Appendix 11.4

Hydromorphology Assessment
Part 1

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1 Introduction

1.1.1 This appendix presents the detail of the hydromorphology assessment of the Proposed Scheme for Project 8 – Dalwhinnie to Crubenmore (Central Section) of the A9 Dualling Programme. It supports the summarised findings presented in **Chapter 11** of the Environmental Statement (ES). The Proposed Scheme that was assessed is described in **Chapter 5** of the ES.

1.1.2 Hydromorphology is the study of landforms associated with river channels and floodplains and the processes that form them. Fluvial processes create a wide range of morphological forms within a catchment providing a variety of habitats within and around rivers. As a result, hydromorphology is integral to river management.

1.1.3 This assessment examines the impacts of the Proposed Scheme on the hydromorphology of the channels and floodplain within the River Spey catchment. Often 'problems', such as excessive bank erosion or bed deposition, are a symptom of a change in discharge and/ or sediment supply elsewhere in the fluvial system so consideration of the hydromorphological implications of channel works at any given site need to be made within the context and understanding of the wider catchment.

1.1.4 This appendix describes the assessment methodology used to undertake the hydromorphology section of the Environmental Impact Assessment (EIA) for Project 8 (**Section 2**). It documents the baseline conditions that represent the current environmental state of the water features within the study area without the construction and operation of the Proposed Scheme (**Section 3**).

1.1.5 Potential impacts that may occur as a consequence of the Proposed Scheme are then documented and considered in terms of both construction and operational-phase impacts for each of these waterbodies (**Section 4**).

1.1.6 Mitigation to avoid, reduce or offset potential adverse impacts is outlined, based on published guidance and best practice (**Section 5**). Thereafter, residual impacts are identified based on the implementation of proposed mitigation (**Section 6**) and cumulative impacts are discussed (**Section 7**).

2 Approach and Methods

2.1 Establishing Baseline Conditions

2.1.1 A total of 69 watercourses have been identified as crossing the A9 and having the potential to be impacted by the Project 8 works, between Dalwhinnie and Crubenmore with four additional watercourses located in the proposed tie-in with Project 7 to the south (**Figure 1**). These have been identified from remotely sensed data and Ordnance Survey (OS) mapping, and subsequently verified via site walkover surveys. Each of these has been given a unique ID number that is used throughout this appendix and its annexes. For the purposes of the hydromorphological assessment each of these watercourses has then been classified as either Major, Minor and Other based on how the watercourse is depicted on OS mapping:

- 'Major' watercourse crossings are those shown on 1:50,000 scale OS mapping
- 'Minor' watercourse crossings are those shown on 1:10,000 scale OS mapping
- 'Other' watercourse crossings are those not shown on OS mapping but identified during walkover surveys

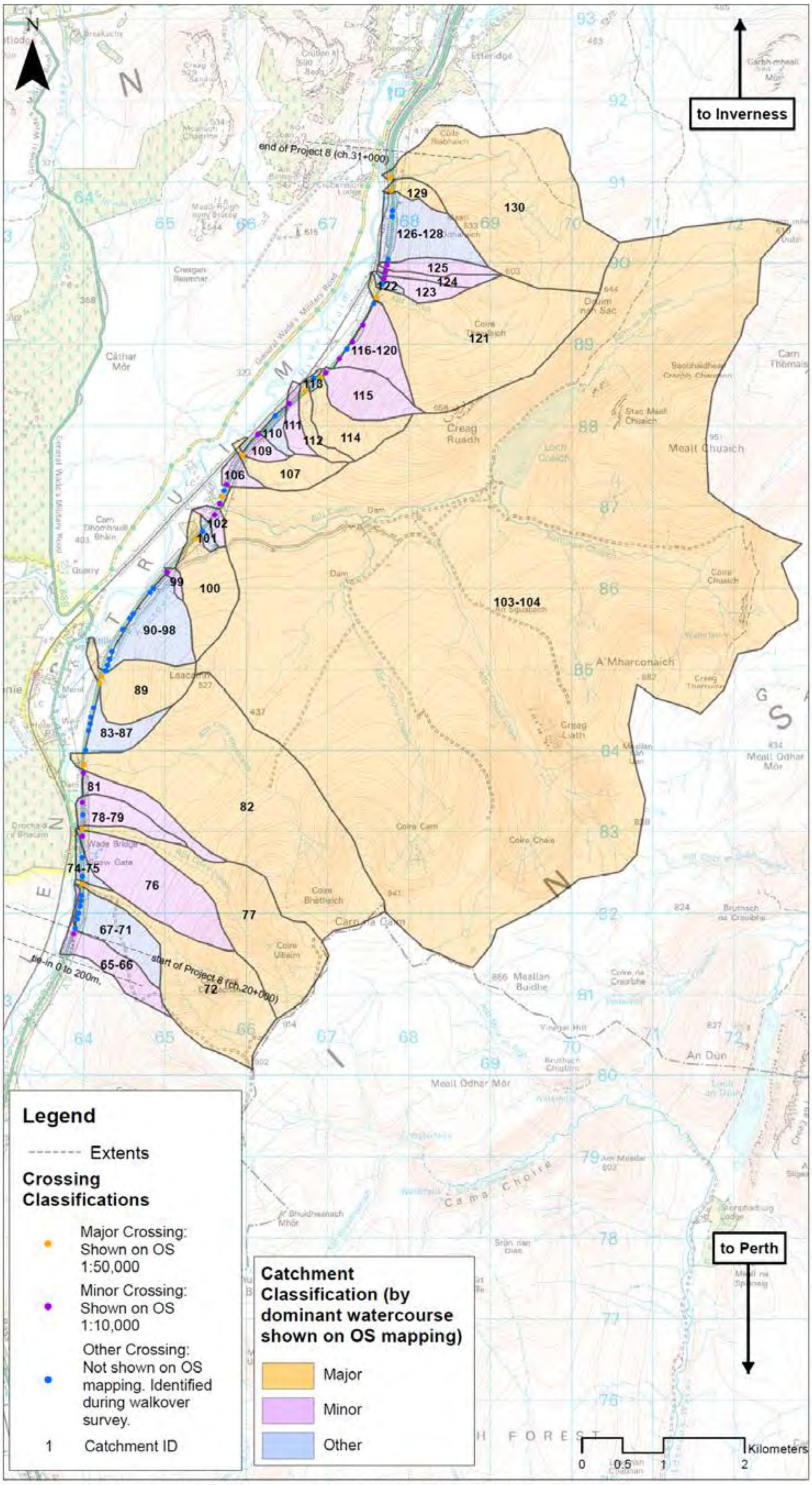


Figure 1: Watercourse Catchment IDs

2.1.2 For each crossing a hydrological catchment has been delineated using Geographic Information Systems (GIS) and the available data. These assessments are based on elevation contours and watercourse features shown on the 1:25,000 scale OS mapping. For the purpose of this assessment some of the watercourses classified as 'Other' share a 'catchment' with other similar sized watercourses due to the difficulties of identifying precise catchment boundaries between very small watercourses with the available data. It should be noted that these catchments have been updated for the Hydrology section of the Environmental Statement so there may be some limited variation in results for these very small watercourses.

