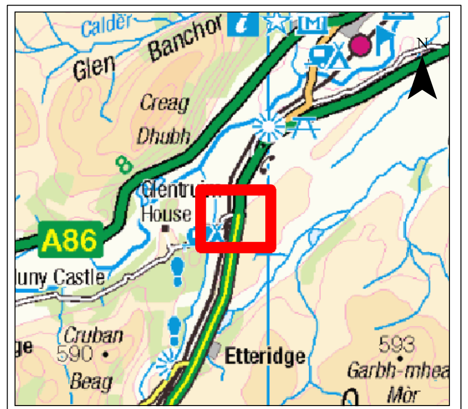
| 1 of 1 | C01 | A3 |




## Legend

- Minor crossing
- Other crossing
- Break in slope
- Original channel
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 136 Baseline Assessment**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | AB | EL | EL |

DATE: 18/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: | REVISION: | SUITABILITY: |
|---|---|---|
| 1 OF 1 | C01 | A3 |

## Annex 11.4.4-Hydromorphological Catchment Assessment-138_2

| | |
|---|---|
| **Catchment No.** | 138_2 |
| **Catchment Name** | Allt Torran Dhaimh |

| | | |
|---|---|---|
| **Channel Nature** | Nature of water course | Natural |
| | Size of water course | Minor |

| | | |
|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.9 |
| | Average slope in catchment (°) | 5.5 |
| | % Catchment over 750m (for snow melt risk) | 0 |

| | | |
|---|---|---|
| **WFD classification** | Water, flows and levels | Good |
| | Physical condition | Good |
| | Overall ecological status | Good |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 138_1) | Loch Laggan Psammite formation-Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 138_1)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |

| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 138_1 | |
| | Is peat present in the catchment? | Yes | In depression in former glacial meltwater channel. High water table appears to be maintained at least in part by a series of small metal dams blocking the channel. |
| | Is there a bog burst risk? | Yes | Possible, as extensive area of peat u/s of a steep drop to crossing, but still unlikely as bog is drained and not raised. Gradients also low where peat is located. |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | Yes | Google Earth Imagery (from 2006) shows extensive area of exposed ground in upper catchment, possibly arising due to multiple shallow failures. Recent aerial photo indicates that this has since revegetated. |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Scrub woodland in lower catchment |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 138_1) | No | |
| | Comment on sediment source potential in catchment | Possible extensive sediment sources in upper catchment from shallow failure of steeper slopes in wet conditions. | |
| | Comment on sediment supply potential to crossing | Limited - very extensive flat wetland area between potential major sediment sources. | |

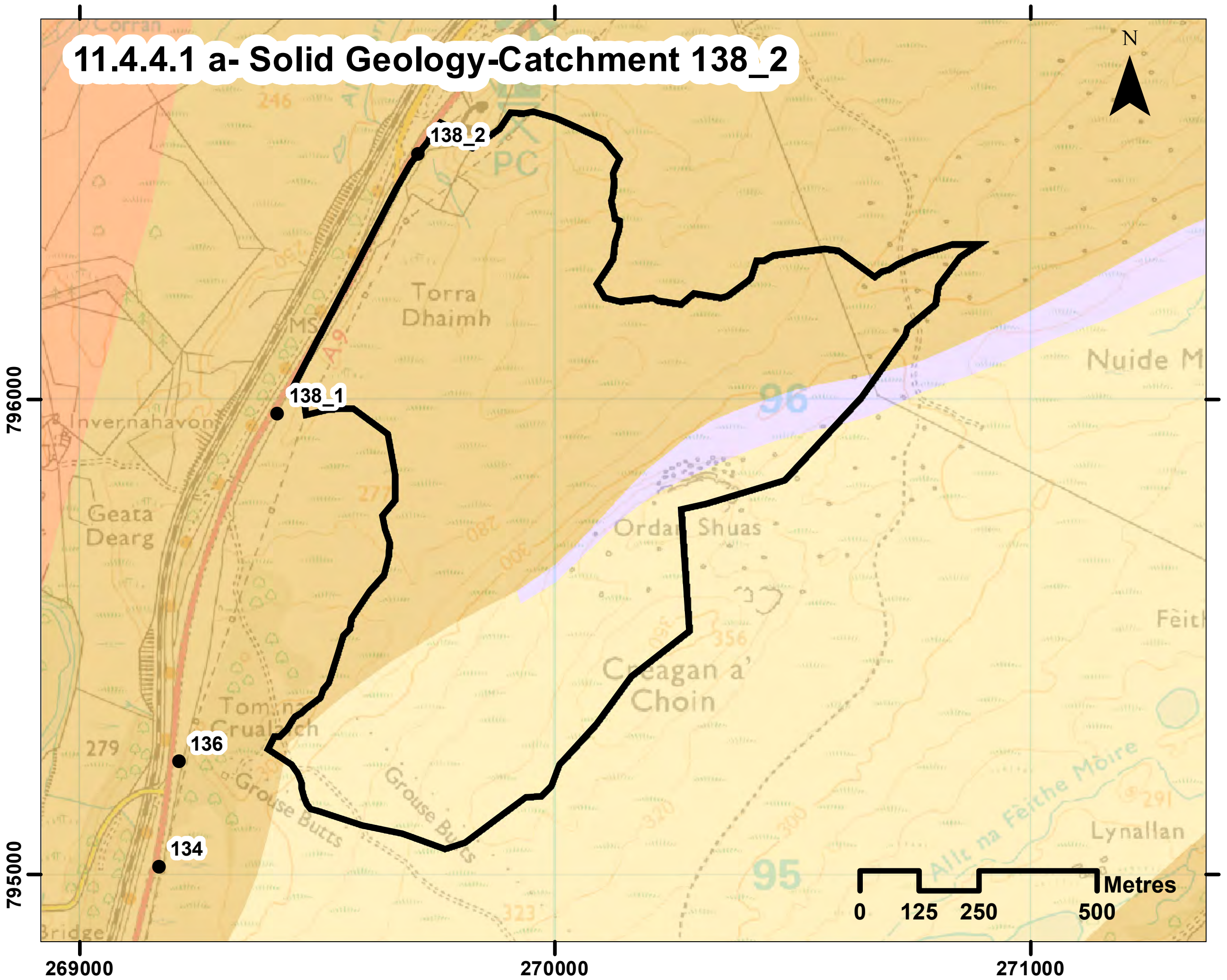
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach upstream of crossing** | Channel morphology | Cascade | Steep drop from flat area immediately u/s of A9 |
| | Predominant sediment size | Gravel-cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | Medium | |
| | Deposition | Medium | u/s of woody debris |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 138_1 | Yes | Small metal dams |
| | Impact of infrastructure | Yes | Restricts flow, presumably to maintain wetland, or supply of water |

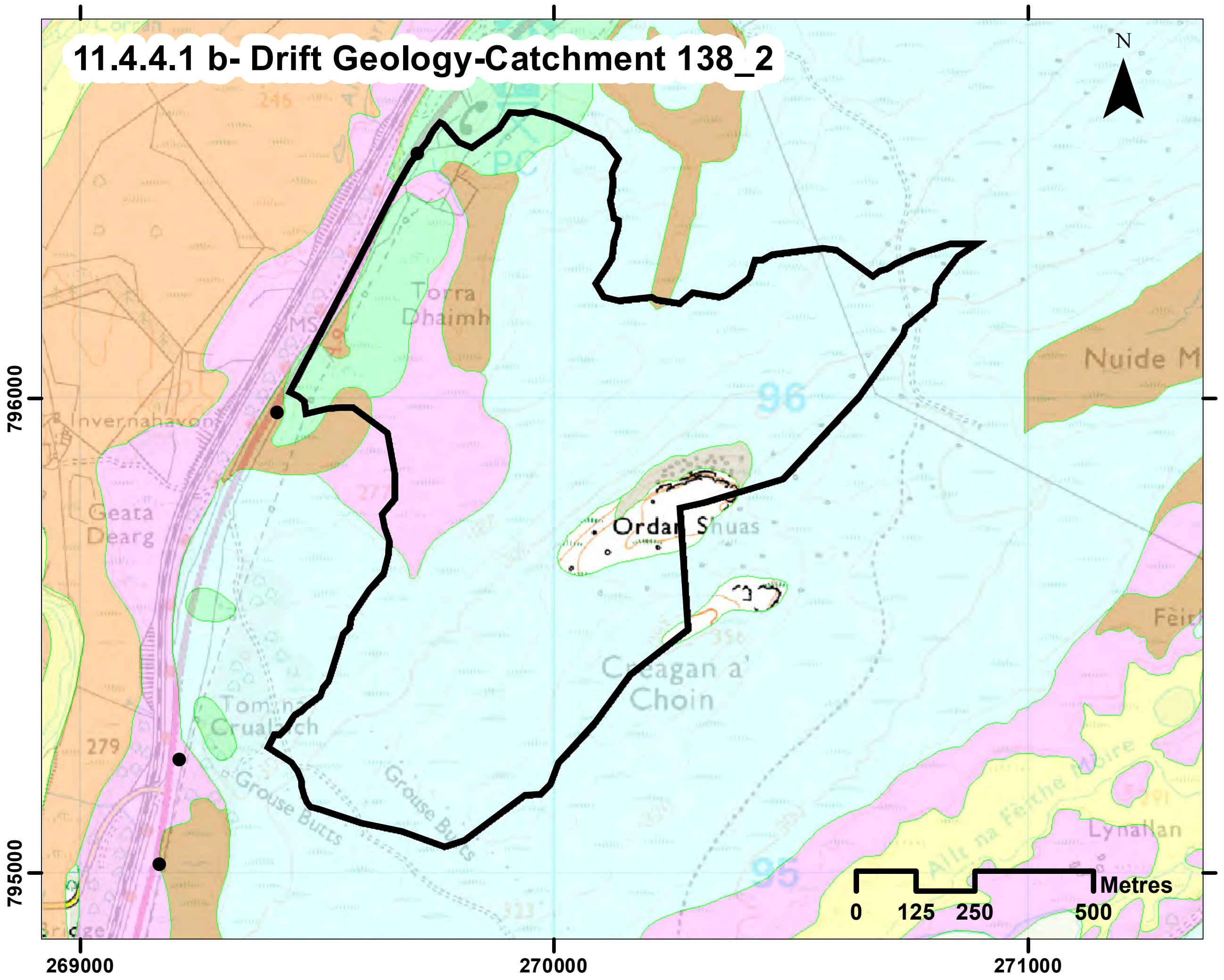
| | | | |
|---|---|---|---|
| | Channel realignment | Yes | Pond shown on modern mapping not shown on 1899 mapping. Pond not visible in aerial photos so may have filled in with sediment or vegetation. Possibly created by metal dams |

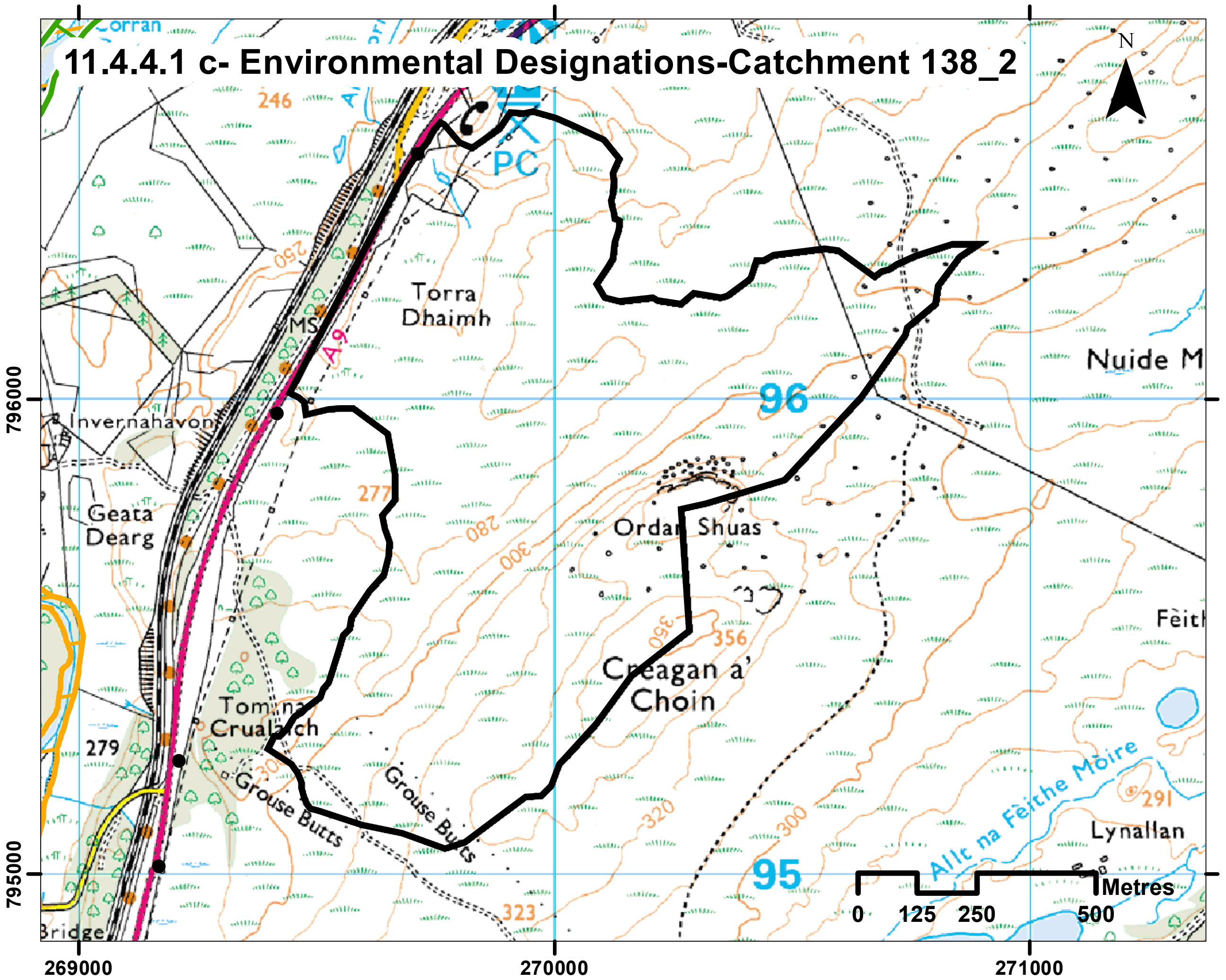
| | | | |
|---|---|---|---|
| **Morphology and Process-At crossing** | Channel morphology | Engineered | Pipe culvert (with some coarse material deposited) |
| | Predominant sediment size | Gravel-cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Medium | Gravel and cobble deposition at u/s and d/s ends of culvert |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | None | |

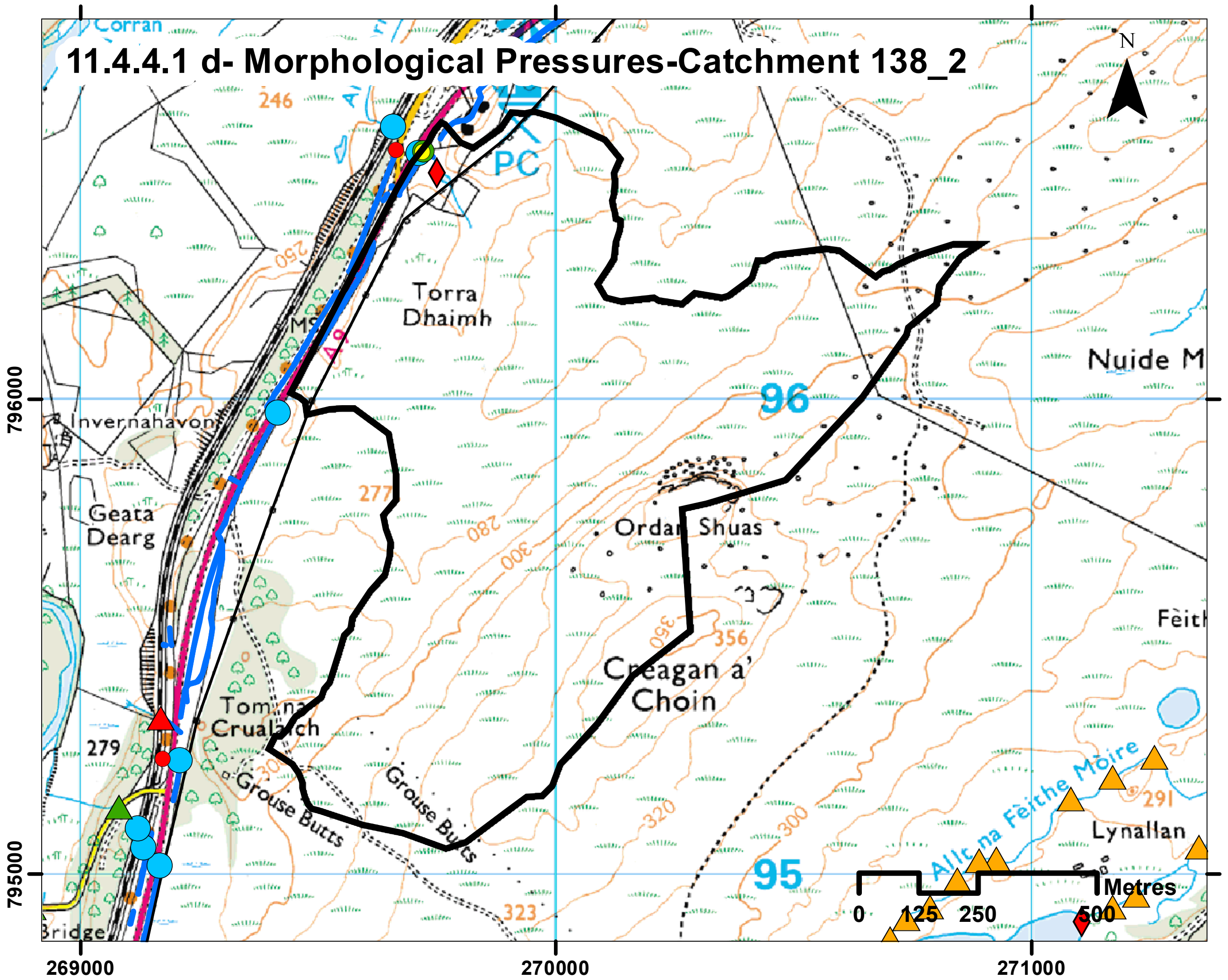
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach downstream of crossing** | Channel morphology | Step-pool | |
| | Predominant sediment size | Gravel-cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | Medium | |
| | Deposition | Medium | Gravel - cobble |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment | Yes | Railway and access route to rest area |
| | Impact of infrastructure | Yes | Channel culverted under both. Likely to |
| | Channel realignment | Yes | Lateral alignment appears relatively unchanged, but the channel is culverted continuously under the A9, rest area, rest area access route and railway. |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