2.1.3 The first phase of the hydromorphological baseline condition assessment involved a rapid expert judgement-based review of all watercourse crossings with an aim to scope out stable road drainage channels with no hydromorphological concern or interest (**Annex 11.4.1**). This involved a review of available site photography for each crossing, as well as the delineated catchments, aerial photograph and OS mapping. Each channel was rated as being at 'Low', 'Medium' or 'High' risk of erosion and deposition upstream of the crossing, at the crossing and downstream of the crossing

2.1.4 All crossings that were classified as Major or Minor were automatically included in the scope for the subsequent detailed assessment. Those crossings classified as Other which were judged in the first phase of assessment as being at low risk of erosion and deposition near the crossing were excluded from the more detailed assessment. In general the channels excluded from the scope of the detailed assessment are short, manmade drains and have small catchments, little sediment availability and no evidence for recent hydromorphological activity. Many are drains created during the construction of the existing A9. This has resulted in 23 watercourses scoped out, leaving 46 included in the second phase of assessment.

2.1.5 The second phase of the baseline condition assessment involved a more detailed evaluation of each of the remaining catchments to better understand the processes acting within those catchments and how the crossings may impact on the geomorphological behaviour of the channel and the catchments. During this phase the potential hazards posed to any structures, earthworks or other built features within the catchments were also identified.

2.1.6 As well as photographs of the watercourses collected during initial walkovers, GIS software, Google Earth Pro and other online resources have been used to analyse multiple sources of data. These include but were not limited to:

- Aerial Photography collected for the project (500m buffer of A9)
- OS mapping (1:10,000, 1:25,000, 1:50,000)
- Satellite imagery (Google and Bing)
- High resolution (5m) digital elevation data (Unfiltered with a 500m buffer of A9)
- Lower resolution (50m) elevation data for whole catchments
- British Geological Survey Data (BGS) (1:50K)
- Scottish Natural Heritage (SNH) Environmental Designation Data
- Historical mapping (1800's)
- SEPA Water Framework Directive (WFD) information

2.1.7 For each catchment included in the scope of the detailed assessment, the above data have been used by geomorphologists to assess:

- Geology (superficial and bedrock)
- Mean slope angle within the catchment
- Sediment sources
- Existing channel morphology
- Sediment supply potential of the channels
- Erosion and deposition risk in the vicinity of the road
- Potential impacts on and impacts of third party infrastructure (railway, non-motorised user routes, residences, water supply infrastructure)

2.1.8 A walkover survey of the Major crossings and some Minor and Other crossings was undertaken by a geomorphologist between the 24th and 28th August 2015. During this walkover a number of georeferenced photographs were taken and current form, processes and channel behaviour were noted for the area upstream, downstream and at the crossings (these have been included in the baseline). At the time of survey the Scottish and Southern Energy (SSE) aqueduct was not in use and water from the River Truim sub-catchments was not being diverted.

2.2 Sensitivity of Channels

2.2.1 The hydromorphological assessment of the DMRB Stage 3 EIA has been undertaken for 46 watercourses. It follows the updated SEPA guidance (Supporting Guidance (WAT-SG-67). Assessing the Significance of Impacts - Social, Economic, Environmental. May 2015) combined with expert judgement to define the sensitivity of the channels, and magnitude and significance of the impacts.

2.2.2 Sensitivity has been assigned to each watercourse based on the existing hydromorphological quality of the watercourses and the extent and impacts of anthropogenic modifications on the morphology and processes within this watercourse. This includes the current sediment regime, channel morphology and processes and is documented in **Table 1**. The sensitivity of each watercourse is shown by catchment on **Figure 2**, with the highest sensitivity shown where there are multiple channels in a catchment.