**General**

- Crossing location

**Solid Geology**

- Gaick Psammite Formation - Psammite
- Loch Laggan Psammite Formation - Psammite, Micaceous
- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite - Microdiorite
- Pitmain Semipelite Member - Semipelite And Calcsilicate-Rock
- Pitmain Semipelite Member - Semipelite, Gneissose
- Scottish Highland Ordovician Minor Intrusion Suite - Leucogranite
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite- (Other Than Dykes) - Microdiorite

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Special Site of Scientific Interest
- Special Area of Conservation

**Morphological Pressures**

- Railway Bridge
- Road Bridge
- Track/Footbridge
- Culvert
- Cascade
- Step in Bed
- Catchpit
- Dam or Weir
- Drainage Ditch
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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9 CRUBENMORE TO KINCRAIG EIA

Drawing 11.4.4.1 Catchment 138_2 Catchment Overview

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

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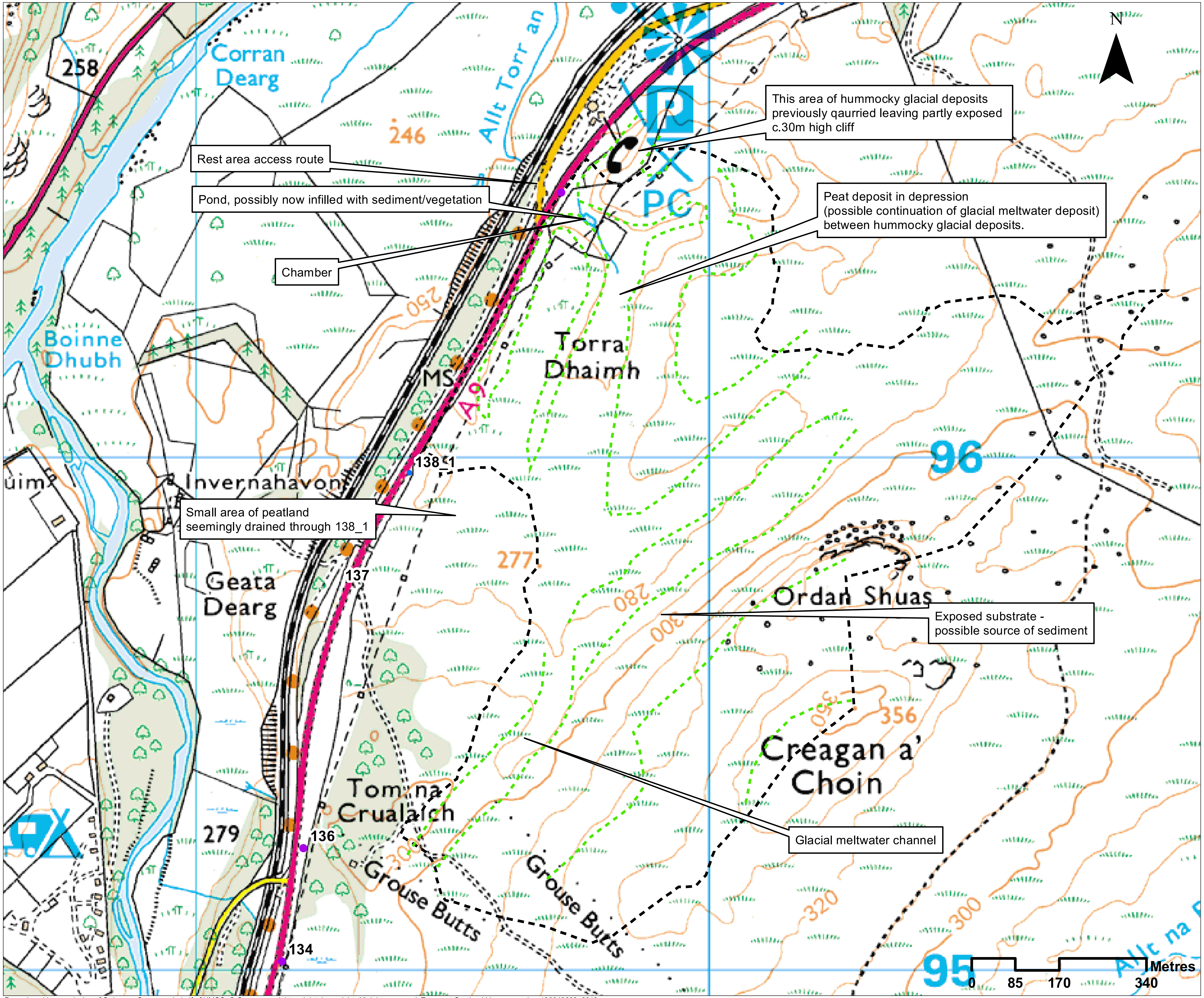


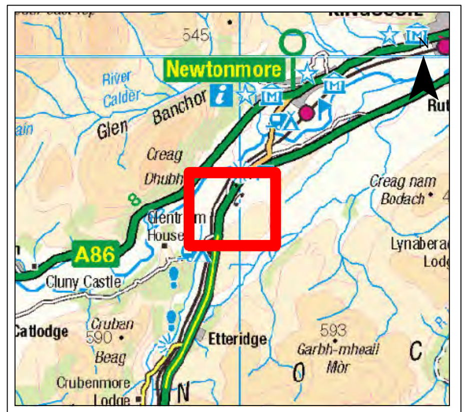


**Legend**

- Minor crossing
- Other crossing
- Break in slope
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**DRAWING 11.4.4.2.**
**Catchment 138_2 Baseline Assessment**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | AB | EL | EL |

DATE: 18/12/2017
PROJ: 495298
DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: | REVISION: | SUITABILITY: |
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| 1 OF 1 | C01 | A3 |

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Photograph 11.4.4.1- Upstream


Photograph 11.4.4.2- Downstream


Photograph 11.4.4.3- Upstream


Photograph 11.4.4.4- Upstream


Photograph 11.4.4.5- Upstream

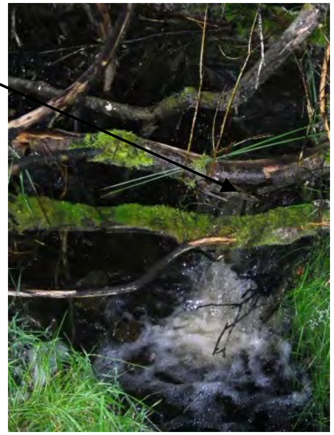

Photograph 11.4.4.6- Manhole in wetland area, upstream of crossing


Photograph 11.4.4.7- Low channel banks


Photograph 11.4.4.8

Cobble and boulder deposition

Photograph 11.4.4.9



Deposition behind wood debris

Photograph 11.4.4.10

Culvert exit

Photograph 11.4.4.11

## Annex 11.4.4-Hydromorphological Catchment Assessment-140

| | |
|---|---|
| **Catchment No.** | 140 |
| **Catchment Name** | - |

| | | | |
|---|---|---|---|
| **Channel Nature** | Nature of water course | Drain | |
| | Size of water course | Minor | |

| | | | |
|---|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.3 | |
| | Average slope in catchment (°) | 4.2 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |

| | | | |
|---|---|---|---|
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Good | |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 140) | Loch Laggan Psammite formation-Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 140)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |

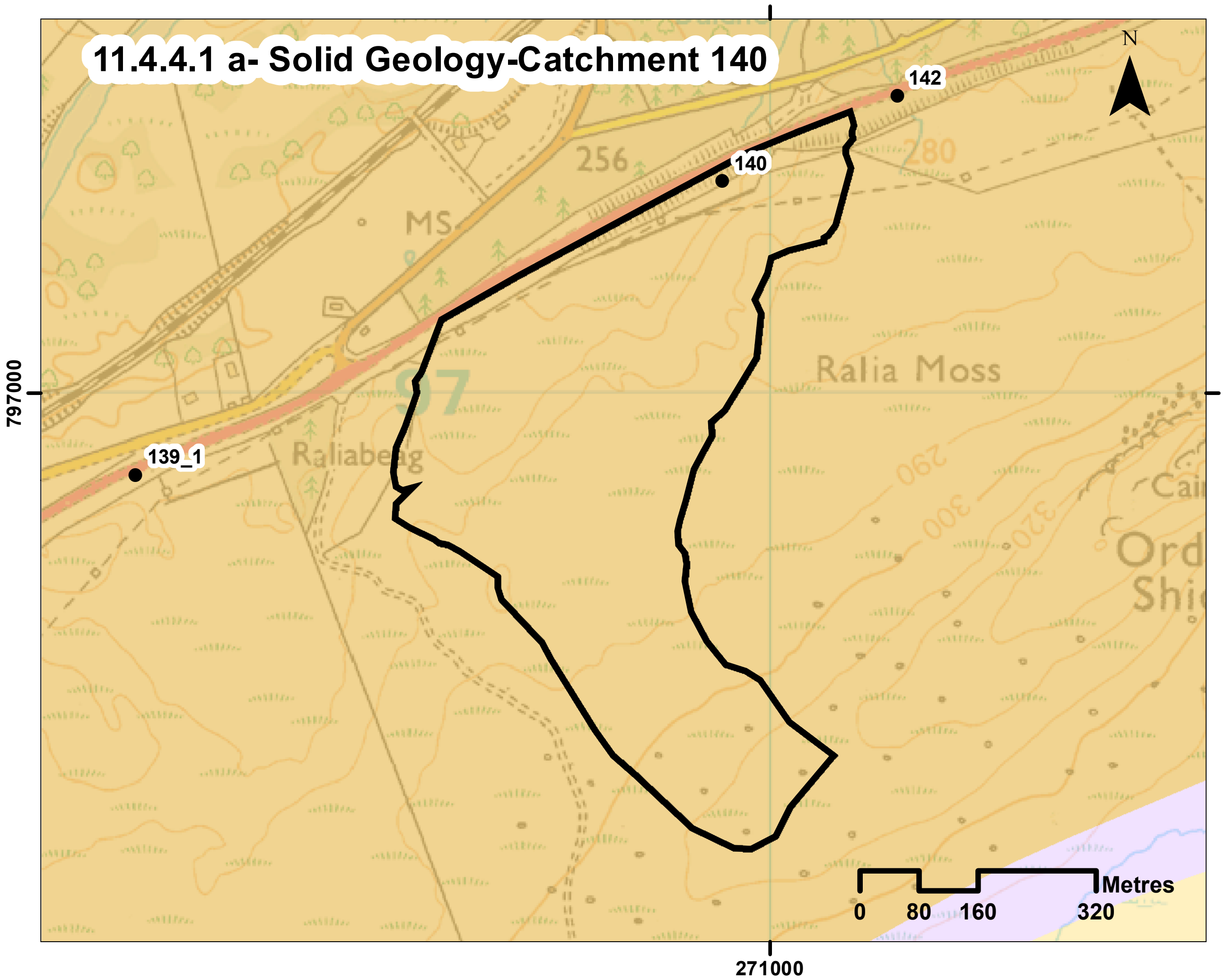
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 140 | |
| | Is peat present in the catchment? | Yes | Shown on BGS1:50k in lower part of catchment. Also historic mapping shows 'Ralia Moss' extending across the upper catchment' |
| | Is there a bog burst risk? | No | BGS 1:50k shows peat not present in upper catchment and topography unlikely to lead to bog burst affecting crossing. |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Coniferous plantation foresty u/s and d/s of A9 |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 140) | Yes | ETL u/s of A9 |
| | Comment on sediment source potential in catchment | Most likely limited to organics and fines. No evidence of major sediment sources | |
| | Comment on sediment supply potential to crossing | Very unlikely to be significant as very low energy channel | |

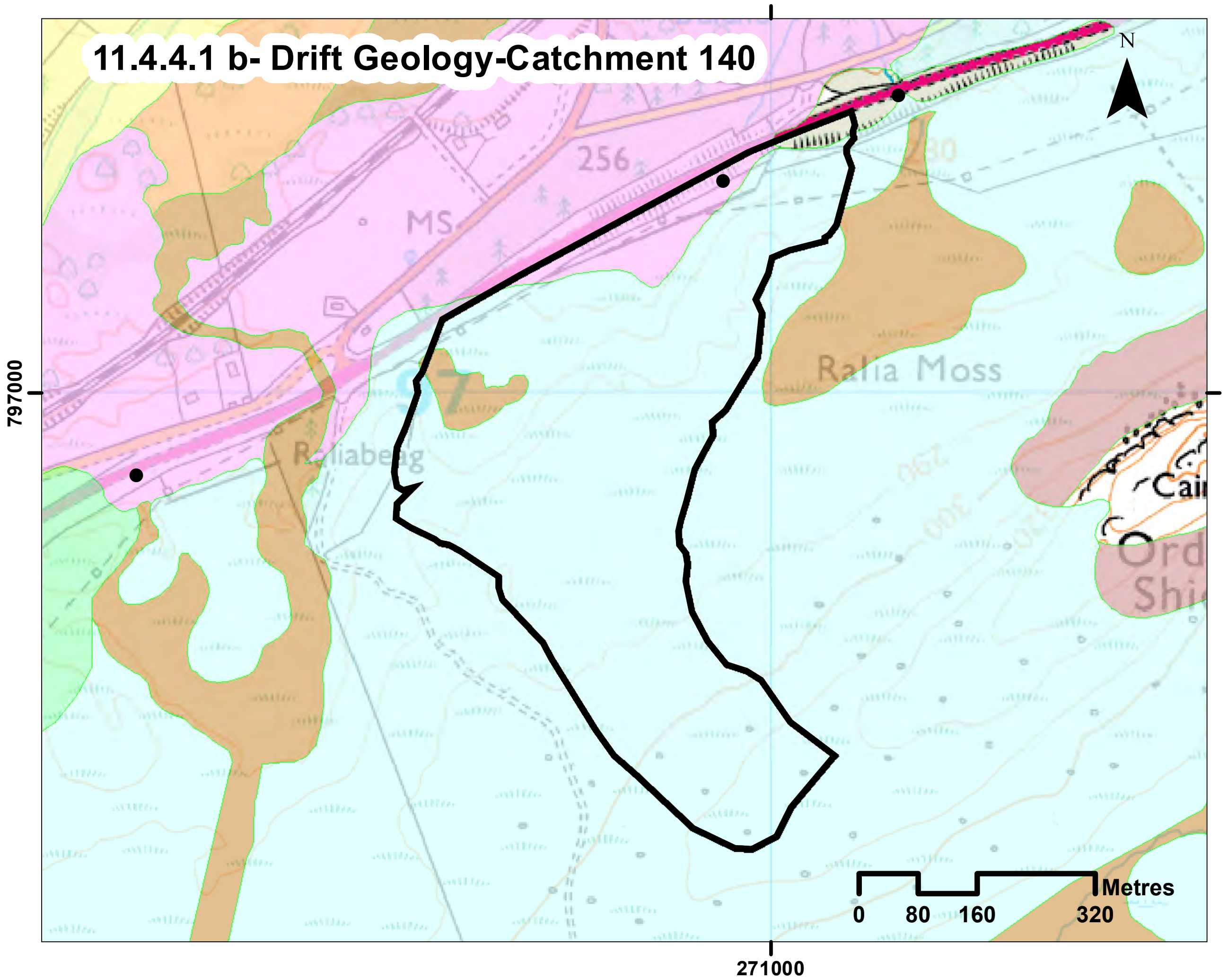
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach upstream of crossing** | Channel morphology | Low gradient passive meandering | Incorporated into cut drain |
| | Predominant sediment size | Fine/organic | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Low | Some forestry debris |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 140 | None | |
| | Impact of infrastructure | None | |
| | Channel realignment | Yes | Appears to be cut drain |