2.2.3

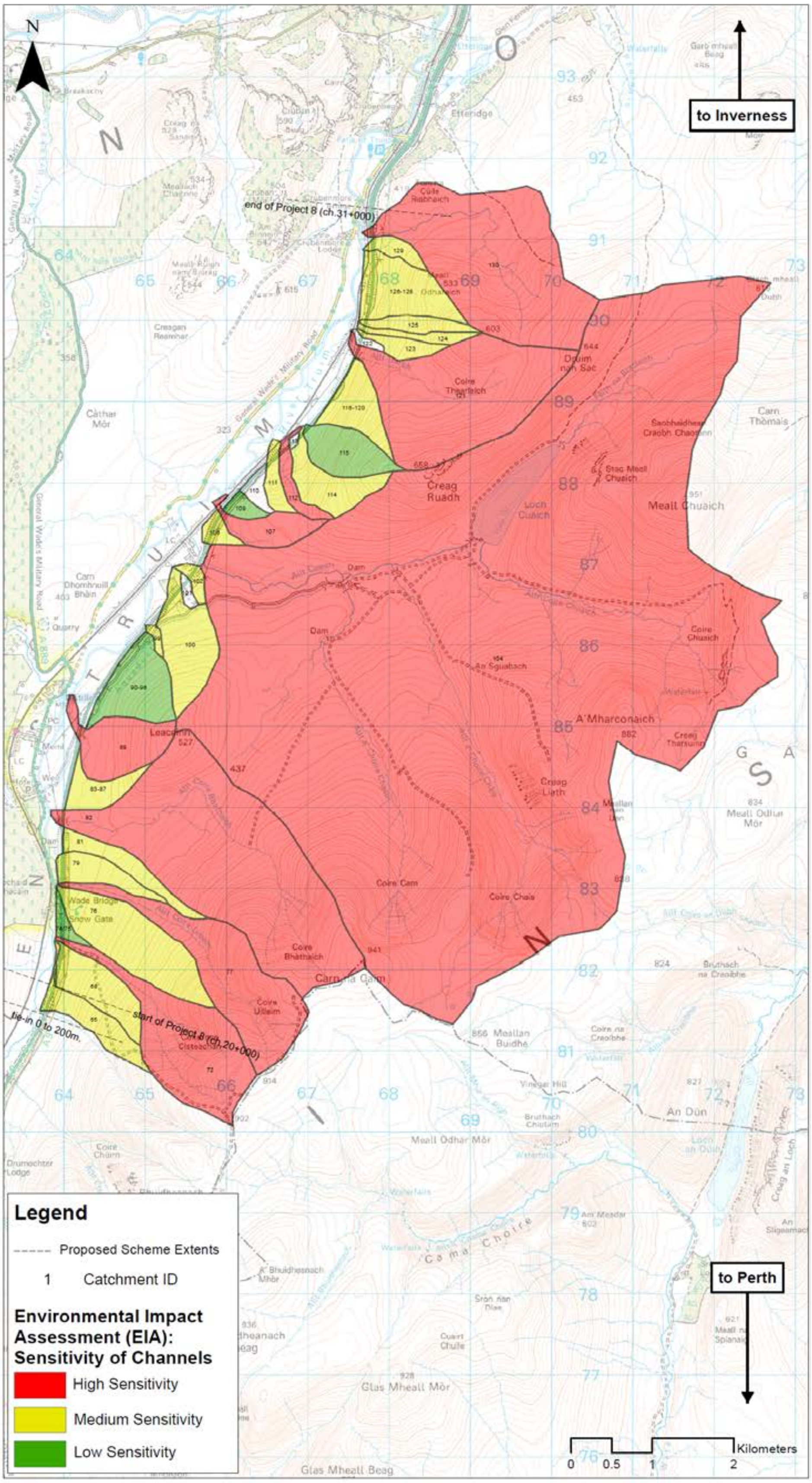


Figure 2: Channel Sensitivity

Table 1: Sensitivity classifications for watercourses

Sensitivity	Criteria/ Indicator of Value
Very High	Sediment Regime Water feature sediment regime provides a diverse mosaic of habitat types suitable for species sensitive to changes in sediment concentration and turbidity, such as migratory salmon, freshwater pearl mussels. Water feature appears in complete equilibrium with natural erosion and deposition occurring. The water feature has sediment processes reflecting the nature of the catchment and fluvial system. Channel Morphology Water feature includes varied morphological features (e.g. pools, riffles, bars, natural bank profiles) with no sign of channel modification. Natural Fluvial Processes Water feature displays natural fluvial processes and natural flow regime, which would be highly vulnerable to change as a result of modification
High	Sediment Regime Water feature sediment regime provides habitats suitable for species sensitive to changes in sediment concentration and turbidity, such as migratory salmon, freshwater pearl mussels. Water feature appears largely in natural equilibrium with some localised accelerated erosion and/or deposition caused by land use and/or modifications. Primarily the sediment regime reflects the nature of the natural catchment and fluvial system. Channel Morphology Water feature exhibiting a natural range of morphological features (e.g. pools, riffles, bars, varied natural river bank profiles), with limited signs of artificial modifications or morphological pressures. Natural Fluvial Processes Predominantly natural water feature with a diverse range of fluvial processes that is highly vulnerable to change as a result of modification.
Medium	Sediment Regime Water feature sediment regime provides some habitat suitable for species sensitive to change in suspended sediment concentrations or turbidity. A water feature with natural processes occurring but modified, which causes notable alteration to the natural sediment transport pathways, sediment sources and areas of deposition. Channel Morphology Water feature exhibiting some morphological features (e.g. pools, riffles and depositional bars). The channel cross-section is partially modified in places, with obvious signs of modification to the channel morphology. Natural recovery of channel form may be present (e.g. eroding cliffs, depositional bars). Natural Fluvial Processes Water feature with some natural fluvial processes, including varied flow types. Modifications and anthropogenic influences having an obvious impact on natural flow regime, flow pathways and fluvial processes.

Sensitivity	Criteria/ Indicator of Value
Low	Sediment Regime Water feature sediment regime which provides very limited physical habitat for species sensitive to changes in suspended solids concentration or turbidity. Highly modified sediment regime with limited/no capacity for natural recovery. Channel Morphology Water feature that has been extensively modified (e.g. by culverting, addition of bank protection or impoundments) and exhibits limited-to-no morphological diversity. The water feature is likely to have uniform flow, uniform banks and absence of bars. Insufficient energy for morphological change. Natural Fluvial Processes Water feature which shows no or limited evidence of active fluvial processes with unnatural flow regime or/and uniform flow types and minimal secondary currents.

2.3 Erosion Risk Assessment

2.3.1 The 4th and 6th iteration design has been reviewed against the aerial photography and historical mapping in order to identify areas of engineering (proposed and existing) potentially at risk from fluvial erosion over the life of the scheme; highlighting areas that may require ongoing monitoring or erosion protection. This is detailed in **Annex 11.4.2**, but the process has resulted in the movement of some infrastructure back from the watercourses and the addition of erosion protection measures in some locations in the Assessment Design.

2.4 Establishing Changes in Conditions

2.4.1 The 4th Iteration Design Freeze has been reviewed and used as the design to undertake the initial (pre mitigation) assessment, outlining the potential impacts of the scheme on each of the waterbodies. It has been used to calculate the length and bed slope of culverts, channel realignments and bridges and the number and location of outfalls (both SuDS basin outfalls and earthworks drainage). In line with 'best practice' guidance and published standards, the following initial design approach was adopted by the engineering team:

- All culverts and bridges will be sized to take a 1:200 year flow
- All crossings on major watercourses will be bridges or box culverts
- Bridge abutments will be set back from the channel banks
- Erosion and scour protection associated with structures will be minimal and only where required

2.4.2 The potential impacts of these works have then been considered for the watercourses in each of the catchments identified (and scoped in) based on the understanding of the form and processes within the watercourse catchments gained in the baseline and a review of the design information. Expert judgement has been used to consider likely changes and an assessment of the impacts of changes has been made for each of the impacted watercourses.

2.4.3 For culverts a comparison of the type (pipe or box), length, discharge, slope, and bed material has been made between the existing culvert and the proposed culvert. The potential impacts of these changes on the morphology, sediment regime and fluvial process of the waterbodies have then been recorded. It should be noted that it has been assumed that all culverts (with the exception of those in Catchment 89) will be designed to take the 1:200 year flow (as per SEPA guidance), and this will involve upsizing of some culverts.

2.4.4 For bridges a comparison of the length, bed material and distance set back from the channel has been made between the existing and the proposed. The potential impacts of these changes on the morphology, sediment regime and fluvial process on the waterbodies have then been recorded. These have also been designed to take the 1:200 year flows.

2.4.5 For channel realignments a comparison of morphology has been undertaken with the existing channels, as well as a review of the design planform, slope, cross section, length, and velocity and stream power, in order to identify potential impacts on the morphology, sediment regime and fluvial process of the waterbodies.

2.4.6 For outfalls, only the proposed locations have been considered and it has been assumed that these have a negligible discharge to the channels, as well as a minimal grey engineering headwall and bed protection.

2.4.7 For erosion protection, the extent and type have been taken into account as well as the proximity to the watercourse (set back or in channel). The potential impacts of these changes on the morphology, sediment regime and fluvial process of the waterbodies have then been recorded.

2.5 Magnitude and Significance of Impacts

2.5.1 The initial assessment of the magnitude of impacts has been undertaken based on SEPA guidance (2015) by combining the potential change in WFD status (based on the Design Freeze-4th Iteration), spatial extent of the impacts on watercourse and timescale of the impact to give the magnitude.

2.5.2 Firstly, the potential change in WFD status has been assessed for the works on each watercourse using the 'Threshold of Significant Impact' (ToSI) test. The thresholds (**Table 2**) are regarded as the maximum extent of an individual pressure (type of engineering work) which, on its own, would cause a significant and long term impact on the water environment and cause a downgrade in WFD status.

2.5.3 In order to undertake this test, a target river type (the natural river type the watercourse would be before any management- **Figure 3**) has been assigned to each impacted reach as part of the baseline study for this report. Where two different types are impacted on the same watercourse the worst case (more sensitive type) has been selected for this test.

2.5.4 This has been applied to each element of works on each of the watercourses and those works that have failed the test are noted in the assessment tables.

2.5.5 Despite few watercourses likely to experience a change in WFD status due to the works, all assessments have assumed the works cause a drop in WFD status of 1 level (for most watercourses this is from Good to Moderate) as per the guidance. However, in the majority of cases (except where the Threshold of Significant Impacts test is reached), there is not expected to be a change in WFD status caused by the works, so the assessment is assuming a worst case.

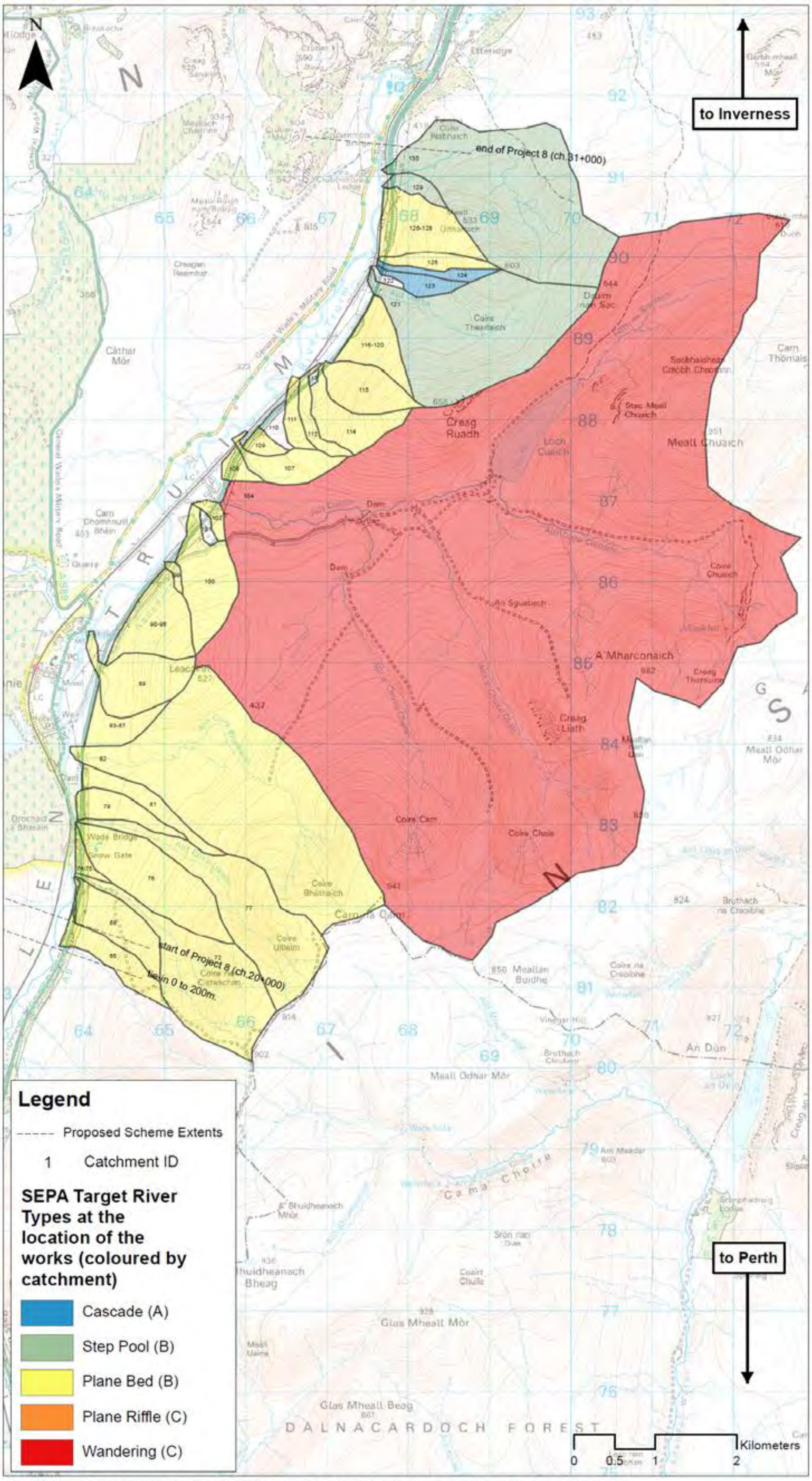


Figure 3: SEPA Target River Types Crossing Locations

Table 2: Threshold of significant impacts for different river types (note: numbers are lengths of works in metres at or over which the threshold is crossed)

Activity	Bedrock or Cascade	Step pool or Plane bed	Braided, Wandering or Plane riffle	Active Meandering	Passive Meandering
	Type A	**Type B**	**Type C**	**Type D**	**Type F**
Riparian vegetation removal	7500	2500	1410	1410	2500
Sediment Removal	900	540	360	320	590
Dredging	540	340	250	210	390
Embankments & Floodwalls (excludes bank reinforcement)	1070	670	270	390	780
Set Back Embankments and Floodwalls	22500	11250	3460	5630	11250
Grey (Hard) Bank Protection	2810	1180	600	710	1180
Green (Soft) Bank Protection	7500	2370	1450	1450	2370
Bank Reprofiling	7500	2370	1450	1450	2370
High Impact Realignment (e.g. straightening)	680	390	140	190	450
Low Impact Realignment (e.g. re-meandering)	1730	1020	730	590	1180
Flood Bypass Channel	900	660	240	330	800
Open Culverts	460	230	100	130	260
Culvert with natural bed (e.g. arch culvert)	540	340	140	190	390
Culvert with artificial bed (e.g. pipe or box culverts)	420	280	120	160	330
Croys, Groynes, Flow Deflectors (length of structure =)	1730	590	300	360	590
Bed Reinforcement	680	390	140	210	450
Impoundments (length of impounded water =)	540	340	140	190	390
Bridges (number of piers x river width)	1410	800	260	400	900

(NB- numbers are lengths of works in metres at or over which the Threshold is crossed)

2.5.6 A scale of impact has been assigned based on **Table 3**, with the WFD status, based on the highest between Water Flows and Levels, and Physical Condition, where there is a difference. Where a channel does not have a WFD status it has been assigned that of the river to which it is a tributary.

2.5.7 The length of the channel affected takes into account the length of direct impacts e.g. the loss of bank (both sides) due to the culvert, and the potential downstream distance of indirect impacts e.g. changes in sediment transport. This indirect impact distance is based on expert judgment and is assumed to be the length of the channel, until it reaches its confluence with a larger watercourse. Where the supply of sediment and water from the larger, receiving watercourse is assumed to be greater than the changes caused by the works, these changes are no longer considered significant.

2.5.8 Where the scale of impacts is between classes (e.g. negligible-very small), expert judgment has been used involving the scale of work, as well as the results of the ToSI test result, to select the appropriate scale. This scale then feeds into **Table 4** and is combined with duration of impact (either construction time or the length of time the infrastructure will be present), to give a magnitude of the impact.

Table 3: Definitions of Scale of impacts

Change in WFD status	Length of river channel/bank affected (km)					
	< 0.5	0.5 to < 1.5	1.5 to < 5	5 to < 10	10 to < 20	≥ 20
High → Good	Negligible	Very Small	Very Small - Small	Small - Medium	Medium	Medium - Large
Good ↔ Moderate Moderate ↔ Poor High → Moderate Poor ↔ Bad	Negligible - Very Small	Very Small - Small	Small	Medium	Medium - Large	Large
High → Poor Good ↔ Poor Moderate ↔ Bad	Very Small	Small	Medium	Medium - Large	Large - Very Large	Large - Very Large
Good ↔ Bad High → Bad	Small	Small - Medium	Medium - Large	Large	Large – Very Large	Very Large

Table 4: Calculations of magnitude of an identified impact

Duration of impact	Scale of impact (extent & severity)					
	Negligible	Very Small	Small	Medium	Large	Very Large
Very short (up to 1 year)	Negligible	Negligible	Minor	Minor	Moderate	Moderate
Short (up to 6 years)	Negligible	Minor	Minor	Moderate	Moderate	Major
Long (more than 6 years)	Negligible	Minor	Moderate	Moderate	Major	Major

2.5.9 These SEPA guidance tables (**Table 3** and **Table 4**) have been used to assess the magnitude of impacts on the hydromorphology of the channel as outlined in this section. For this assessment, all the works undertaken are assumed to change the WFD status (downwards/negatively) by one category (see above) so length of channel affected is the key control on scale of impact. All works considered at this stage are long term so the length of impact is the key consideration with respect to magnitude.