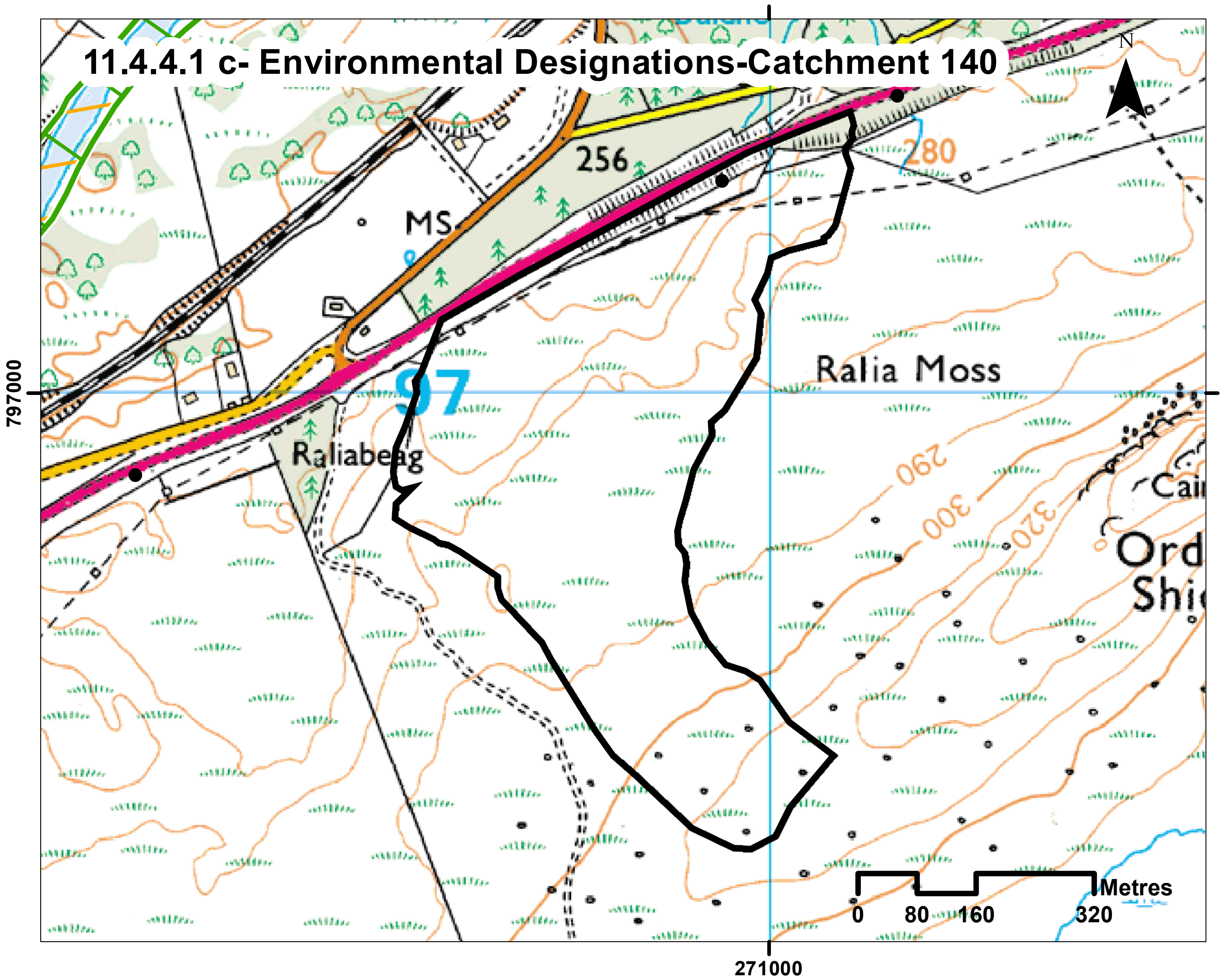
| | | | |
|---|---|---|---|
| **Morphology and Process-At crossing** | Channel morphology | Engineered | Pipe culvert |
| | Predominant sediment size | Fines, some small gravel | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Low | Some fine and small gravel deposition |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | No | |

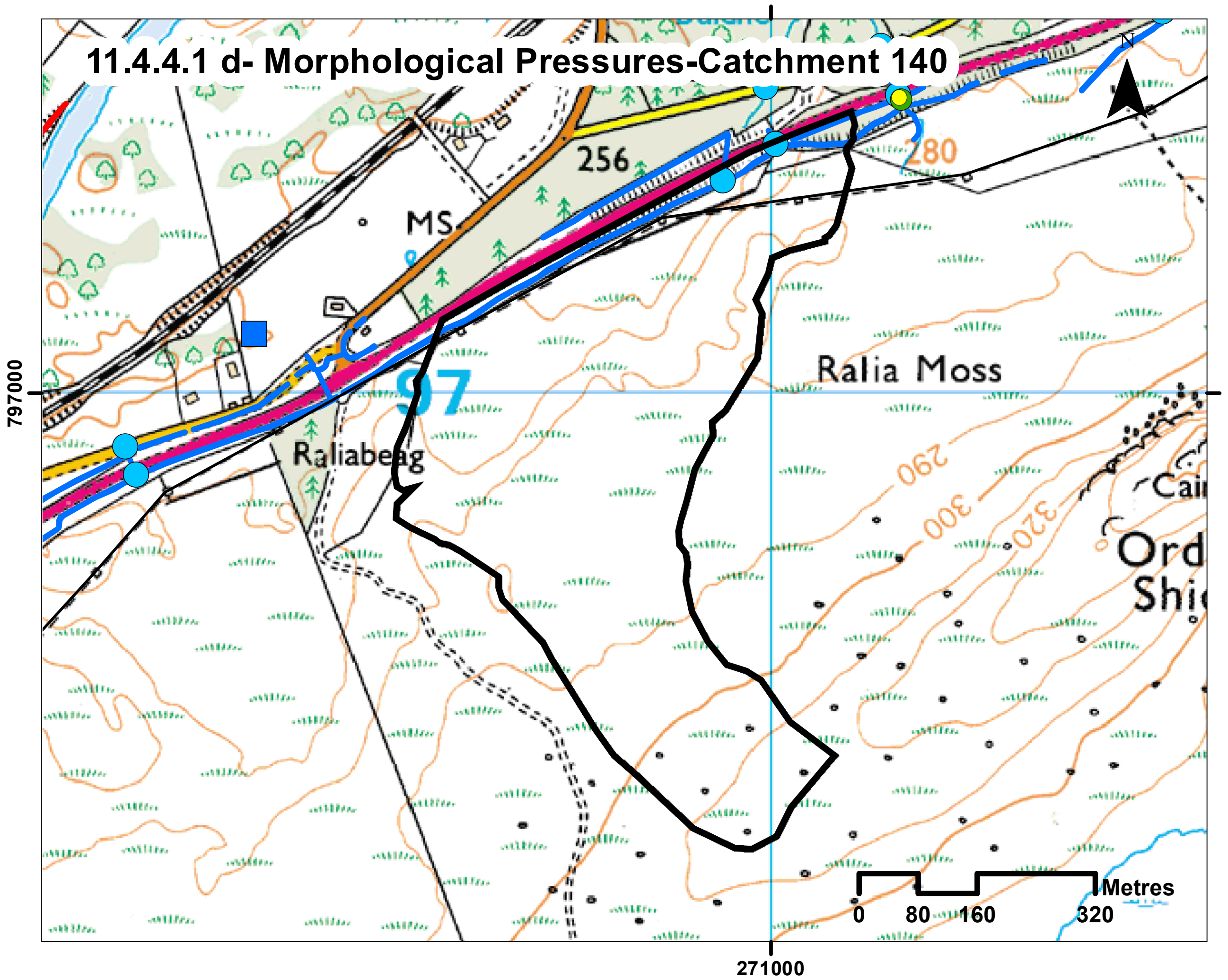
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach downstream of crossing** | Channel morphology | Engineered | Cut drain |
| | Predominant sediment size | Fines | |
| | Unvegetated bars | Yes | |
| | Vertical incision | None | |
| | Deposition | None | |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment | Minor Road | |
| | Impact of infrastructure | None | |
| | Channel realignment | Yes | Channel likely straightened |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

### General

- Crossing location

### Solid Geology

- Loch Laggan Psammite Formation - Psammite, Micaceous

### Drift Geology

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

### Environmental Designations

- Special Site of Scientific Interest
- Special Area of Conservation

### Morphological Pressures

- Culvert
- Cascade
- Catchpit
- Discharge Location
- Drainage Ditch
- Flood Embankment
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|

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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 140 Catchment Overview**

| DESIGN: EL | DRAWN: EV | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

| SHEET: 1 of 1 | REVISION: C01 | SUITABILITY: A3 |
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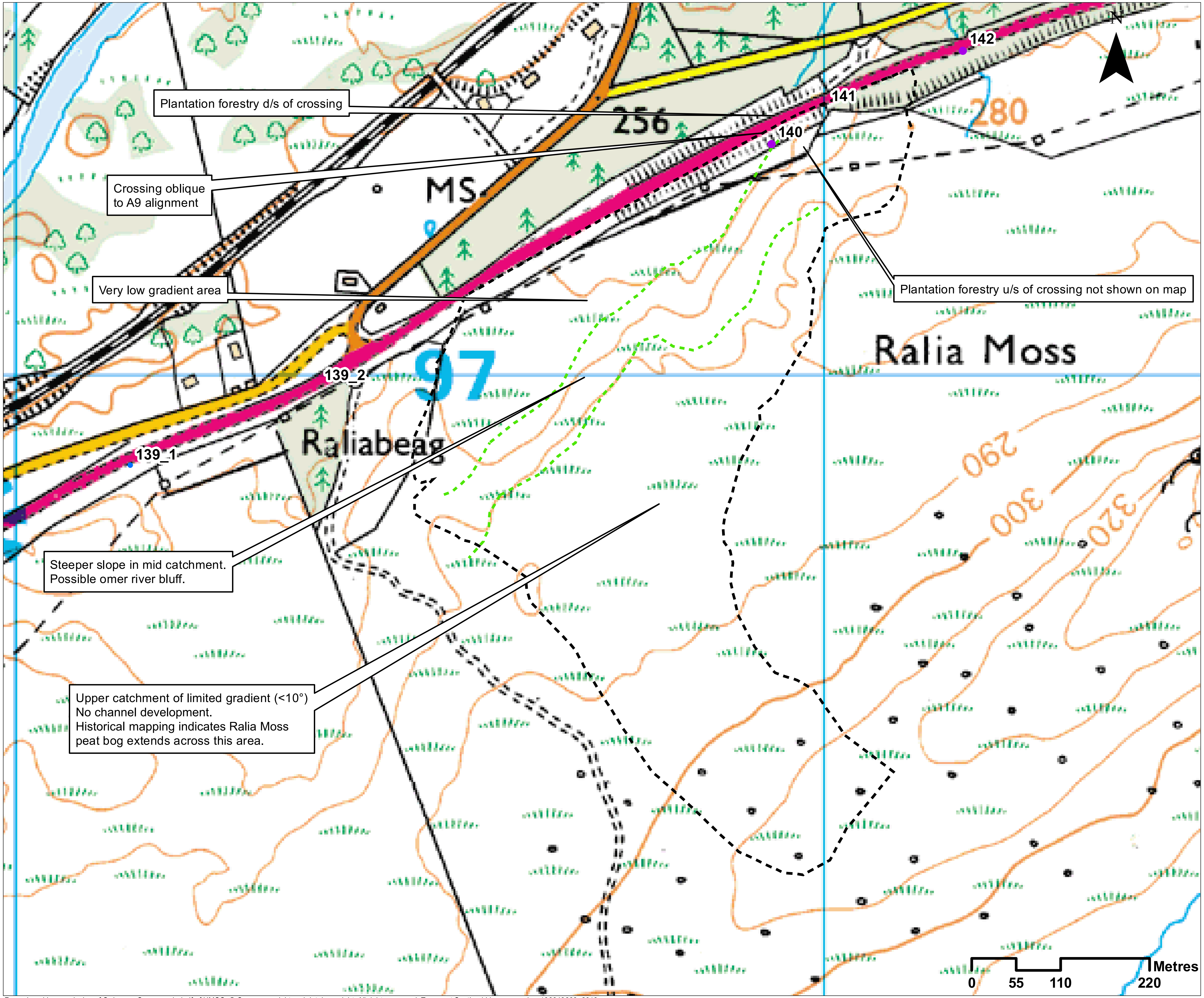


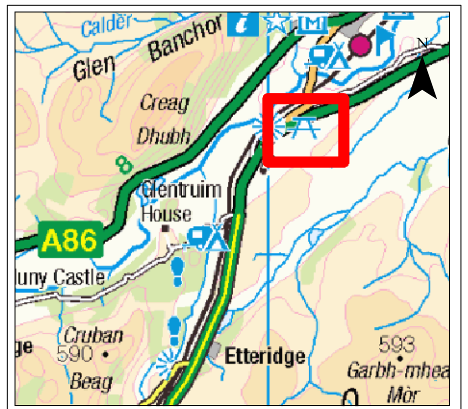


## Legend

- Minor crossing
- Other crossing
- Break in slope
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|

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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 140 Baseline Assessment**

| DESIGN: EL | DRAWN: AB | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 18/12/2017
PROJ: 495298
DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: 1 OF 1 | REVISION: C01 | SUITABILITY: A3 |
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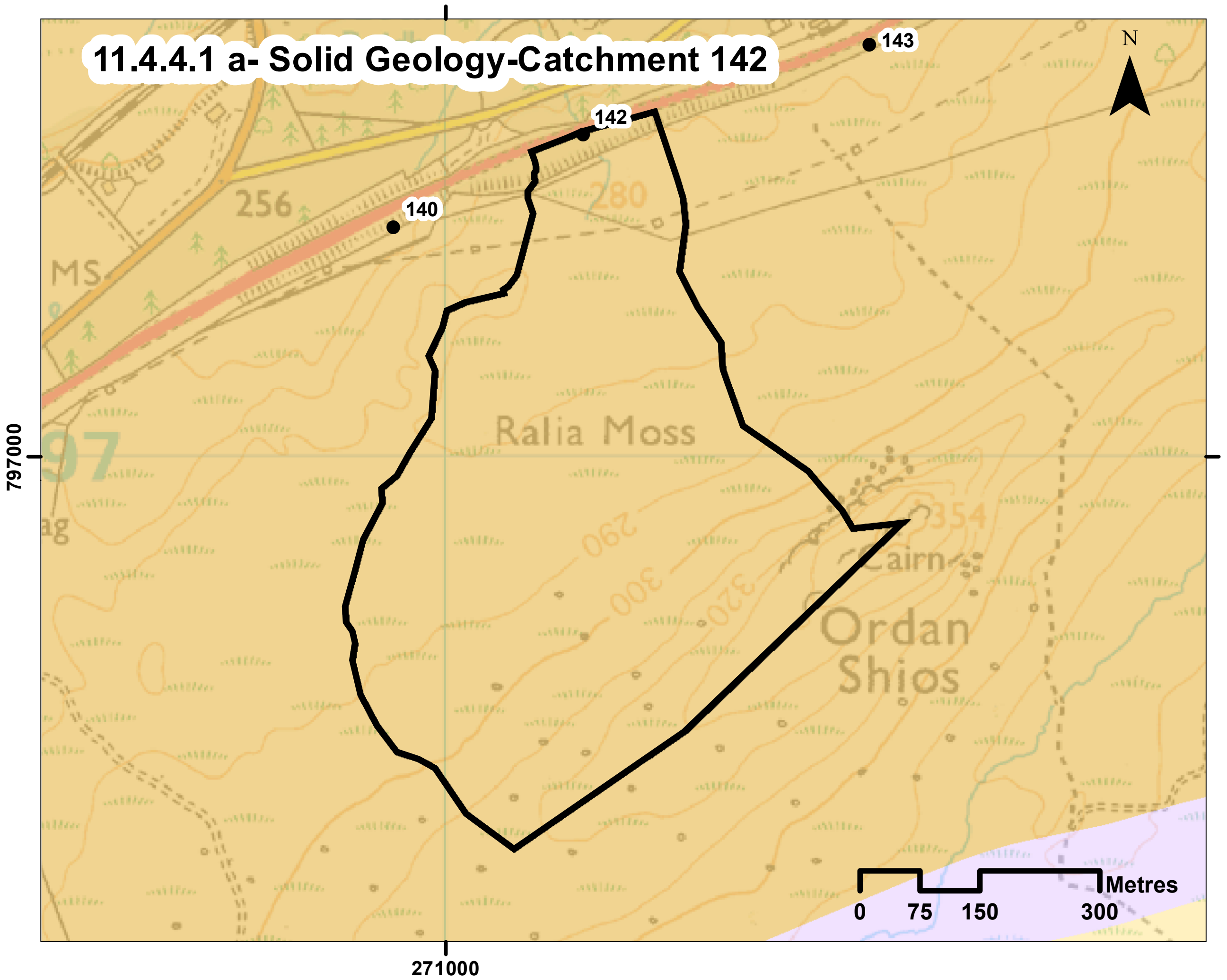
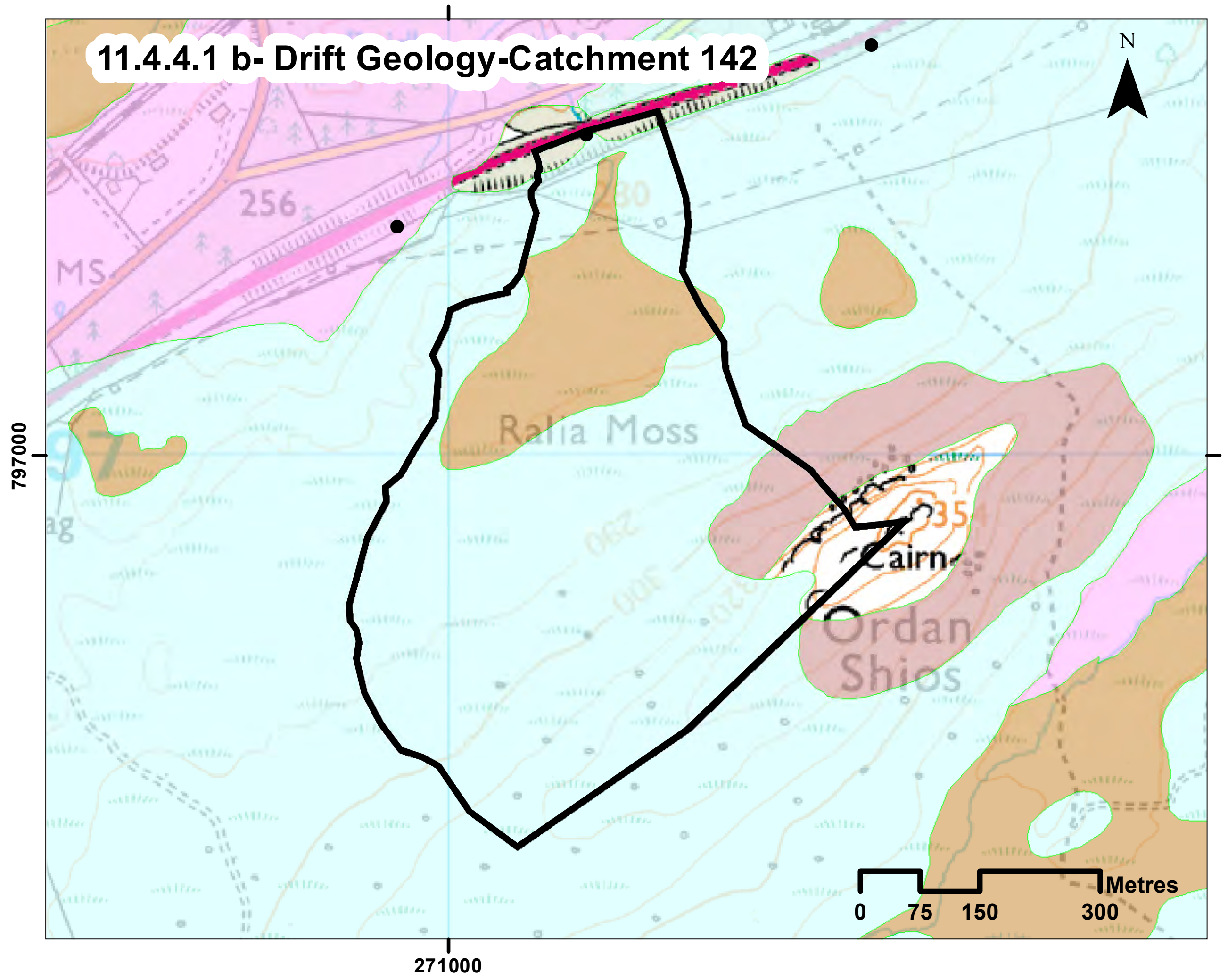
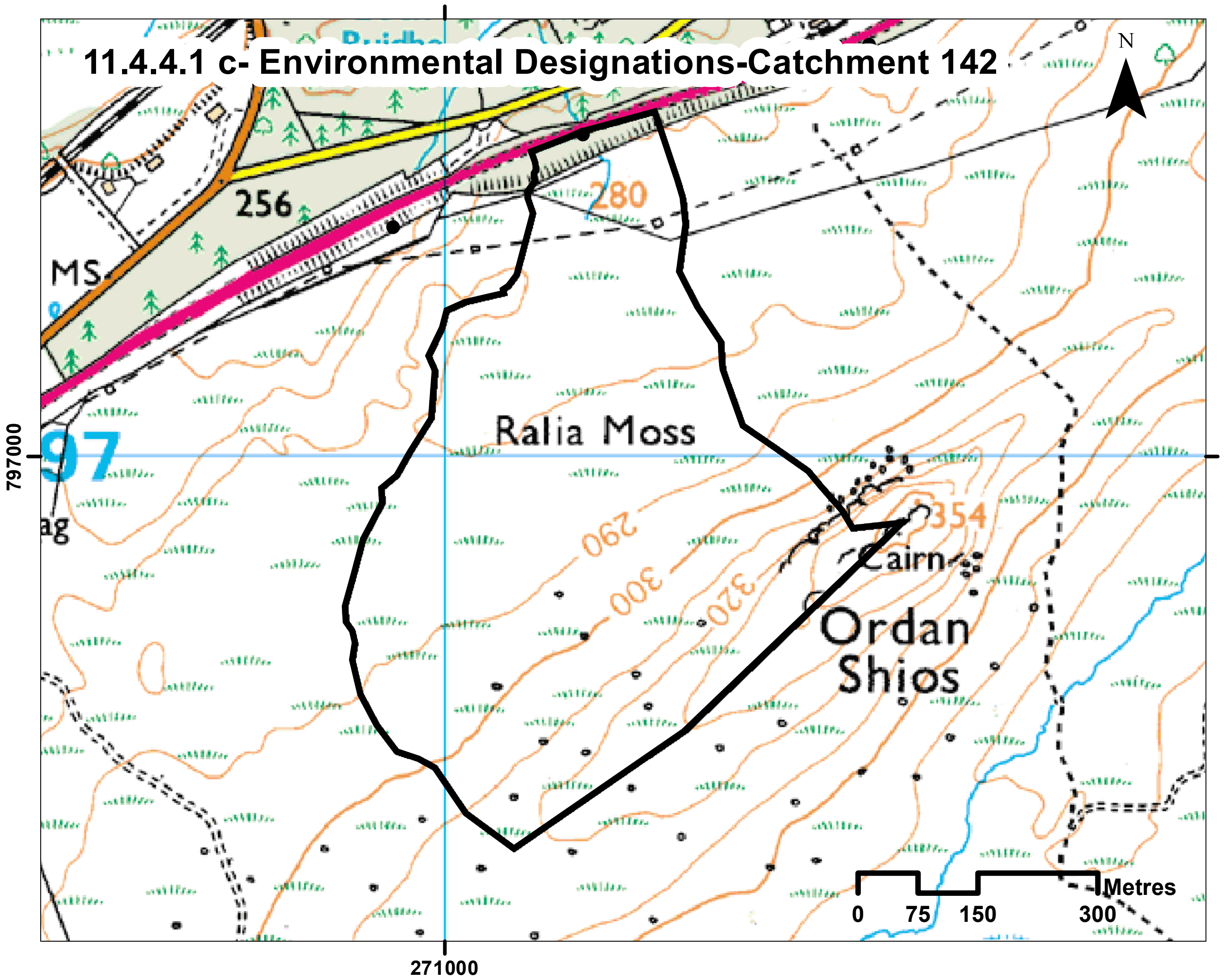
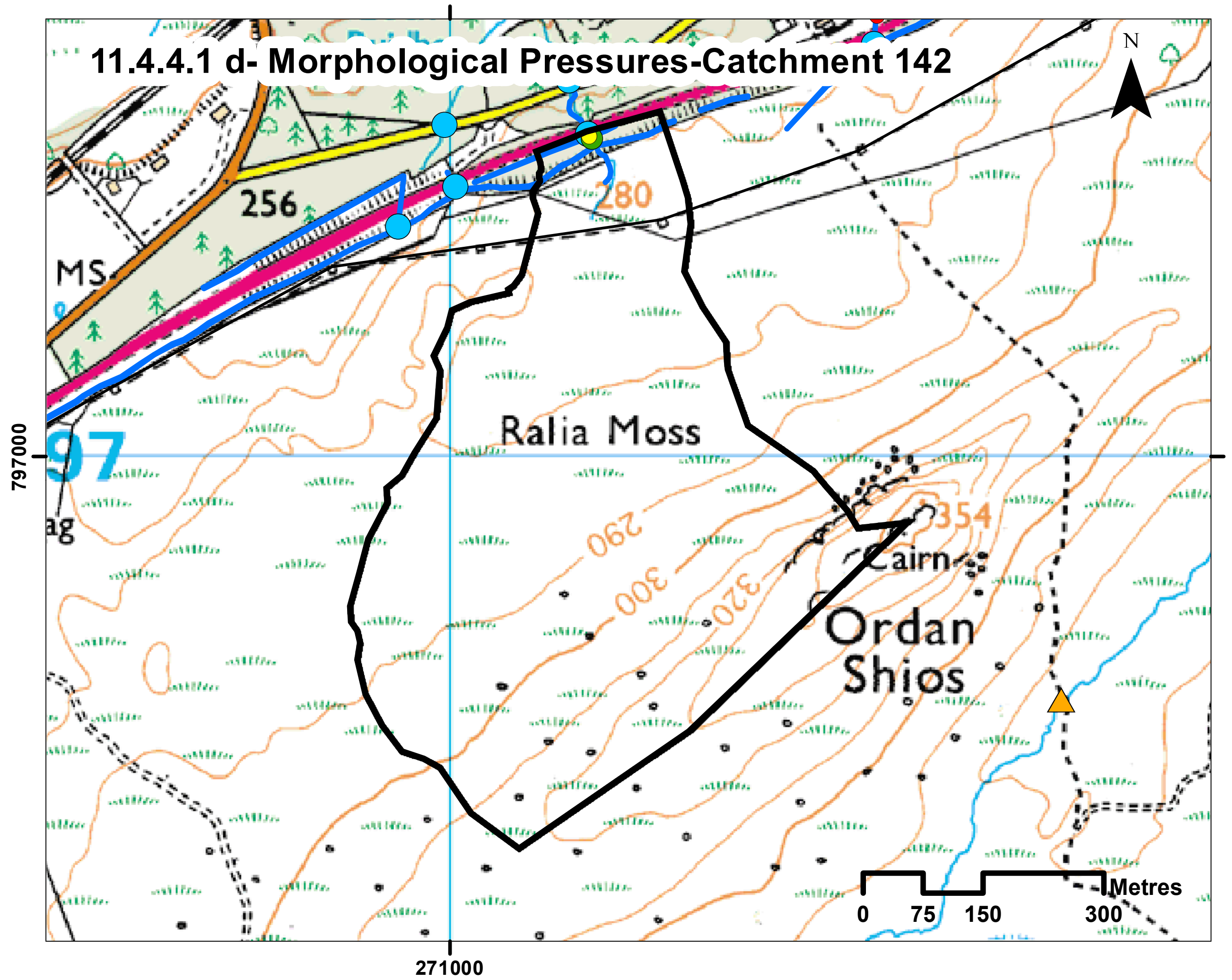
## Annex 11.4.4-Hydromorphological Catchment Assessment-142

| | | | |
|---|---|---|---|
| **Catchment No.** | 142 | | |
| **Catchment Name** | Caochan Rhiabach | | |
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Minor | |
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.3 | |
| | Average slope in catchment (°) | 5 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Good | |
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 142) | Loch Laggan Psammite formation- Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 142)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 142 | |
| | Is peat present in the catchment? | Yes | 'Ralia Moss' indicates peat in upper catchment and BGS 1:50k indicates peat present immediately u/s of road. |
| | Is there a bog burst risk? | Yes | Potentially, from Ralia Moss. Bogburst less likely from valley mire deposits in lower slopes. |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | NO | |
| | Wooded/forested areas in catchment | Yes | Coniferous plantation forestry on cutting slopes u/s of road |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 142) | Yes | ETL - 1 tower in catchment |
| | Comment on sediment source potential in catchment | Seems limite. Possibly some sediment generated from limited incision into cutting slope. | |
| | Comment on sediment supply potential to crossing | Limited from upper catchment (low gradients), possible sediment delivered to crossing from steeper cutting slope. | |
| **Morphology and Process- Reach upstream of crossing** | Channel morphology | Step-pool | Not an engineered cascade and very low volume |
| | Predominant sediment size | Gravel | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 142 | No | |
| | Impact of infrastructure | NO | |
| | Channel realignment | Yes | Vertical realignment |
| **Morphology and Process- At crossing** | Channel morphology | Engineered | Pipe culvert |
| | Predominant sediment size | Gravel | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Medium | Gravel deposition at culvert exit |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | None | |
| **Morphology and Process- Reach downstream of crossing** | Channel morphology | Step-pool | |
| | Predominant sediment size | Gravel (some anglar small cobbles) | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 142 | Yes | Minor road and possibly artificial lake |
| | Impact of infrastructure | No | |
| | Channel realignment | Yes | Possibly dammed to create artificial pond. |
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. | | |




## Legend

**General**

- Crossing location

**Solid Geology**

- Loch Laggan Psammite Formation - Psammite, Micaceous

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Morphological Pressures**

- Track/Footbridge
- Culvert
- Cascade
- Step in Bed
- Catchpit
- Drainage Ditch
- Power Lines

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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 142 Catchment Overview**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

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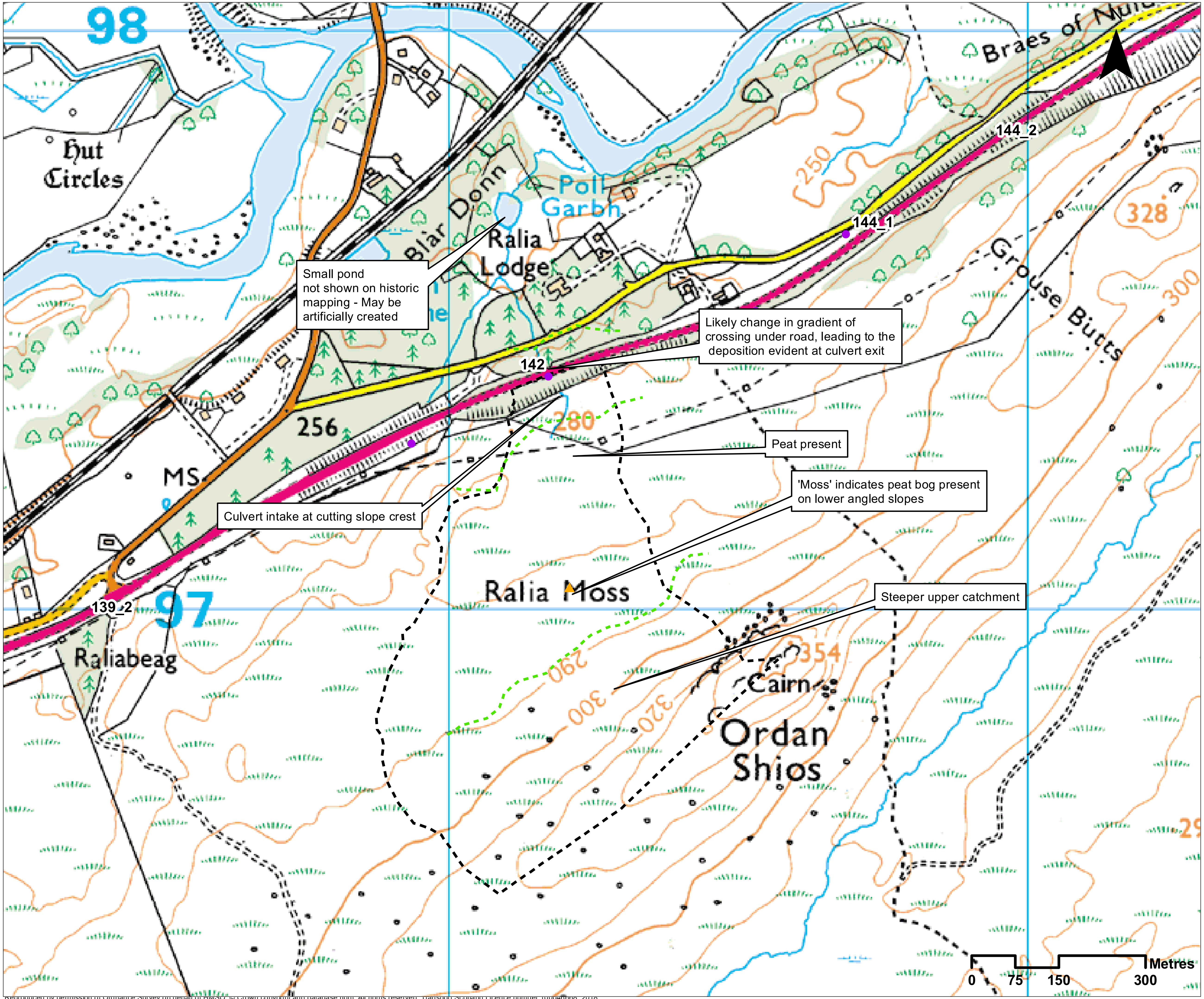




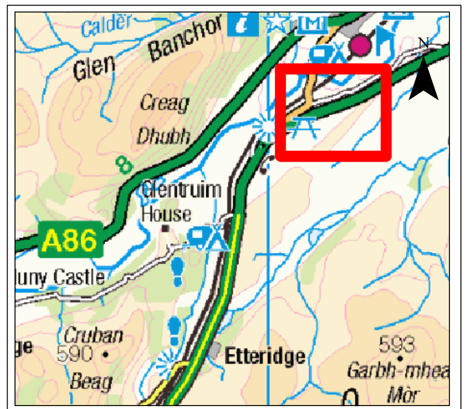


## Legend

- Minor crossing
- Peat slide
- Break in slope
- Crossing catchment

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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 142 Baseline Assessment**

| DESIGN: EL | DRAWN: AB | CHK: EL | APP: EL |
|---|---|---|---|

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| SHEET: 1 OF 1 | REVISION: C01 | SUITABILITY: A3 |
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## Annex 11.4.4-Hydromorphological Catchment Assessment-143

| | | | |
|---|---|---|---|
| **Catchment No.** | 143 | | |
| **Catchment Name** | - | | |

| | | | |
|---|---|---|---|
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Minor | |

| | | | |
|---|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.3 | |
| | Average slope in catchment (°) | 6 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |

| | | | |
|---|---|---|---|
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Good | |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 143) | Loch Laggan Psammite formation- Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 143)** | Ramsar | Yes | **River Spey - Insh Marshes** Breeding birds, wetlands, freshwater habitats, trophic range river/stream,Whooper Swan |
| | SAC | Yes | **Insh Marshes -** Alder woodland on floodplains, clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels, Otter, very we mires often identified by an unstable quaking surface<br><br>**River Spey** - Atlantic salmon, freshwater pearl mussel, otter, sea lamprey |
| | SPA | Yes | **River Spey - Insh Marshes** - Hen Harrier, Osprey breeding, Spotted Crake breeding, Whooper swan, Wigeon breeding, Wood Sandpiper |
| | SSSI | Yes | **River Spey - Insh Marshes -** Arctic charr, breeding bird assemblage, flood plain fen, invertebrate assemblage, mesotrophic loch, Osprey breeding, Otter, vascular plant assemblage, Whooper swan |