2.5.10 The DMRB method of defining magnitude (outlined in **Table 5**) differs from the SEPA method; however, the two are easily aligned with the magnitude for each being directly compatible, based on a change in WFD status, duration of impacts (in this case all Long Term) and more importantly the length of channel impacted. This alignment is outlined in **Table 5** based on long term impacts.

Table 5: Definitions of magnitude of an identified impact

SEPA Magnitude (as assessed)	DMRB Magnitude Criteria
Major Adverse Impact that has the potential to impact on a waterbody scale- Over 10km of channel affected and/or would cause a drop in WFD status by 2 levels (e.g. Good to Poor)	Sediment Regime Significant impacts on the water feature bed, banks and vegetated riparian corridor resulting in changes to sediment characteristics, transport processes, sediment load and turbidity. This includes extensive input of sediment from the wider catchment due to modifications. Impacts would be at the waterbody scale. Channel Morphology Significant/extensive alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. This could include: significant channel realignment (negative); extensive loss of lateral connectivity due to new/extended embankments; and/or, significant modifications to channel morphology due to installation of culverts or outfalls. Impacts would be at the waterbody scale. Natural Fluvial Processes Significant shift away from baseline conditions with potential to alter processes at the catchment scale. Condition Status Substantial adverse impacts at the water body scale, which causes loss or damage to habitats. Impacts have the potential to cause deterioration in hydromorphology quality elements*. Prevents the water body from achieving Good status.
Moderate Adverse 1.5-10km of channel impacted, or 0.5-1.5km of channel impacted where the Threshold of significant impacts test is failed and a drop in WFD status is likely due to the works.	Sediment Regime Some changes and impacts on the water feature bed, banks and vegetated riparian corridor resulting in some changes to sediment characteristics, transport processes, sediment load and turbidity. Impacts would be at the multiple reach scale. Channel Morphology Some alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. Activities could include: channel realignment, new/extended embankments, modified bed and/bank profiles, replacement of bed and/or banks with artificial material and/or installation of culverts. Impacts would be at the multiple reach scale. Natural Fluvial Processes A shift away from baseline conditions with potential to alter processes at the reach or multiple reach scale. Condition Status Moderate adverse impacts at the reach or multiple reach scale, which causes some loss or damage to habitats. Impacts have the potential to cause failure or deterioration in one or more of the hydromorphological quality elements. May prevent the water body from achieving Good status.
Minor Adverse 0.5-1.5km of channel impacted, or <0.5km of channel impacted where the Threshold of significant impacts test is failed and a drop in WFD status is likely due to the works.	Sediment Regime Limited impacts on the water feature bed, banks and vegetated riparian corridor resulting in limited (but notable) changes to sediment characteristics, transport processes, sediment load and turbidity at the reach scale. Channel Morphology A small change or modification in the channel planform and/or cross section. Includes upgrade to and/or extension of existing watercourse crossing and/or structure with associated minor channel realignment with localised impacts. Natural Fluvial Processes Minimal shift away from baseline conditions with typically localised impacts up to the reach scale. Condition Status Minor adverse impacts at the reach scale, which may cause partial loss or damage to habitats. Impacts have the potential to cause failure or deterioration in one of the hydromorphological quality elements.
Negligible <0.5km of channel affected One drop in WFD status used in assessment but no change likely.	Minimal or no measurable change from baseline conditions in terms of sediment transport, channel morphology and natural fluvial processes. Any impacts are likely to be highly localised and not have an effect at the reach scale.

SEPA Magnitude (as assessed)	DMRB Magnitude Criteria
Minor Beneficial 0.5-1.5km of channel impacted, with little to no change in WFD status.	Sediment Regime Partial improvement to sediment processes at the reach scale, including reduction in siltation and localised recovery of sediment transport processes. Channel Morphology Partial improvements include enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks. Natural Fluvial Processes Slight improvement on baseline conditions with potential to improve flow processes at the reach scale. Condition Status Slight beneficial impacts at the reach scale, which may cause partial habitat enhancement. Impacts have the potential to improve one of the hydromorphological quality elements.
Moderate Beneficial Multiple reaches impacted- 1.5-10km of channel impacted with potential for improved WFD status by one level, or a shorter impact with the potential to improve WFD by 2 levels.	Sediment Regime Reduction in siltation and recovery of sediment transport processes at the reach or multiple reach scale. Channel Morphology Partial creation of both in-channel and vegetated riparian habitat. Improvement in morphological diversity of the bed and/or banks at the reach or multiple reach scale. Includes partial or complete removal of structures and/or artificial materials. Natural Fluvial Processes Notable improvements on baseline conditions and recovery of fluvial processes at the reach or multiple reach scale. Condition Status Notable beneficial impacts at the reach to multiple reach scale. Impacts have the potential to improve one or more of the hydromorphological quality elements and/or assist the water body in achieving Good status.
Major Beneficial Impacts improve much of the waterbody (10km or over) by one WFD status or 5-10km by 2 WFD status.	Sediment Regime Improvement to sediment processes at the catchment scale, including recovery of sediment supply and transport processes. Channel Morphology Extensive creation of both in-channel habitat and riparian zone. Morphological diversity of the bed and/or banks is restored, such as natural planform, varied natural cross-sectional profiles, recovery of fluvial features (e.g. cascades, pools, riffles, bars) expected for river type. Removal of modifications, structures, and artificial materials. Natural Fluvial Processes Substantial improvement on baseline conditions at catchment scale. Recovery of flow and sediment regime.

*Hydromorphological quality elements are: quality and quantity of flow; river depth and width variation; structure and substrate of the bed dynamics; river continuity; structure of the riparian zone.

2.6 Significance of Impacts (without mitigation)

2.6.1 The magnitude and sensitivity that have been assigned are then multiplied as per **Table 6** to give the initial, pre mitigation impact significance based on the 4th Iteration Design Freeze. Where there is a difference between the differing elements considered the worst case significance is taken.

Table 6: Definitions of the significance of impact

Magnitude of impact/ sensitivity of attribute	Negligible	Minor	Moderate	Major
Very High	Neutral	Moderate/ Large	Large/ Very large	Very Large
High	Neutral	Slight/ Moderate	Moderate/ Large	Large/ Very Large
Medium	Neutral	Slight	Moderate	Large
Low	Neutral	Neutral	Slight	Slight/ Moderate

2.7 Significance of Impacts (with embedded mitigation)

2.7.1 Mitigation required to reduce or eliminate adverse impacts of the Proposed Scheme on the hydromorphology of the channels has been documented for each catchment and incorporated into design where possible, and reasons given where not. This mitigation has then been 'embedded' into the Assessment Design (**Drawings 5.1 to 5.9**, contained in **Volume 3**). The assessment process has then been repeated with this embedded mitigation in place, and a significance of impacts has been assigned.

2.8 Significance of Impacts (with additional 'Project specific' mitigation)

2.8.1 A schedule of Project Specific mitigation (i.e. that not included in the Assessment Design) has been created to mitigate any remaining impacts, and the assessment process run for a third time as discussed in **Section 5.3** of this appendix.

3 Baseline Conditions

3.1.1 This section of the report provides hydromorphological context for catchments being assessed, identifying zones of sediment production, transfer and deposition, and characterisation of the watercourses as a whole and the location of different processes. This understanding is then used to assess the impact of the Proposed Scheme on the hydromorphology of the channels within the catchments.

3.1.2 All watercourses and their catchments within the project have been given an ID and these have been used to distinguish between different channels and catchments and to identify each of the hydromorphological receptors considered in this assessment (**Figure 1**). All will be affected by changes in flow and sediment regime that could be caused by the proposed scheme; however, the impacts of these changes may take years to manifest themselves.

3.1.3 Hydromorphological baseline conditions have been established for each impacted waterbody catchment and these are presented as a series of tables, maps and photographs in **Annex 11.4.3**. The methodologies used to undertake this baseline are described in **Section 2**. As part of this process each area of impacted watercourse has been assigned a river type based on SEPA, 2011, and these are summarised (based on catchment) in **Figure 3.**

3.1.4 The WFD aims to maintain or improve the physical and chemical quality of watercourse within Europe by 2027. In order to achieve this, River Basin Management Plans (RBMP) have been created for all European catchments. The watercourses within the Project 8 extent are part of the wider River Spey catchment. Two large watercourses have been individually assigned WFD ecological status by Scottish Environment Protection Agency (SEPA) based on a variety of attributes including Water Flows and Levels and Physical Condition (i.e. hydrology and morphology) (**Table 7**).

Table 7: WFD classification

WFD designated water course	Ecological Status	Water flows and levels classification	Physical condition classification	Tributaries to watercourse (ID)
23638: River Truim from source to Allt Cuaich	Good	Good	Good	59-64 Tie in Channels 65 -103
23639: Allt Cuaich	Bad	Bad	Good	104
23146: River Truim-lower catchment	Moderate	Good	Good	105-132

3.1.5 The smaller watercourses within the study area have not been assigned individual Ecological Status. Where these occur, the status of the larger watercourse into which it flows has been assigned for the purpose of this report and **Chapter 11**, as the waterbody/ catchment likely to be potentially impacted (**Table 7**).

3.1.6 As well as aiming to stop deterioration of the watercourses, the RBMPs also promote improvement of habitats impacted by existing morphological pressures in order to achieve future Good ecological status. The physical condition of the watercourse is a key part to achieving this as it impacts the ecological and chemical components. As such, the WFD status of the watercourses and potential change in this status is considered in **Chapter 11**.

3.1.7 These baseline conditions have been assessed for each watercourse to give a sensitivity of each catchment based on **Table 1** and this is summarised in **Figure 2.**

4 Potential Impacts

4.1 Construction Impacts

4.1.1 This section addresses the potential impacts of the activities that will be carried out during construction of the Proposed Scheme. By their nature, culverts, bridges, realignments, erosion protection and outfalls all pose a risk to the hydromorphology of the channel and floodplain, as significant proportions of the required works, such as excavation, construction and landscaping are located within or in close proximity to watercourses. The exact construction methods are currently unknown, but the potential impacts likely to be caused by construction are considered below.

4.1.2 Any works that involving engineering within the channel (culverts, bank protection, realignment, bridges and headwalls) will destabilise and permanently change the form of the banks. The significance of this impact will vary depending of the existing nature of the banks, and will be much reduced where banks are currently manmade or altered. These works will have an adverse impact on the morphology of the channels where they occur and this impact has the potential to have a medium duration, with adjustment potentially taking many years.

4.1.3 Vegetation clearance will destabilise the more natural banks, changing the form, as the vegetation helps to bind the bank material together, as well as drawing water, and protecting the underlying material from erosion from runoff and flow. This will have an adverse impact on the morphology of the channel in the areas where it occurs, that will have a medium term duration.

Damage to Bed Form

4.1.4 Construction works within the channel will damage the existing bed forms (including areas of gravel bars, pools and steps), bed armouring and sediment composition of the bed over the duration of construction, and for some years after, until sufficient flows have occurred to redistribute sediment across the channel and reform the bed morphology and sediment profile of the channel. They will also release find sediment during construction that may smother gravels at the site and further downstream.

Increased Sediment Supply

4.1.5 The working methods are likely to result in damage to and increased instability of the channel bed and banks. As both bed and banks potentially become destabilised by the works, material from them becomes more likely to be delivered to the channel and is therefore available to be entrained and transported downstream. This increase in supply is likely to be ongoing for some time post construction as the banks and bed then readjust.

Change in Flow Conditions

4.1.6 Any temporary narrowing of the channel to create a dry working environment will alter the discharge, velocity and water levels of the channel. This will have a very short term impact on the morphology of the channel in the areas where this occurs as well as potentially impacting on the channel downstream.

Change of Continuity of Sediment Transfer

4.1.7 Methods of construction that include stopping downstream sediment transport such as damming the channel or pumping of water downstream will temporarily reduce the downstream continuity of sediment transfer during the works, having an adverse, short term impact on sediment continuity.

Change in Sediment Dynamics

4.1.8 The works are likely to temporarily increase local supply from the damaged bed and banks. This will lead to a change in sediment dynamics within the channel at the site and downstream, and is likely to result in increased downstream transport and/or local deposition. This will extend past construction until there has been sufficient flow to redistribute sediment and adjust to the change in conditions. This will have an adverse impact on the morphology of the channel in the areas where it occurs as well as impacting on the channels downstream.

4.2 Operational Impacts

4.2.1 Operational impacts are those which will occur following the completion of the Proposed Scheme and are considered to be long term impacts. Often it is difficult to quantify the magnitude of long term impacts due to the timescales over which they may occur (tens to hundreds of years) and the resilience of the environment to adapt to future changes; professional judgement is used to undertake the assessment, based on the methodology in **Section 2**.

4.2.2 The initial impact assessment has been undertaken on the 4th Iteration Design Freeze (**Annex 11.4.4**). Works proposed on each watercourse have been identified, and grouped per waterbody catchment. These have then been assessed, based on the baseline information (**Annex 11.4.3**), with the workings and results for each waterbody/ catchment given in a series of tables in **Annex 11.4.5** and summarised in **Table 8**. The impacts are documented below.

Table 8: Summary of Hydromorphology assessment result

Watercourse ID	EIA sensitivity	Significance of impact (Design Freeze 4th iteration)	Significance of impact (Assessment Design)	Residual significance of impact (after all mitigation is applied)
59 (Tie in only)	High	Neutral	Neutral	Neutral
61 (Tie in only)	Medium	Neutral	Neutral	Neutral
63 (Tie in only)	Medium	Neutral	Neutral	Neutral
64 (Tie in only)	High	Neutral	Neutral	Neutral
65	Medium	Moderate adverse	Neutral	Slight beneficial
66	Low	Neutral	Neutral	Neutral
68	Medium	Neutral	Neutral	Neutral
70	Medium	Neutral	Neutral	Neutral
71	Low	Neutral	Neutral	Neutral
72	High	Neutral	Neutral	Neutral
74	Low	Neutral	Neutral	Neutral
75	Low	Neutral	Neutral	Neutral
76	Medium	Neutral	Neutral	Neutral
77	High	Neutral	Neutral	Neutral
78	Low	Neutral	Neutral	Neutral
79	Medium	Neutral	Neutral	Neutral
81	Medium	Neutral	Neutral	Neutral
82	High	Neutral	Neutral	Neutral
83	Low	Neutral	Neutral	Neutral
84	Medium	Neutral	Neutral	Neutral
85	Medium	Neutral	Neutral	Neutral
87	Low	Neutral	Neutral	Neutral
89	High	Neutral	Neutral	Neutral
94	Low (impacted by aqueduct)	Neutral	Neutral	Neutral
95	Low (impacted by aqueduct)	Neutral	Neutral	Neutral
98	Low (impacted by aqueduct)	Neutral	Neutral	Neutral
99	Medium	Neutral	Neutral	Neutral
100	Medium (impacted by aqueduct)	Neutral	Slight adverse	Neutral
102	Medium	Neutral	Neutral	Neutral
103	Low-Drain	Neutral	Neutral	Neutral
104	High	Neutral	Neutral	Neutral
106	Medium	Neutral	Neutral	Neutral
107	High	Neutral	Neutral	Neutral
109	Low-Drain	Neutral	Neutral	Neutral
111	Medium	Neutral	Neutral	Slight beneficial
112	High	Neutral	Neutral	Slight beneficial
114	Medium-artificial channel	Neutral	Neutral	Neutral
115	Low-Drain	Neutral	Neutral	Neutral
116	Low-Drain	Neutral	Neutral	Neutral
117	Low	Neutral	Neutral	Neutral