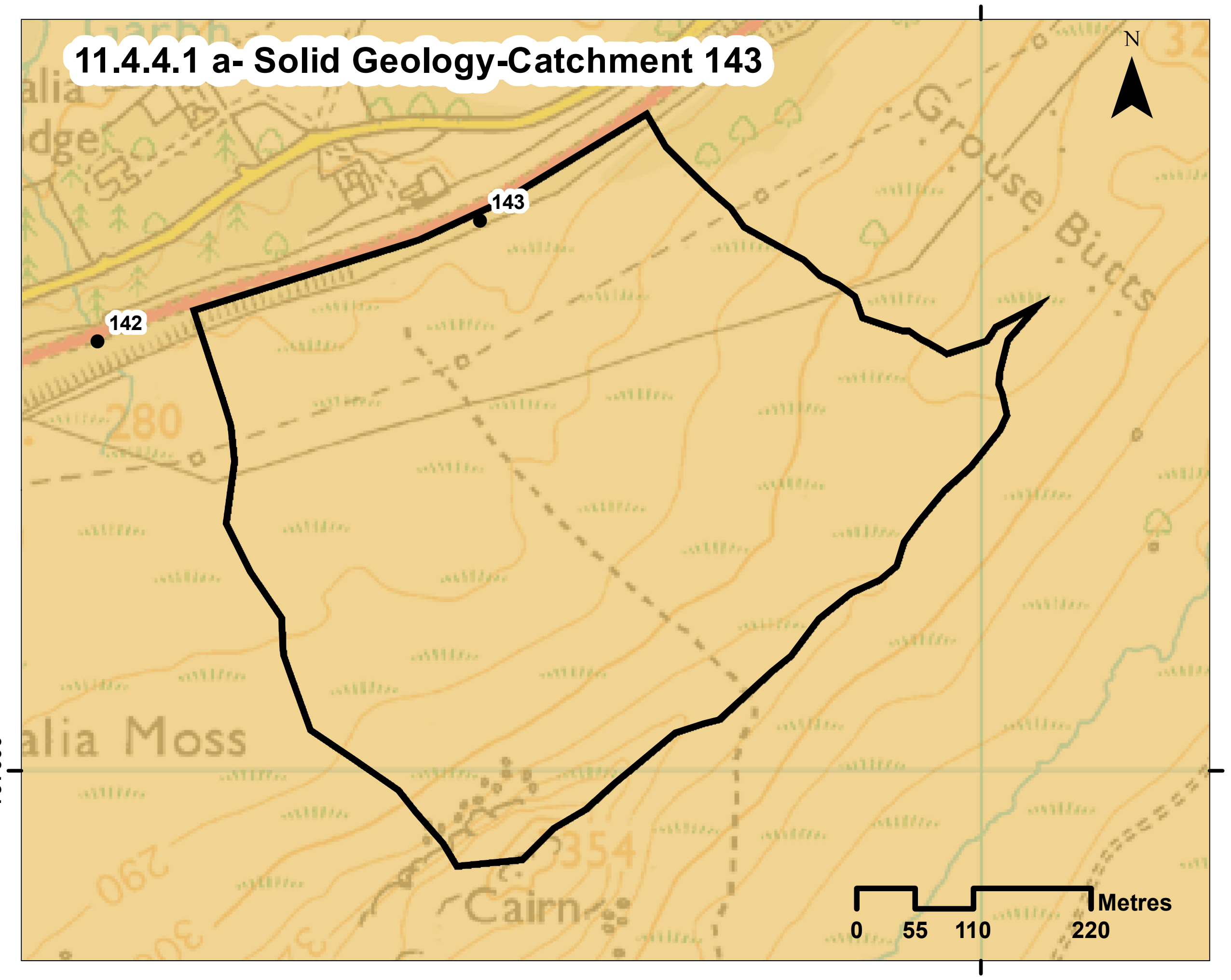
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 143 | |
| | Is peat present in the catchment? | Yes | Possible valleyside mires, patchy |
| | Is there a bog burst risk? | No | Highly unlikely |
| | Current valley side or terrace erosion | Yes | C.400m d/s of road channel is incised into bluff separating contemporary floodplain from terrace immediately downslope of the minor road which runs parallel to the A9 |
| | Potential valley side or terrace erosion | Yes | Increased energy in channel d/s of the road may cause further incision |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | Yes | Active incision c.400m d/s of road has caused geotechnical bank failures |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Linear deciduous woodland immediatley u/s and d/s of the A9 |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 143) | Yes | ETL |
| | Comment on sediment source potential in catchment | Appears limited, but evidence of gravel deposition at crossing, which is probably being generated from scour of the bed of the cross-slope drain (which is likely cut into till, which would provide the coarse sediment seen deposited at the crossing | |
| | Comment on sediment supply potential to crossing | High. Evidence for significant levels of coarase sedimetn being deposited at crossing, therefore energy u/s is high enough to erode and transport medium size gravel to this point. | |

| | | | |
|---|---|---|---|
| **Morphology and Process- Reach upstream of crossing** | Channel morphology | Engineered | Cut drain and small stepped cascade (although difficutlt to tell from photo whether cascade is in bedrock or constructed). |
| | Predominant sediment size | Gravel | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | Some incision likely taking place u/s of crossing |
| | Deposition | None | |
| | Lateral migration/bank erosion | None | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 143 | No | |
| | Impact of infrastructure | None | |
| | Channel realignment | NO | Not immediately u/s of crossing, but drain has captured another tributary c.190m u/s of crossing entrance. |

| | | | |
|---|---|---|---|
| **Morphology and Process- At crossing** | Channel morphology | Engineered | Pipe culvert |
| | Predominant sediment size | Gravel | None at u/s end, plenty at d/s end. |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Medium | Gravel deposition at d/s end of culvert |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | No | |

| | | | |
|---|---|---|---|
| **Morphology and Process- Reach downstream of crossing** | Channel morphology | Plane bed | |
| | Predominant sediment size | Gravel | |
| | Unvegetated bars | Yes | Very small gravel bar developing on inside of bend where channel exits minor road crossing c.150m d/s of A9 crossing |
| | Vertical incision | Medium | Some vertical incision c.400m d/s of crossing where channel starts to descend bluff between terrace and contemporary floodplain. |
| | Deposition | Medium | Gravel depositon on bed |
| | Lateral migration/bank erosion | Low | Limited migration evident (from destabilised protection) at sharp bend where stream channel turns to parallel minor road |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 143 | Yes | Minor road |
| | Impact of infrastructure | Yes | Channel currently makes sharp right turn to parallel minor road. |
| | Channel realignment | Yes | As well as everything mentioned above, channel has been straightened across terrace d/s of the minor road. |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |

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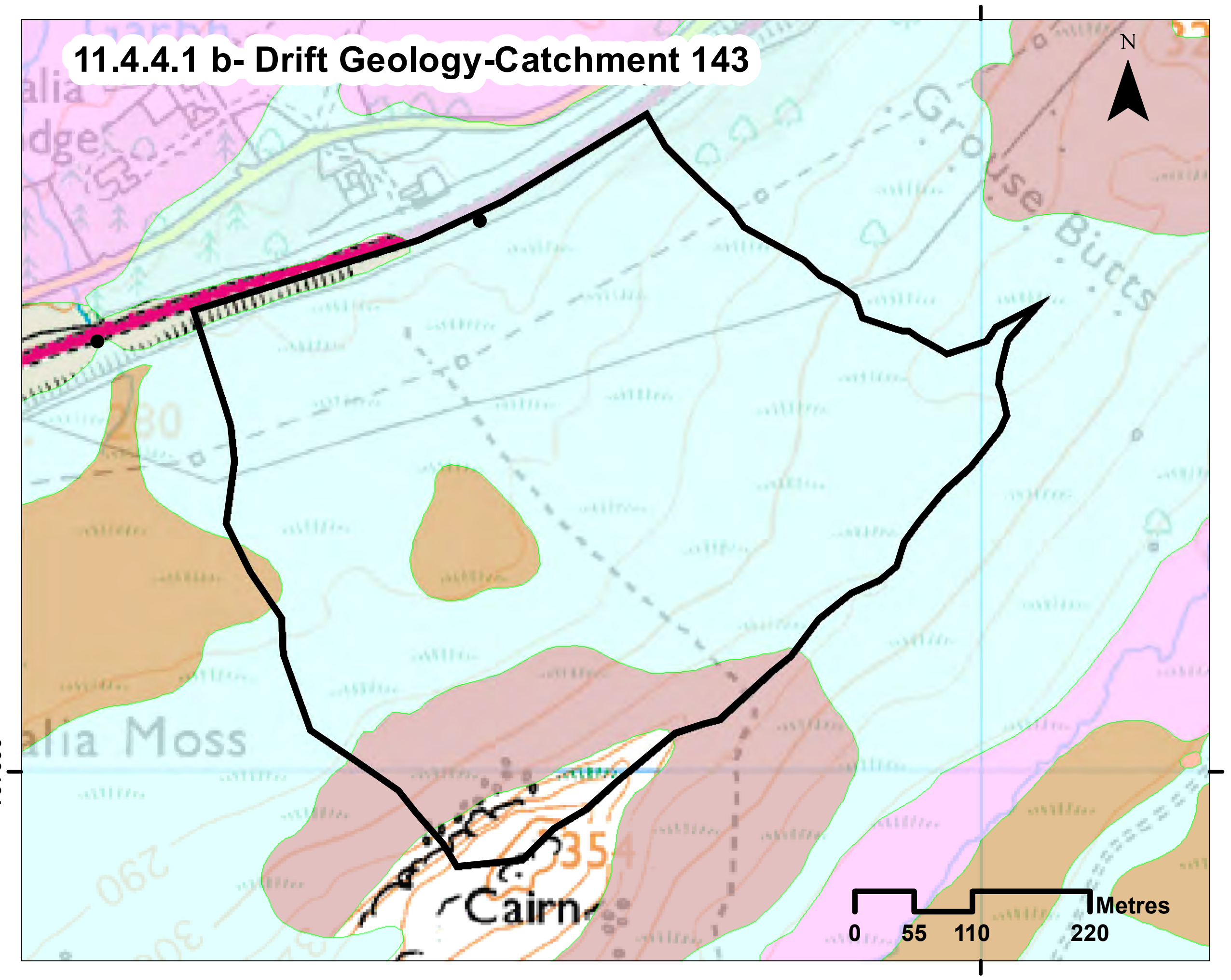


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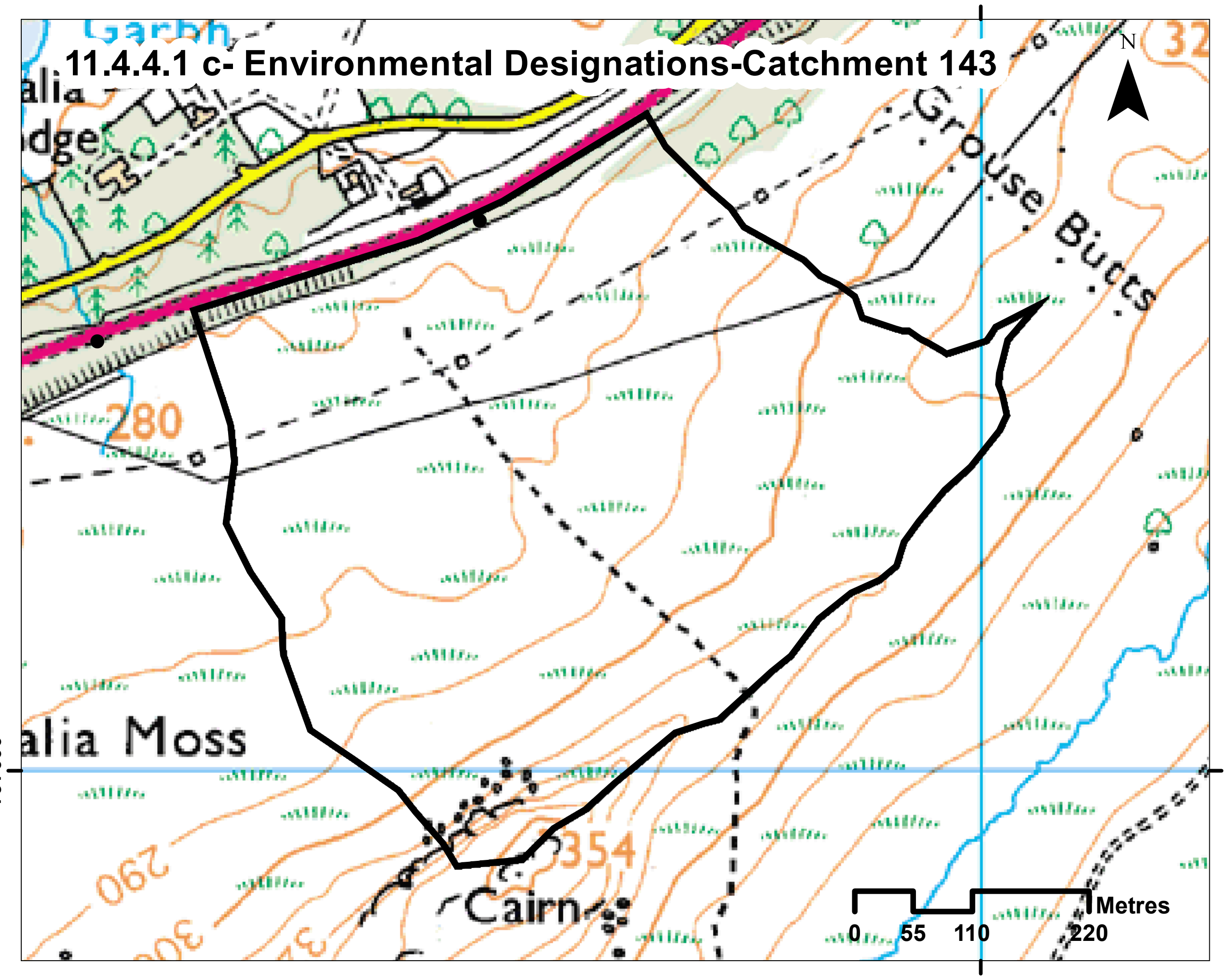


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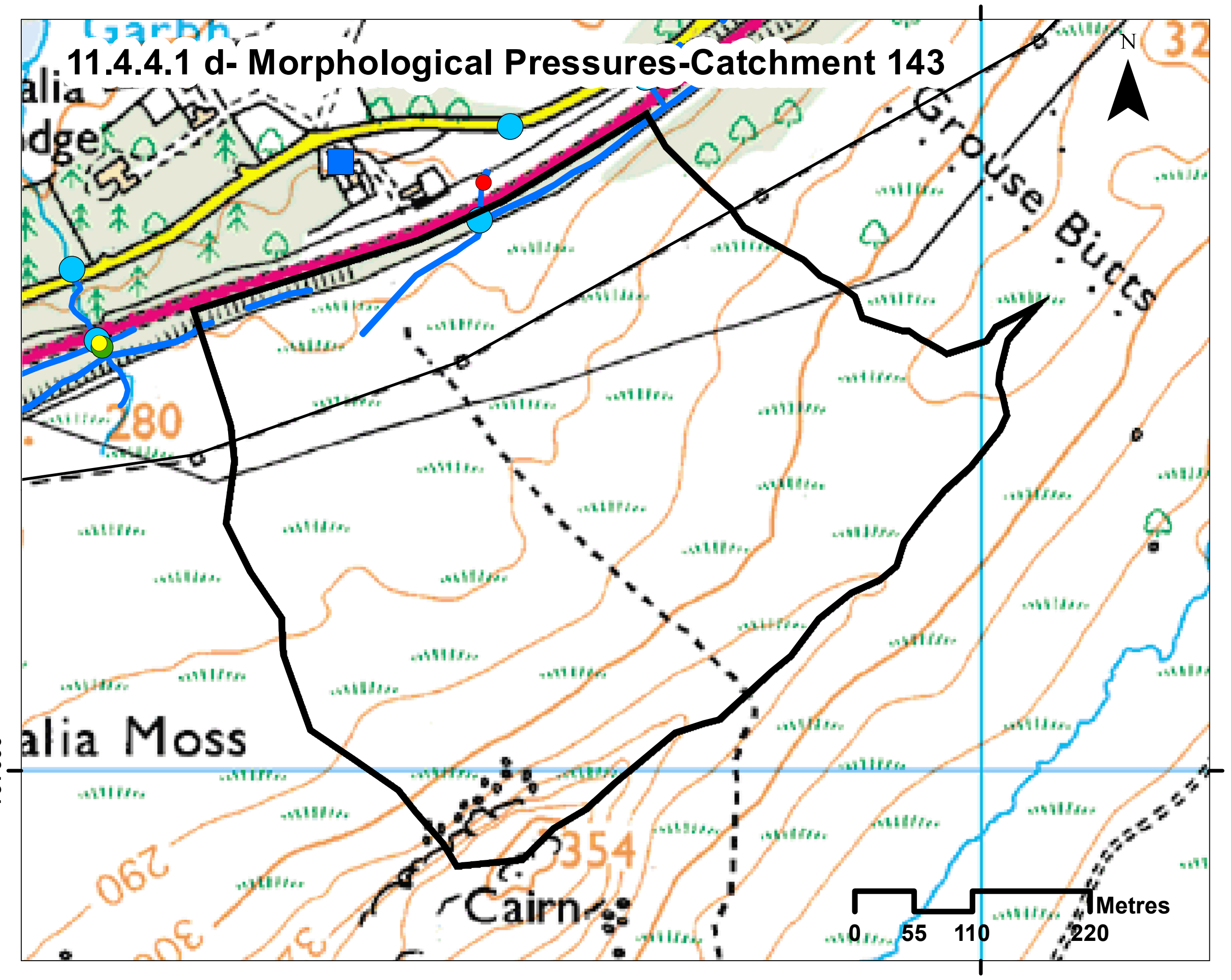


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272000

## Legend

**General**

- Crossing location

**Solid Geology**

- Loch Laggan Psammite Formation - Psammite, Micaceous

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Morphological Pressures**

- Culvert
- Cascade
- Step in Bed
- Catchpit
- Discharge Location
- Drainage Ditch
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 143 Catchment Overview**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