Watercourse ID	EIA sensitivity	Significance of impact (Design Freeze 4th iteration)	Significance of impact (Assessment Design)	Residual significance of impact (after all mitigation is applied)
118	Low-Drain	Neutral	Neutral	Neutral
119	Medium (natural channel)	Neutral	Neutral	Neutral
121	High	Neutral	Neutral	Neutral
123	Medium	Neutral	Neutral	Neutral
124	Medium	Neutral	Neutral	Neutral
125	Medium	Neutral	Neutral	Neutral
126	Medium (natural channel)	Neutral	Neutral	Neutral
127	Low	Neutral	Neutral	Neutral
128	Low	Neutral	Neutral	Neutral
129	Medium (small channel)	Neutral	Neutral	Neutral
130	High	Neutral	Neutral	Neutral

Loss of Natural Bed Form and Sediment Inputs

4.2.3 The permanent loss of natural bed form will occur where pipe culverts are to replace a natural (adjustable) channel bed. However, it should be noted that for the main line, where pipe culverts are proposed in the design, they replace and extend an existing pipe culvert (all be in in an offset location), so loss of natural bed will be minimal. Permanent loss of natural bed will also occur, to a lesser extent where outfall headwalls and any bank protection works occur.

4.2.4 The existing bed substrate will also be removed in the shorter term through the installation of box culverts and channel diversions, but over time a natural bed should reform in these situations, and these culvert types are often replacing current pipe culverts, improving the current conditions by encouraging a more natural bed to form over the long term. The loss of natural bed will reduce the morphological diversity of the channel bed and will alter the sediment supply from the bed. This will have an adverse impact on the natural processes and morphological diversity of the channel at the location of engineering and in downstream reaches where the bed is currently able to erode and add sediment to the channel.

Replacement of Natural Bed Form and Sediment Inputs

4.2.5 In some instances, the natural bed form of the channel will be replaced by the Proposed Scheme, for example, where a pipe culvert is to be replaced with a box culvert and where alterations to bridges are proposed to allow more natural bed forms. This will have a beneficial impact on the watercourses by improving the natural processes, sediment continuity and morphology within the bed of the channel.

Loss of Natural Bank Form and Sediment Inputs

4.2.6 The permanent loss of natural bank form will occur through the installation of erosion protection, head walls, channel realignment and culverts. This will only impact on the channel where banks are currently natural in form, as opposed to where they are currently engineered. The loss of natural bank form will result in reduced sediment supply from these banks that may impact on the processes and morphological diversity of the channel at the location of engineering and in downstream reaches. This will have an adverse impact on the morphology and sediment regime of the channel where banks are currently able to erode and add sediment to the channel.

Fixing Channel Position

4.2.7 Culverts, bank protection, headwalls and bridges all involve fixing the current position of the channel (planform and vertical), limiting the channel's ability to respond to environmental change through channel adjustment. This may result in scour to the engineered structures and bed, changing the current processes and potentially sediment regime. It reduces the resilience of the channel to future changes in water and sediment inputs (climate and/or landuse change). The degree of significance of the impacts varies depending on the extent of the works on the channel and the location of existing infrastructure/ hard engineering, but it will impact the watercourse for the length of the works.

Change in Flow Conditions

4.2.8 All of the works have the potential to alter the flow conditions (discharge and velocity, as well as flow patterns) within the channels. The changes from natural to engineered channels (addition/ extension of culverts, realignments, bridges) have a local adverse impact on the flows in the waterbodies. Similarly, at outfalls and other areas where water is moved across catchments, the natural discharge of the channels is altered, changing flow, sediment regime and potential processes (locations of erosion and deposition) away from the existing

4.2.9 Where current culverts and bridges are causing reduced downstream discharge under high flow events this pressure is proposed to be removed as part of the Proposed Scheme. So a more natural flow (and resultant sediment regime) will be achieved. This will have a beneficial impact on flows within watercourse where the structure sits (upstream and downstream), as well as in the receiving downstream with the potential to improve morphology and processes.

Change in Continuity of Sediment Transfer

4.2.10 Significant steps, culverts and channel diversions have the potential to alter the continuity of sediment transfer, by causing excessive erosion or deposition. For example the significant steps (catchment pits, weirs etc.) hold back the sediment, reducing its downstream transfer. Undersized culverts hold back the flow, causing sediment to drop out upstream (creating and area of deposition) and then have excessive energy downstream of the culvert so cause scour. Equally increasing the downstream discharge of a channel could destabilise the channel causing excessive erosion and incision as it adjusts, and thus producing and transporting excess sediment.

4.2.11 The upsizing of culverts will improve the downstream continuity of sediment transfer, as sediment will be moved through the culvert rather than being deposited upstream as water backs up behind the culvert, but this may lead to downstream channel adjustment.

4.2.12 The removal of catchment pits and other significant steps as part of the design has the potential to increase the continuity of downstream sediment transfer, improving downstream morphology and processes and having a beneficial impact of the waterbodies.

4.2.13 The change of culverts from pipe to box, as well as alterations to bridges to allow a more natural bed will also improve the continuity of sediment transfer, having a beneficial impact on the waterbody.

Change in Sediment Dynamics

4.2.14 The works will alter the sediment inputs to the channel, as well as changing the way that the sediment moves within the waterbody. These changes will result in a change to sediment dynamics and natural processes within the channel at the location of the works and in the reaches downstream.

4.2.15 Excessive erosion of the proposed infrastructure (mainline or track embankment) has the potential to generate excessive sediment (as more sediment is available from the embankment that would be from the channel banks), and change patterns of deposition within the channels. Conversely areas of bank protection stop the inputs of sediment to the channel from erosion, also changing sediment dynamics.