DATE: 20/12/2017

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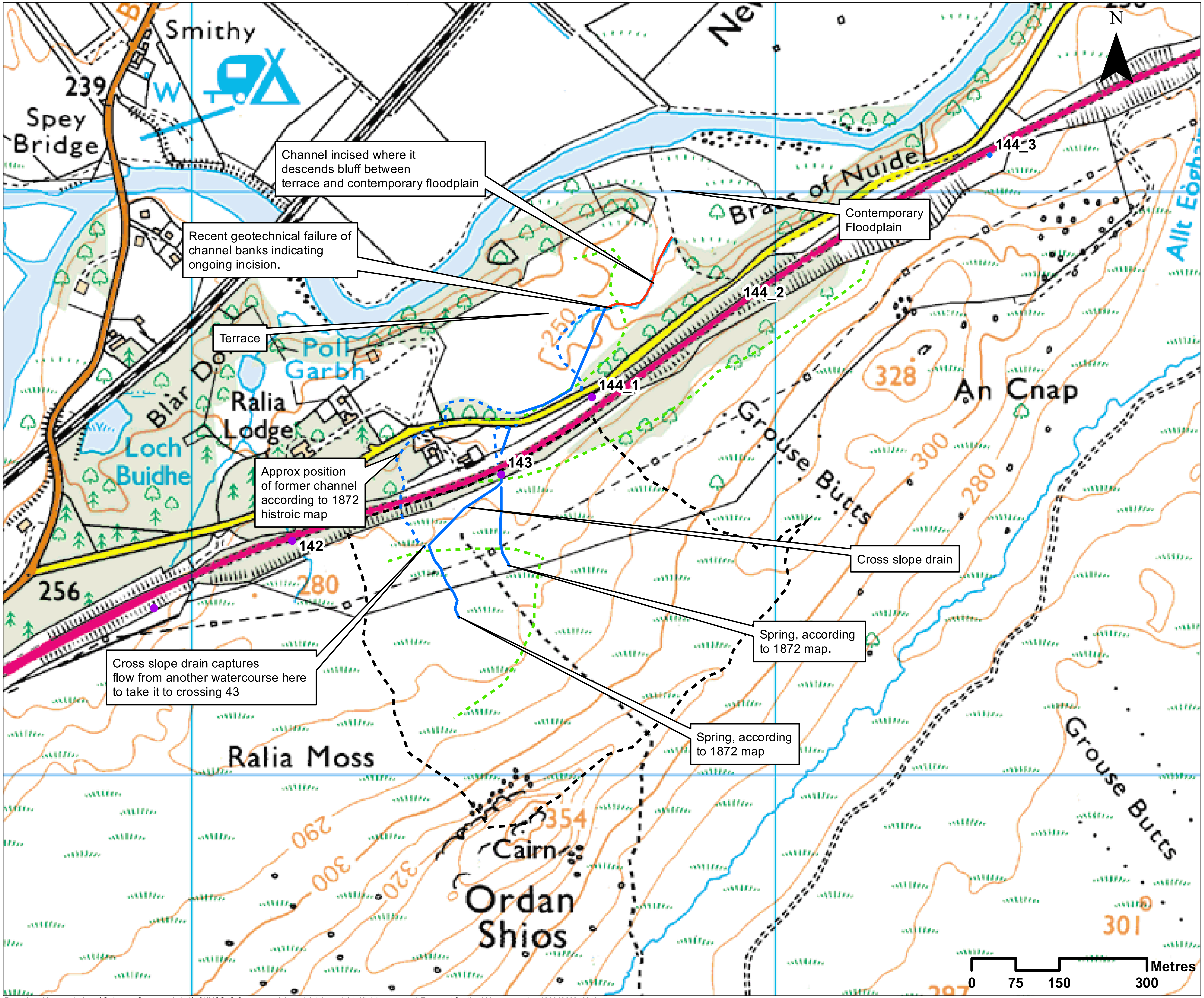


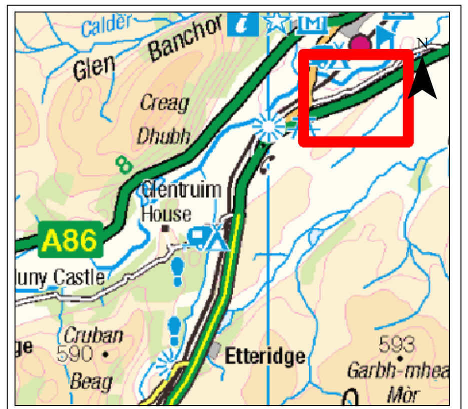


## Legend

- Minor crossing
- Other crossing
- Break in slope
- Contemporary channel
- Original channel
- Incision
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 143 Baseline Assessment**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | AB | EL | EL |

DATE: 18/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

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## Annex 11.4.4-Hydromorphological Catchment Assessment-144_1

| | |
|---|---|
| **Catchment No.** | 144_1 |
| **Catchment Name** | - |

| | | | |
|---|---|---|---|
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Minor | |

| | | | |
|---|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 0.2 | |
| | Average slope in catchment (°) | 9 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |

| | | | |
|---|---|---|---|
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Good | |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 144_1) | Loch Laggan Psammite formation- Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 144_1)** | Ramsar | No | |
| | SAC | No | |
| | SPA | No | |
| | SSSI | No | |

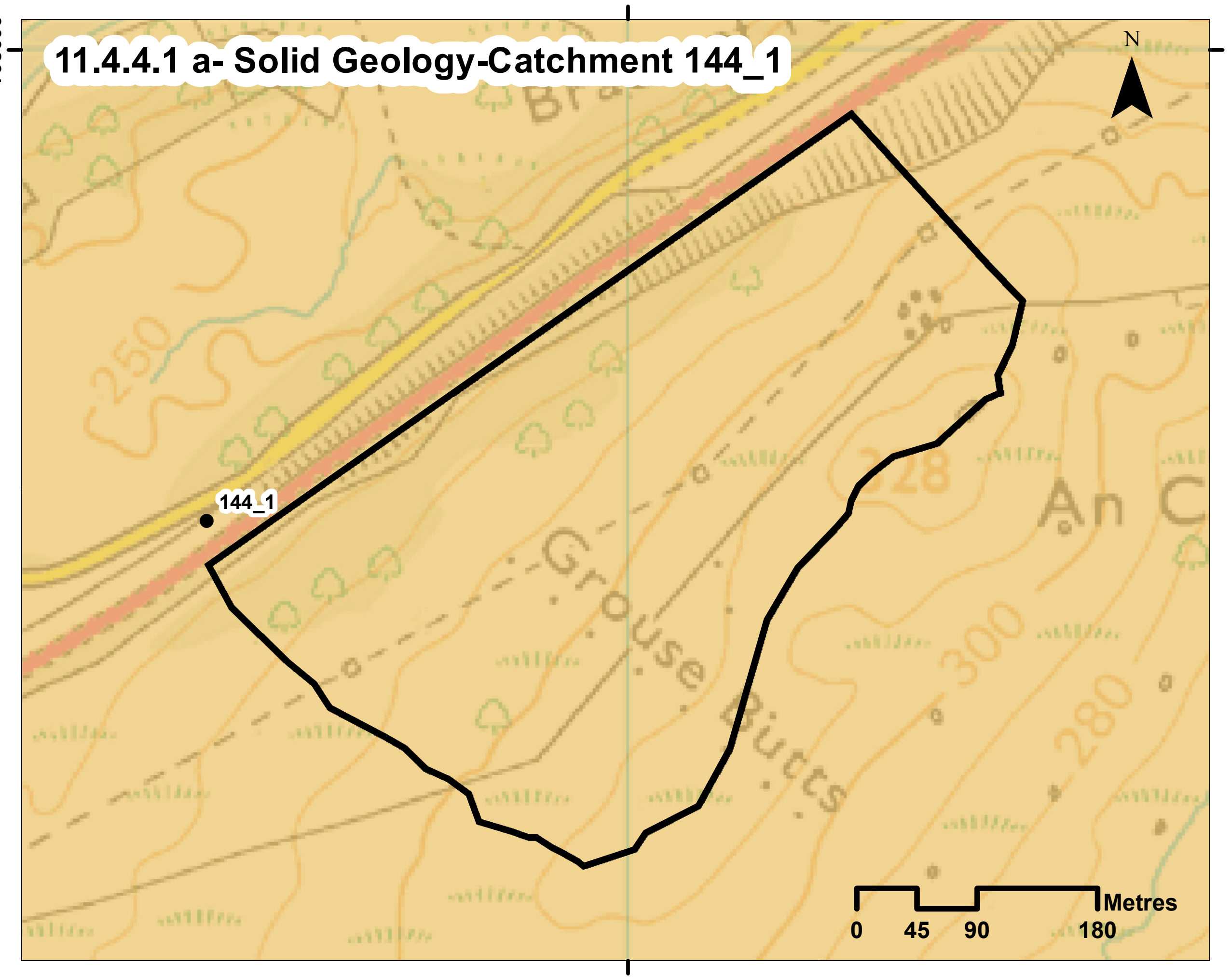
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 144_1 | |
| | Is peat present in the catchment? | No | |
| | Is there a bog burst risk? | No | |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | No | |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | No | |
| | Bank erosion/lateral migration | No | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Linear deciduous plantation on cutting slope |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 144_1) | Yes | ETL and towers |
| | Comment on sediment source potential in catchment | Seems limited - well vegetated catchment | |
| | Comment on sediment supply potential to crossing | Limited sources so unlikely to receive much sediment but any generated has a relatively high chance of reaching the crossing due to relatively steep channel gradients | |

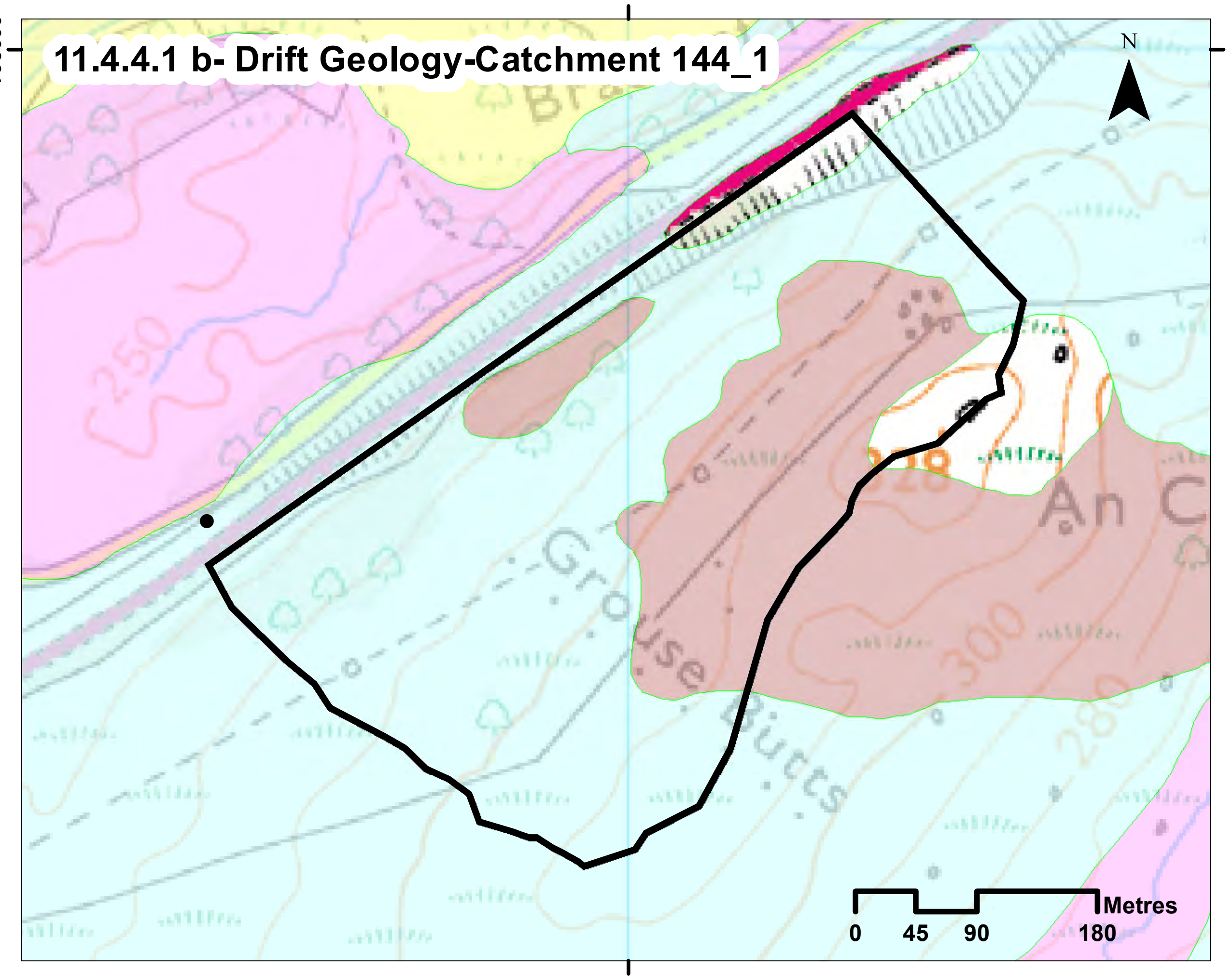
| | | | |
|---|---|---|---|
| **Morphology and Process- Reach upstream of crossing** | Channel morphology | Engineered | Channel is in a drain sub-parallel to road which descends the cutting to a chamber into which flow drops vertically to a culvert below road level |
| | Predominant sediment size | - | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 144_1 | No | |
| | Impact of infrastructure | No | |
| | Channel realignment | Yes | No map evidence but channel appears to be taken into a sub-parallel drain to descend cutting to near road level. |

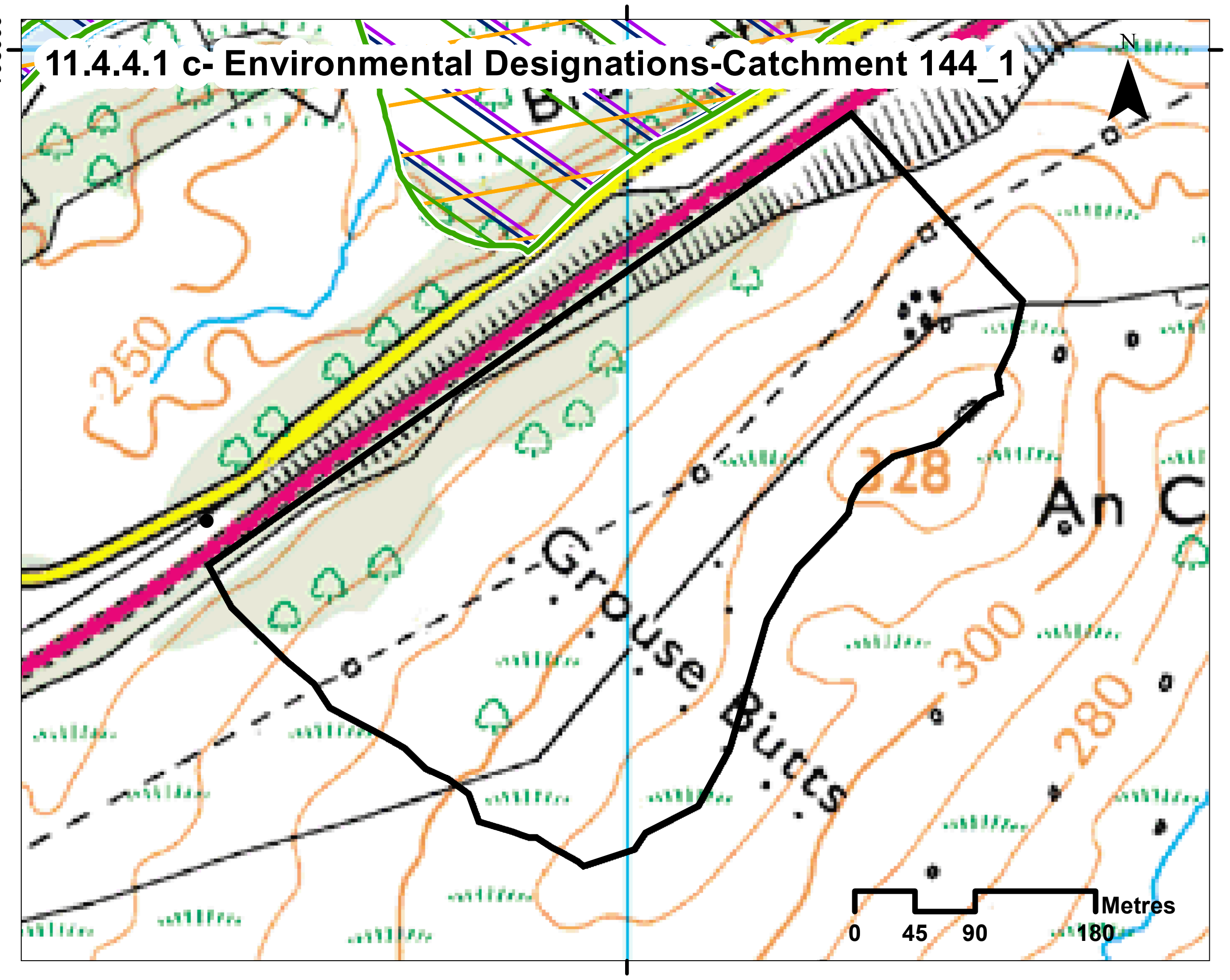
| | | | |
|---|---|---|---|
| **Morphology and Process- At crossing** | Channel morphology | Engineered | Corrugated steel pipe culvert |
| | Predominant sediment size | - | |
| | Unvegetated bars | No | |
| | Vertical incision | None | |
| | Deposition | Low | Some fine accumulation and vegetation (mosses) taking hold |
| | Lateral migration/bank erosion | None | |
| | Damaged/unstable drains or armouring | None | |

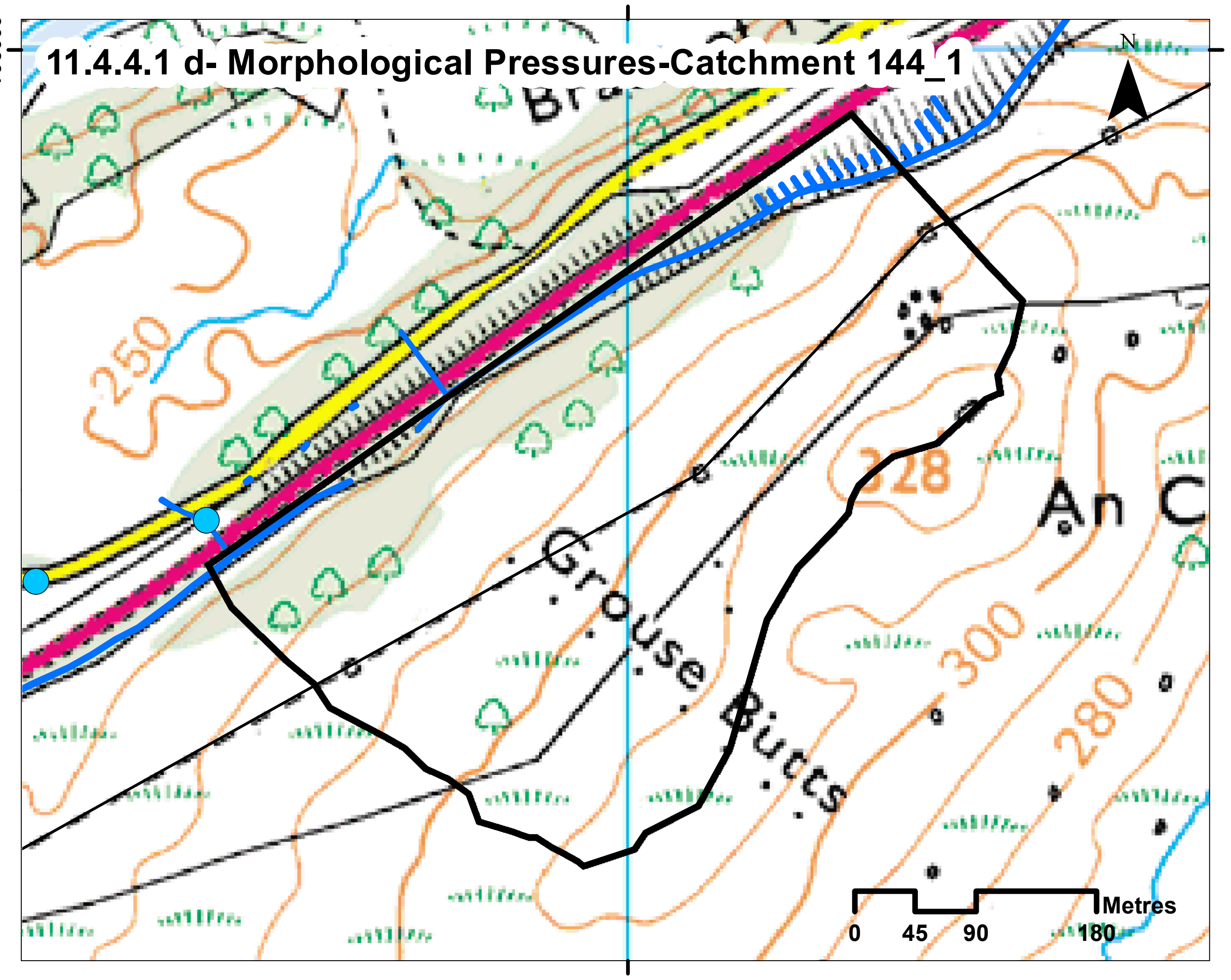
| | | | |
|---|---|---|---|
| **Morphology and Process- Reach downstream of crossing** | Channel morphology | Cascade | |
| | Predominant sediment size | Cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 144_1 | Yes | Fence across channel appears to be holding back coarse sediment and creating a step. Minor road d/s of A9 - channel passes through culvert before joining crossing 143 channel almost immediately downstream. |
| | Impact of infrastructure | Yes | Fence across channel appears to be holding back coarse sediment and creating a step. Minor road may constrain options for realignment |
| | Channel realignment | No | None apparent other than that indicated d/s of confluence with crossing 143 channel |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

**General**

- Crossing location

**Solid Geology**

- Loch Laggan Psammite Formation - Psammite, Micaceous

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Ramsar
- Special Site of Scientific Interest
- Special Area of Conservation
- Special Protection Area

**Morphological Pressures**

- Culvert
- Drainage Ditch
- Power Lines

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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 144_1 Catchment Overview**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | EV | EL | EL |

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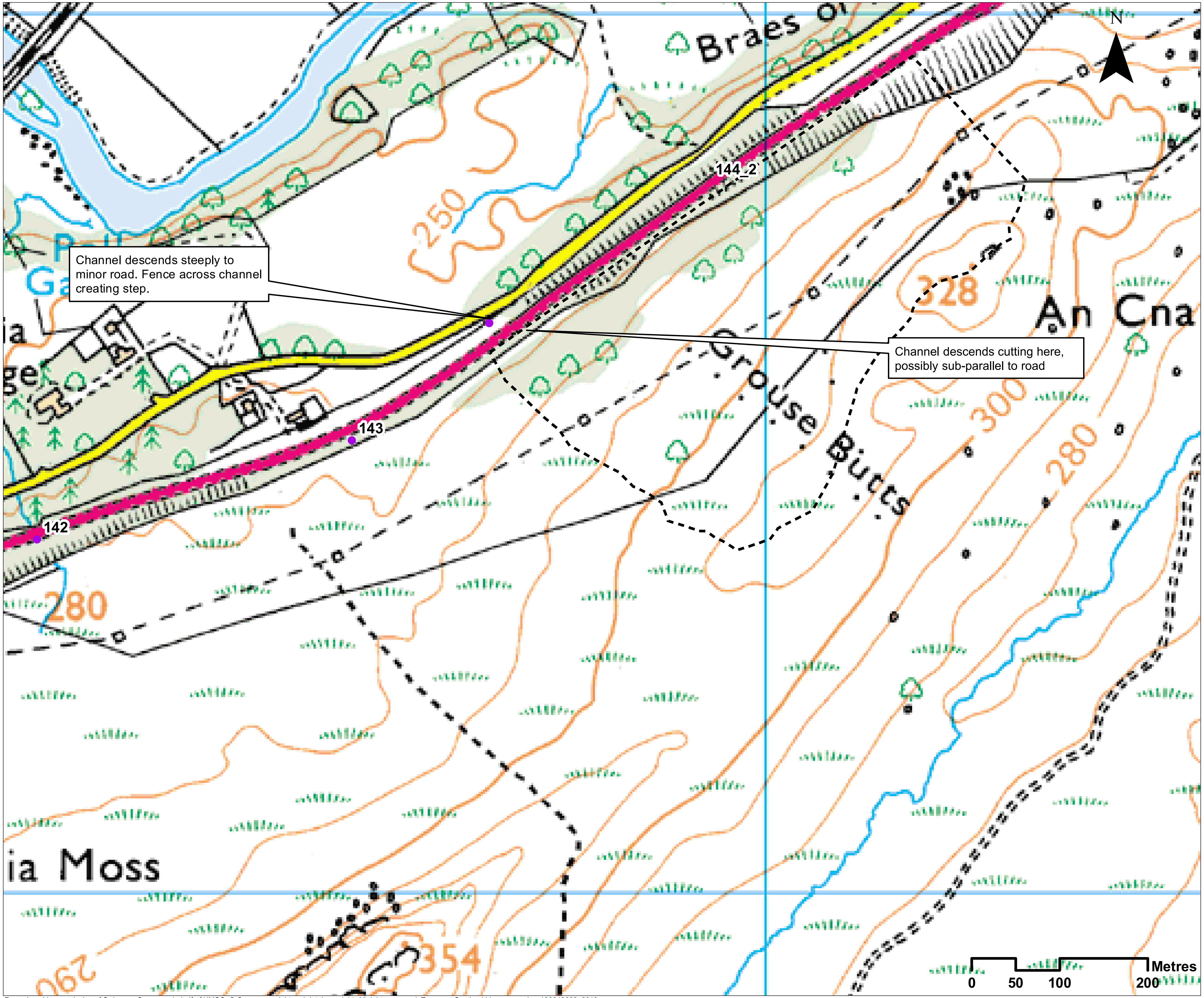


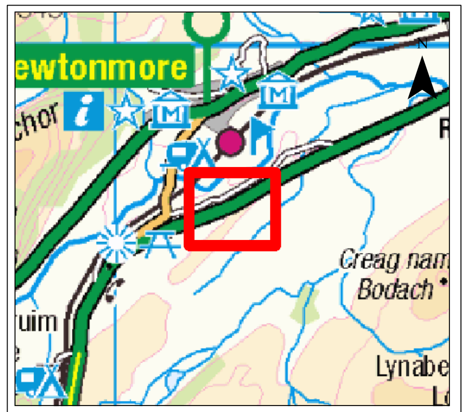


## Legend

- Minor crossing
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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TRANSPORT SCOTLAND | A9 DUALLING PERTH TO INVERNESS

**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 144_1 Baseline Assessment**

| DESIGN: | DRAWN: | CHK: | APP: |
|---|---|---|---|
| EL | AB | EL | EL |

DATE: 19/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0010

| SHEET: | REVISION: | SUITABILITY: |
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## Annex 11.4.4-Hydromorphological Catchment Assessment-145_1

| | |
|---|---|
| **Catchment No.** | 145_1 |
| **Catchment Name** | Allt Eoghainn |

| | | | |
|---|---|---|---|
| **Channel Nature** | Nature of water course | Natural | |
| | Size of water course | Major | |

| | | | |
|---|---|---|---|
| **Quantitative Spatial Elements** | Catchment Area ($km^2$) | 2.1 | |
| | Average slope in catchment (°) | 5 | |
| | % Catchment over 750m (for snow melt risk) | 0 | |

| | | | |
|---|---|---|---|
| **WFD classification** | Water, flows and levels | Good | |
| | Physical condition | Good | |
| | Overall ecological status | Good | |

| | | | |
|---|---|---|---|
| **Geology** | Majority Bedrock (see Drawing 11.4.4.1 a and b Catchment 145_1) | Loch Laggan Psammite formation-Psammite, Micaeous | resistant to weathering, impermeable |
| | Is an alluvial fan present at or near the crossing? | No | |

| | | | |
|---|---|---|---|
| **Environmental designations (see Drawing 11.4.4.1 c, Catchment 145_1)** | Ramsar | Yes | **River Spey - Insh Marshes** Breeding birds, wetlands, freshwater habitats, trophic range river/stream,Whooper Swan |
| | SAC | Yes | **Insh Marshes** Alder woodland on floodplains, clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels, Otter, very we mires often identified by an unstable quaking surface **River Spey** Atlantic salmon, freshwater pearl mussel, otter, sea lamprey |
| | SPA | Yes | **River Spey - Insh Marshes** Hen Harrier, Osprey breeding, Spotted Crake breeding, Whooper swan, Wigeon breeding, Wood Sandpiper |
| | SSSI | Yes | **River Spey - Insh Marshes** Arctic charr, breeding bird assemblage, flood plain fen, invertebrate assemblage, mesotrophic loch, Osprey breeding, Otter, vascular plant assemblage, Whooper swan |

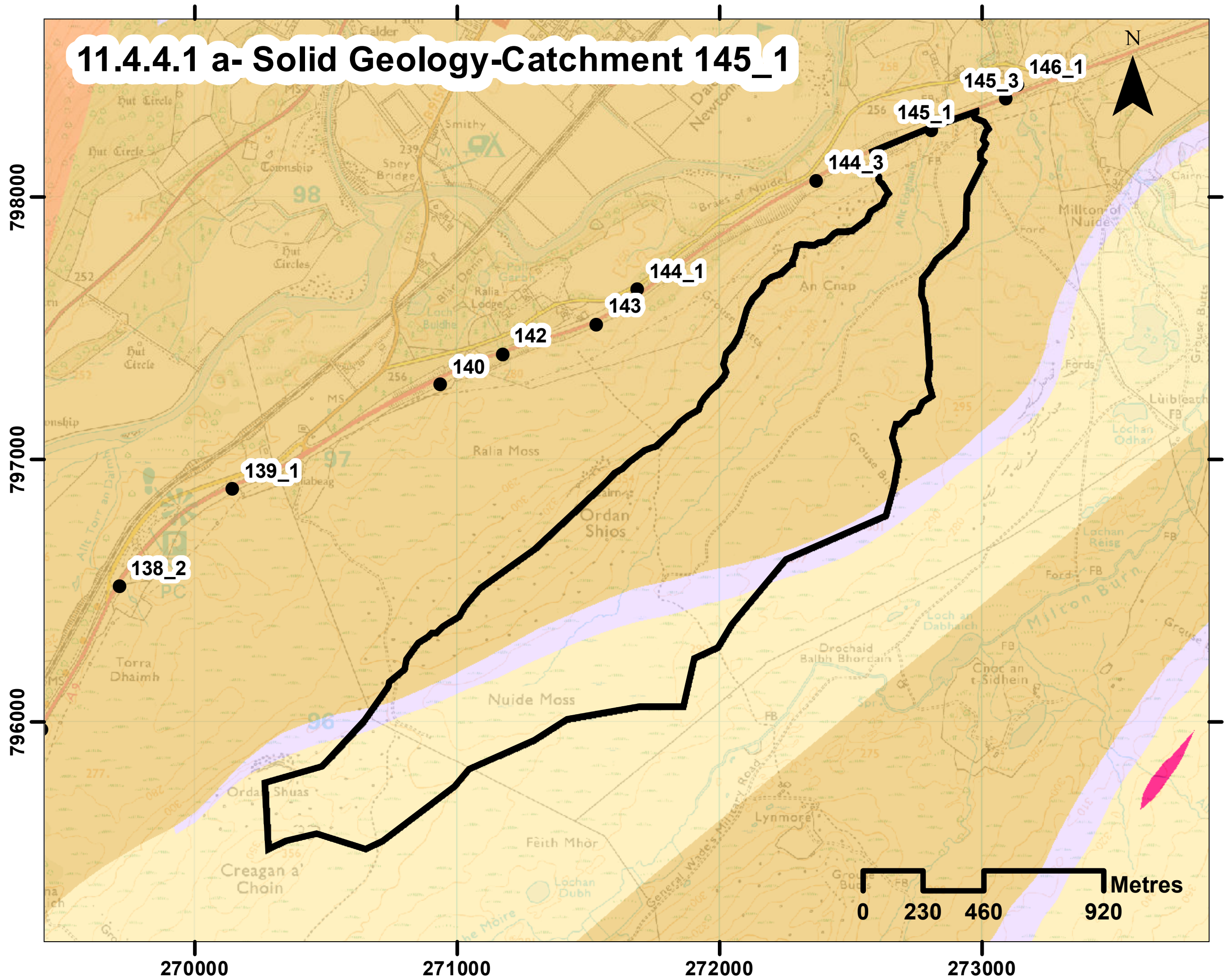
| | | | |
|---|---|---|---|
| **Sediment source and supply - Catchment Scale** | Changes in slope and channel confinement | See Drawing 11.4.4.2, Catchment 145_1 | |
| | Is peat present in the catchment? | Yes | Relatively extensive peat deposits (Nuide Moss) in upper catchment. |
| | Is there a bog burst risk? | Yes | Possible. Peat deposit has been cut extensively for drainage and stability worth investigating further. |
| | Current valley side or terrace erosion | No | |
| | Potential valley side or terrace erosion | No | |
| | Hill slope failures (including peat slides and debris flows and slides) | Yes | Uppermost part of catchment. Mapped in Google Earth |
| | Hill slope failures coupled to channel | No | |
| | Vertical incision present in catchment | Yes | Some vertical incision in open valley noted in lower reaches of channel. |
| | Bank erosion/lateral migration | NO | |
| | Unvegetated bars | No | |
| | Wooded/forested areas in catchment | Yes | Small wooded section immediately u/s of crossing. Deciduous woodland d/s of road |
| | Infrastructure type (see Drawing 11.4.4.1 d, Catchment 145_1) | Yes | Access tracks - one crossing channel in lower and one parallel on valleyside throughout catchment |
| | Comment on sediment source potential in catchment | Shallow failures evident in Google Earth Imagery in upper catchment indicate that there may be a substantial sediment supply to the channel, but relatively low volume and gradient for most of valley indicate this is unlikely to be transported quickly to the crossing. | |
| | Comment on sediment supply potential to crossing | See above | |

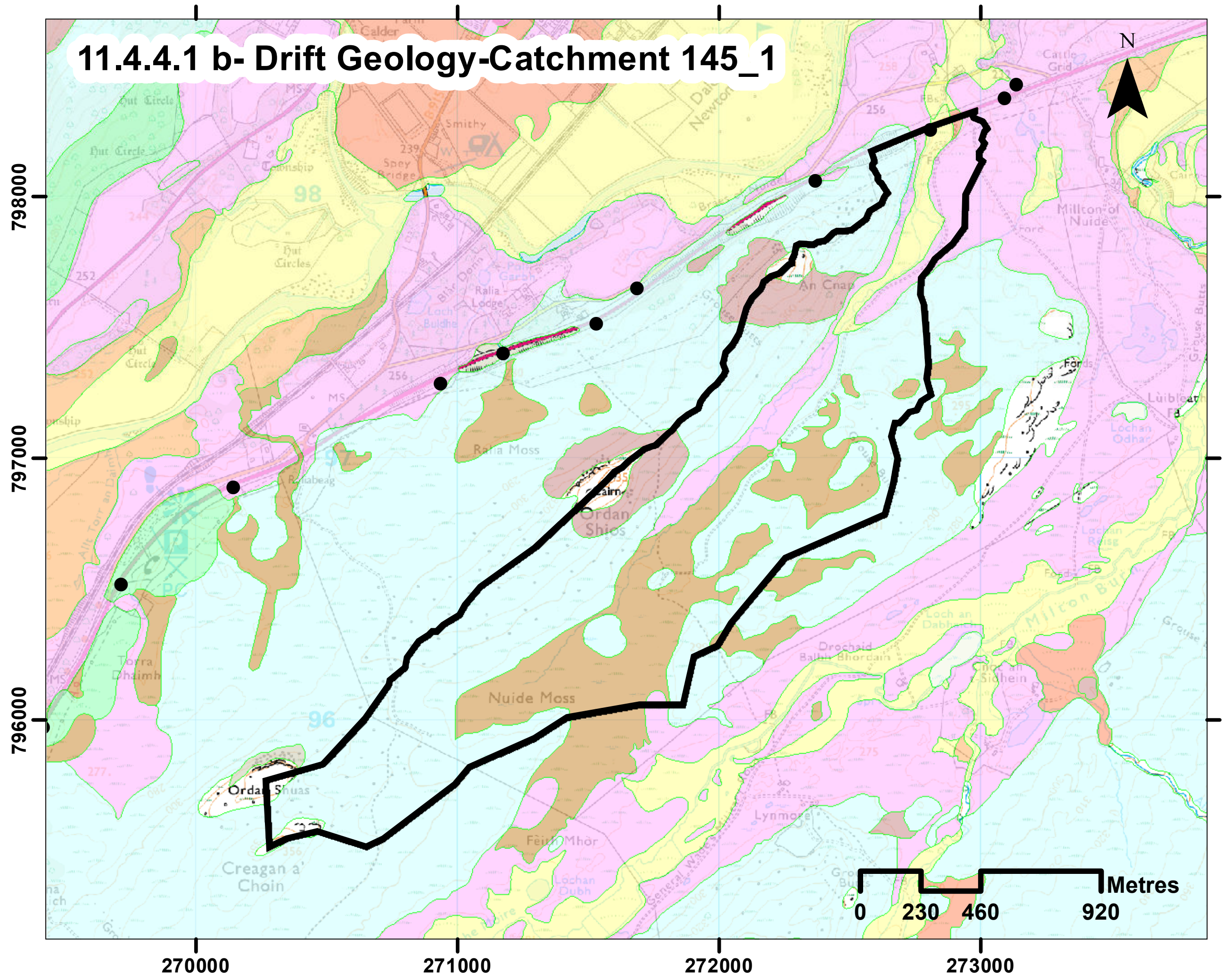
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach upstream of crossing** | Channel morphology | Step-pool | Also plane bed further u/s |
| | Predominant sediment size | Gravel-cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment 145_1 | Yes | Access track crosses channel in lower catchment u/s of road. |
| | Impact of infrastructure | Yes | Probably culverted and restricts flow and sediment transfer, but not photos available. |
| | Channel realignment | No | |

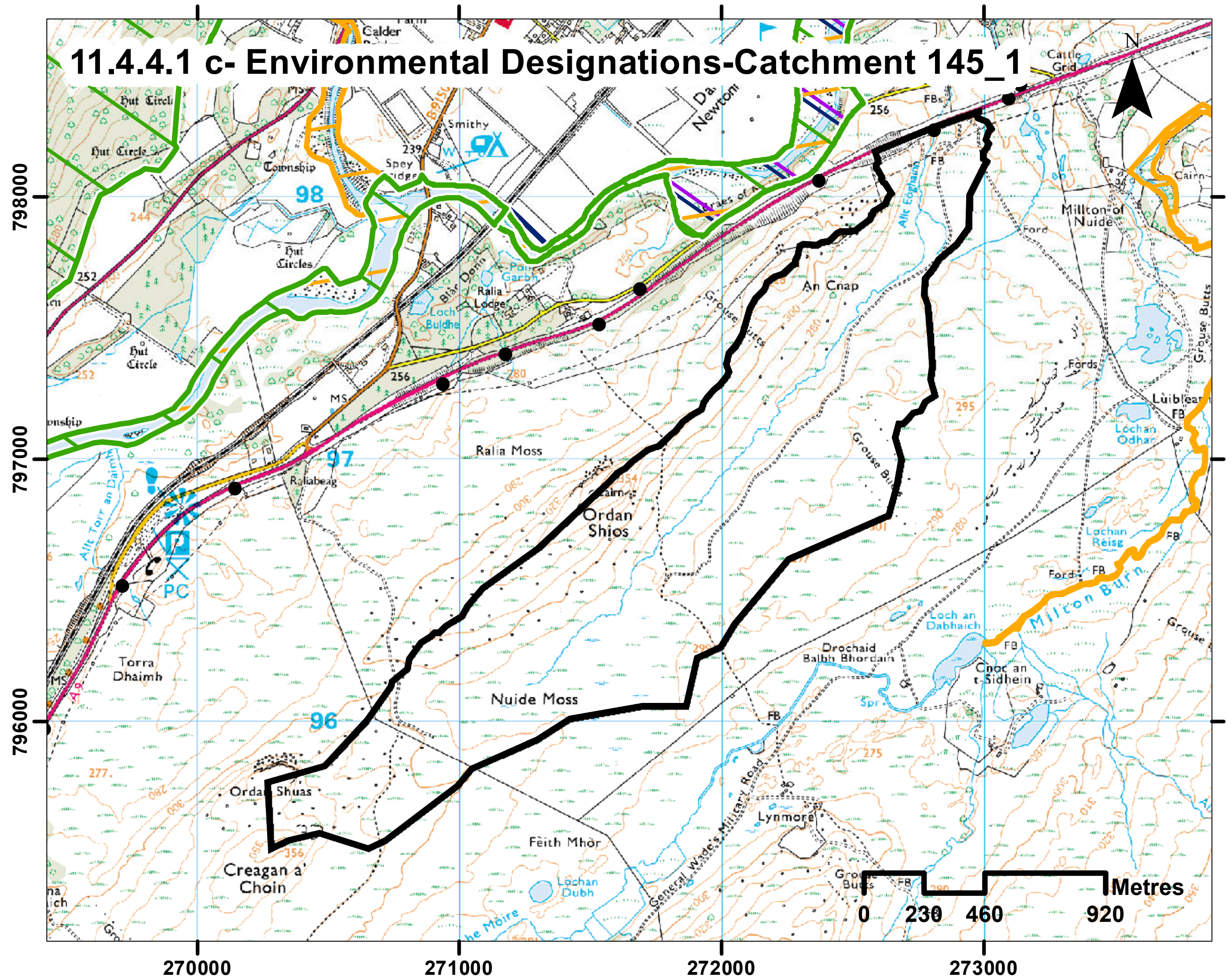
| | | | |
|---|---|---|---|
| **Morphology and Process-At crossing** | Channel morphology | Engineered | Pipe culvert |
| | Predominant sediment size | Gravel-cobble | in natural channel on approach to culvert |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Medium | |
| | Lateral migration/bank erosion | Low | |
| | Damaged/unstable drains or armouring | Yes | Some of the lining of the culvert appears to be breaking up. |

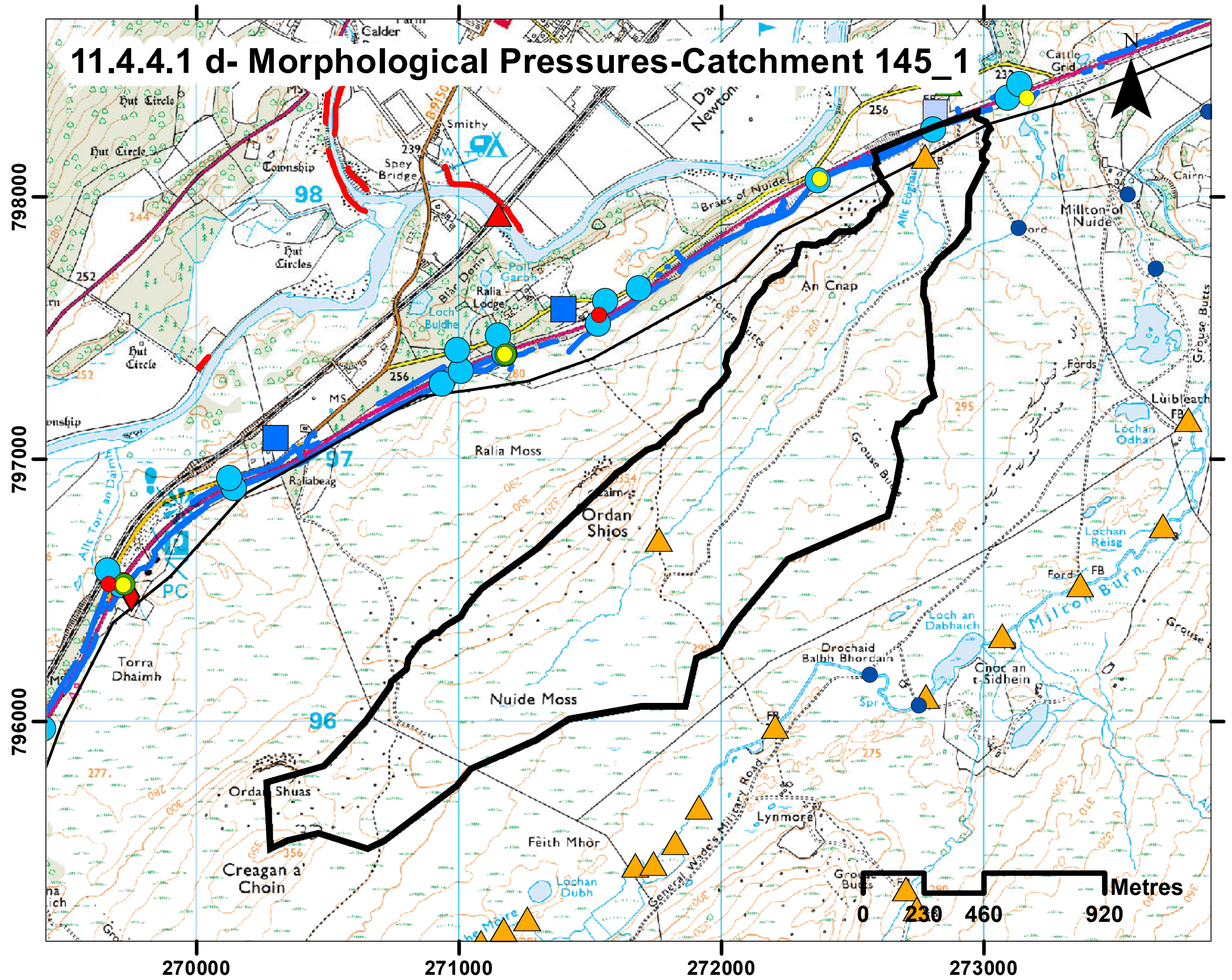
| | | | |
|---|---|---|---|
| **Morphology and Process-Reach downstream of crossing** | Channel morphology | Plane bed | |
| | Predominant sediment size | Gravel-cobble | |
| | Unvegetated bars | No | |
| | Vertical incision | Low | |
| | Deposition | Low | |
| | Lateral migration/bank erosion | Low | |
| | Presence and nature of infrastructure (see Drawing 11.4.4.1 d, Catchment | Yes | Minor road and settlement of Nuide |
| | Impact of infrastructure | Yes | Consideration needs to be given on how changes to culvert might impact on sediment supply to minor road's culvert. |
| | Channel realignment | No | Channel has been realigned in the past (straightening around the settlement of Nuided/s of A9) but not changed since 1899 mapping. |

| | |
|---|---|
| **Summary behaviour** | Limited activity in this catchment. Limited realignment u/s of crossing. Seems stable and vegetated. D/s of crossing realigned, probably during railway construction to take flow from this and other channels through just one point along the railway embankment. |




## Legend

**General**

- Crossing location

**Solid Geology**

- Gaick Psammite Formation - Psammite
- Loch Laggan Psammite Formation - Psammite, Micaceous
- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite - Microdiorite
- Pitmain Semipelite Member - Semipelite And Calcsilicate-Rock
- Pitmain Semipelite Member - Semipelite, Gneissose
- Scottish Highland Ordovician Minor Intrusion Suite - Leucogranite
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite- (Other Than Dykes) - Microdiorite

**Drift Geology**

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
- Hummocky Glacial Deposits
- Ardverikie Till Formation - Diamicton
- Glaciofluvial Sheet Deposits
- Alluvium
- River Terrace Deposits
- Alluvial Fan Deposits
- Head
- Talus - Rock Fragments
- Talus Cone

**Environmental Designations**

- Ramsar
- Special Site of Scientific Interest
- Special Area of Conservation
- Special Protection Area

**Morphological Pressures**

- Railway Bridge
- Road Bridge
- Track/Footbridge
- Culvert
- Cascade
- Step in Bed
- Catchpit
- Ford
- Dam or Weir
- Discharge Location
- Abstraction Location
- Drainage Ditch
- Flood Embankment
- Power Lines

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**9 CRUBENMORE TO KINCRAIG EIA**

**Drawing 11.4.4.1 Catchment 145_1 Catchment Overview**

| DESIGN: EL | DRAWN: EV | CHK: EL | APP: EL |
|---|---|---|---|

DATE: 20/12/2017

PROJ: 495298

DWG: A9P09-CFJ-EWE-Z_ZZZZZ_ZZ-DR-EN-0009

| SHEET: 1 of 1 | REVISION: C01 | SUITABILITY: A3 |
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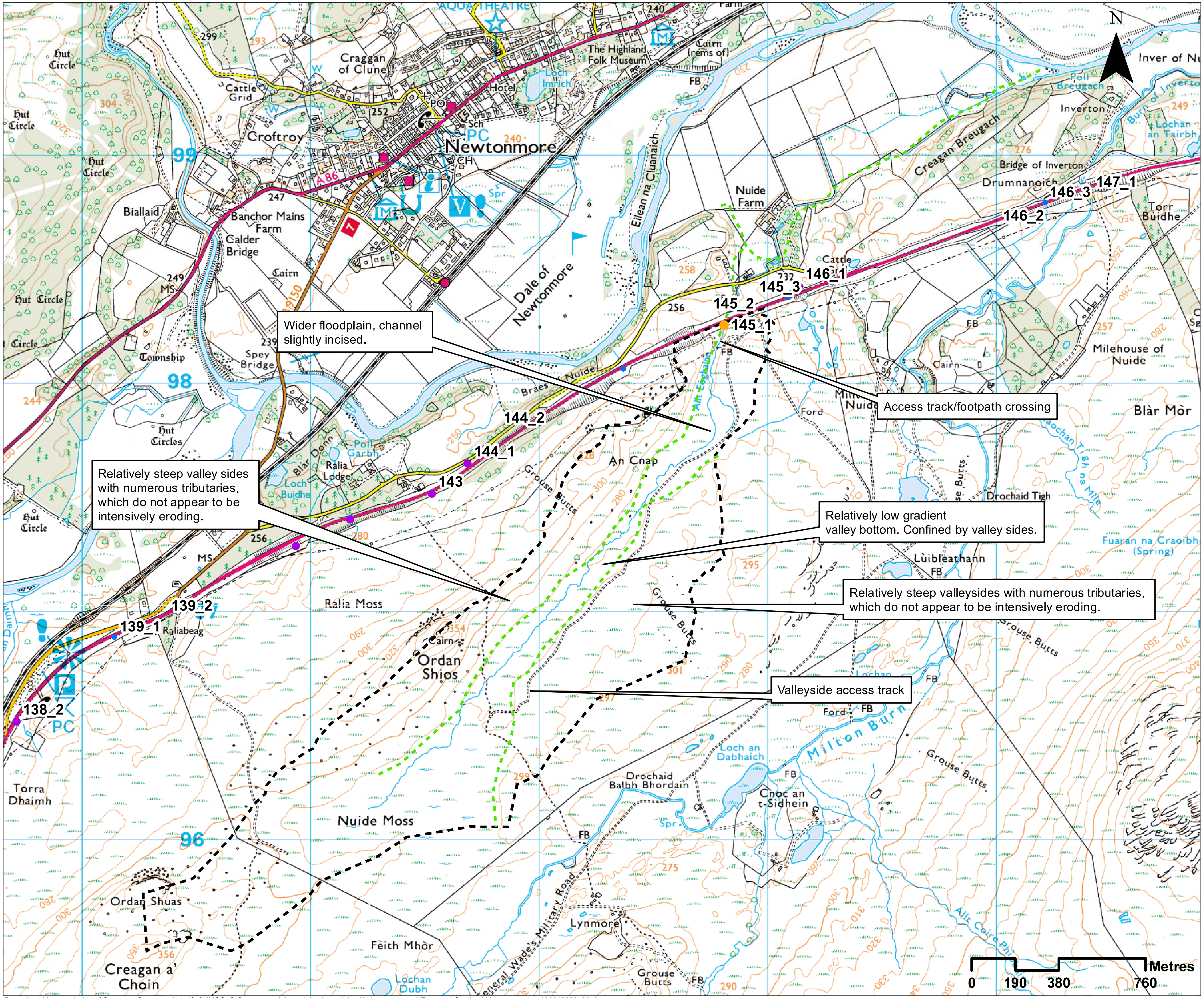


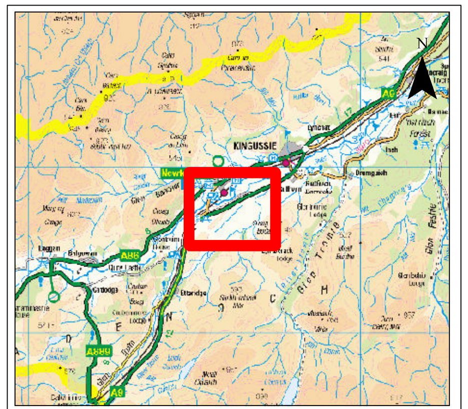

## Legend

- Major crossing
- Minor crossing
- Other crossing
- Break in slope
- Crossing catchment

| REV | SUIT | DATE | DESCRIPTION | BY | APP |
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**PROJECT 9 CRUBENMORE TO KINCRAIG EIA**

**DRAWING 11.4.4.2.**
**Catchment 145_1 Baseline Assessment**

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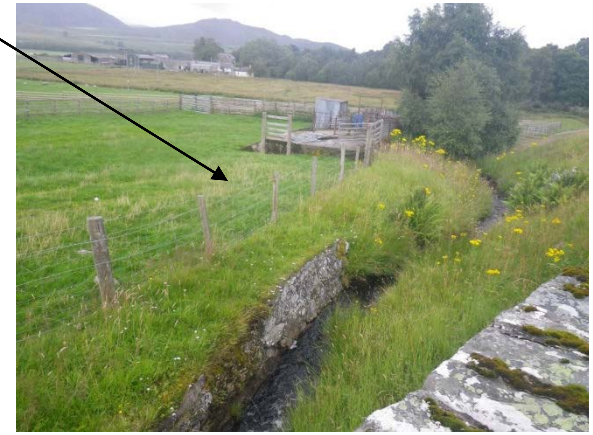
Photograph 11.4.4.12- Upstream




Photograph 11.4.4.13- Downstream


Photograph 11.4.4.14- Upstream


Photograph 11.4.4.15- Downstream


Photograph 11.4.4.16- Downstream of crossing


Photograph 11.4.4.17- Looking upstream


Photograph 11.4.4.18- Downstream


Photograph 11.4.4.19-Looking downstream towards crossing


Photograph 11.4.4.20


Photograph 11.4.4.21- Looking downstream to crossing