5 Mitigation

5.1 Construction Impacts

5.1.1 Standard A9 mitigation for the shorter term construction impacts of the Proposed Scheme has been introduced and the measures outlined in **Table 9** are relevant to the hydromorphological aspects of the proposed works. As well as these, additional measures listed below will help to reduce damage to the bed and banks and reduce the release and transport of fine sediment downstream:

- Keep as much riparian vegetation as possible to help maintain bank stability and habitat
- Keep tree root balls within the banks to help maintain stability
- Retain existing bed material from channel for re-use in diversions
- Ensure temporary structures are set back from bank and do not impact high or low flows or damage bank integrity

Table 9: Standard mitigation relevant to Hydromorphology

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
Standard A9 Mitigation					
SMC-W1	Throughout proposed scheme	Design, Pre-Construction & Construction	In relation to authorisations under CAR, the Contractor will be required to provide a detailed Construction Method Statement which will include proposed mitigation measures for specific activities including any requirements identified through the pre-CAR application consultation process.	To mitigate construction impacts on the water environment.	CAR applications require approval from SEPA
SMC-W2	Throughout proposed scheme	Pre-Construction & Construction	In relation to flood risk, the Contractor will implement the following mitigation measures during construction: • The Flood Response Plan (as part of the CEMP, refer to Mitigation Item SMC-S1 in Table 21-1 of Chapter 21 (Schedule of Environmental Commitments)) will set out the following mitigation measures to be implemented when working within the functional floodplain (defined here as the 0.5% AEP (200-year) flood extent): ➢ Routinely check the Met Office Weather Warnings and the SEPA Floodline alert service for potential storm events (or snow melt), flood alerts and warnings relevant to the area of the construction works. ➢ During periods of heavy rainfall or extended periods of wet weather (in the immediate locality or wider river catchment) river levels will be monitored using for example SEPA Water Level Data when available/visual inspection of water features. The Contractor will assess any change from base flow condition and be familiar with the normal dry weather flow conditions for the water feature, and be familiar with the likely hydrological response of the water feature to heavy rainfall (in terms of time to peak, likely flood extents) and windows of opportunity to respond should river levels rise. ➢ Should flooding be predicted, works close or within the water features should be immediately withdrawn (if practicable) from high risk areas (defined as: within the channel or within the bankfull channel zone - usually the 50% (2-year) AEP flood extent). Works should retreat to above the 10% AEP (10-year) flood extent) with monitoring and alerts for further mobilisation outside the functional floodplain should river levels continue to rise. • Plant and materials will be stored in areas outside the functional floodplain where practicable, with the aim for temporary construction works to be resistant or resilient to flooding impacts, to minimise/prevent movement or damage during potential flooding events. Where this is not possible, agreement will be required with the Environmental Clerk of Works (EnvCoW). • Stockpiling of material within the functional floodplain, if unavoidable, will be carefully controlled with limits to the extent of stockpiling within an area, to prevent compartmentalisation of the floodplain, and stockpiles will be located >10m from watercourse banks. • Temporary drainage systems will be implemented to alleviate localised surface water flood risk and prevent obstruction of existing surface runoff pathways. Where practicable, temporary haul routes will be located outside of the functional floodplain.	To reduce the risk of flooding impacts on construction works.	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-W3	Throughout proposed scheme	Pre-Construction Construction & Post-Construction/ Operation	In relation to construction site runoff and sedimentation, the Contractor will adhere to GPPs/PGGs (SEPA, 2006-2017) and other good practice guidance (Section 11.2), and implement appropriate measures which will include, but may not be limited to: • avoiding unnecessary stockpiling of materials and exposure of bare surfaces, limiting topsoil stripping to areas where bulk earthworks are immediately programmed; • installation of temporary drainage systems/SuDS systems (or equivalent) including pre-earthworks drainage; • pre-earthworks drainage/ SuDS with appropriate outfalls to be in place prior to any earthworks activities; • treatment facilities to be scheduled for construction early in the programme, to allow settlement and treatment of any pollutants contained in site runoff and to control the rate of flow before water is discharged into a receiving watercourse; • the adoption of silt fences, check dams, settlement lagoons, soakaways and other sediment trap structures as appropriate; • the maintenance and regrading of haulage route surfaces where issues are encountered with the breakdown of the existing surface and generation of fine sediment; • provision of wheel washes at appropriate locations (in terms of proposed construction activities) and >10m from water features; • protecting soil stockpiles using bunds, silt fencing and peripheral cut-off ditches, and location of stockpiles at distances >10m from water features; and • restoration of bare surfaces (seeding and planting) throughout the construction period as soon as possible after the work has been completed, or protecting exposed ground with geotextiles if to be left exposed	To implement appropriate controls for site runoff and sedimentation and reduce impacts on the water environment.	If flocculants are considered necessary to aid settlement of fine suspended solids, such as clay particles, the chemicals used must first be approved by SEPA. Where required, temporary discharge consents to be obtained from SEPA through the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended).
SMC-W4	Throughout proposed scheme	Pre-Construction & Construction	In relation to in-channel working, the Contractor will adhere to GPPs/PPGS (SEPA, 2006-2017) and other good practice guidance (Section 11.2), and implement appropriate measures which will include, but may not be limited to: • undertaking in-channel works during low flow periods (i.e. when flows are at or below the mean average) as far as reasonably practicable to reduce the potential for sediment release and scour; • no in-channel working during the salmonid spawning seasons unless permitted within any CAR licence; • minimise the length of channel disturbed and size of working corridor, with the use of silt fences or bunds where appropriate to prevent sediment being washed into the water feature; • limit the removal of vegetation from the riparian corridor, and retaining vegetated buffer zone wherever reasonably practicable; and • limit the amount of tracking adjacent to watercourses and avoid creation of new flow paths between exposed areas and new or existing channels.	To reduce impacts on the water environment during in-channel working.	Method statements for any in-channel working require approval by SEPA

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-W5	Throughout proposed scheme	Construction	Where channel realignment is necessary, the Contractor will adhere to good practice guidance (Section 11.2) and implement appropriate measures which will include, but may not be limited to: • Once a new channel is constructed, the flow should, where practicable, be diverted from the existing channel to the new course under normal/low flow conditions; • diverting flow to a new channel should be timed to avoid forecast heavy rainfall events at the location and higher up in the catchment (the optimum time will be the spring and early summer months to allow vegetation establishment to help stabilise the new channel banks); • with offline realignments, the flow will be diverted with a steady release of water into the newly constructed realignment to avoid entrainment of fine sediment or erosion of the new channel; and • any proposed realignment works will be supervised by a suitably qualified fluvial geomorphologist.	To reduce impacts on the water environment where channel realignment is proposed.	Consultation with SEPA
SMC-W6	Throughout proposed scheme	Construction	In relation to refuelling and storage of fuels, the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Section 11.2), and implement appropriate measures which will include, but may not be limited to: • only designated trained and competent operatives will be authorised to refuel plant; • refuelling will be undertaken at designated refuelling areas (e.g. on hardstanding, with spill kits available, and >10m from water features) where practicable; • appropriate measures will be adopted to avoid spillages (refer to Mitigation Item SMC-W7); and • compliance with the Pollution Incident Control Plan (refer to Mitigation Item SMC-S1).	To avoid spillages and reduce impacts on the water environment in relation to refuelling.	None required
SMC-W9	Throughout proposed scheme	Construction	In relation to concrete, cement and grout, the Contractor will adhere to GPPs/PPGs (SEPA, 2006-2017) and other good practice guidance (Section 11.2), and implement appropriate measures which will include, but may not be limited to: • concrete mixing and washing areas will: ➢ be located more than 10m from water bodies; ➢ have settlement and re-circulation systems for water reuse; and ➢ have a contained area for washing out and cleaning of concrete batching plant or ready-mix lorries. • wash-water will not be discharged to the water environment and will be disposed of appropriately either to the foul sewer (with permission from Scottish Water), or through containment and disposal to an authorised site; • where concrete pouring is required within a channel, a dry working area will be created; • where concrete pouring is required within 10m of a water feature or over a water feature, appropriate protection will be put in place to prevent spills entering the channel (e.g. isolation of working area, protective sheeting); and • quick setting products (cement, concrete and grout) will be used for structures that are in or near to watercourses.	To reduce impacts on the water environment in relation to concrete, cement and grout.	Permission required from Scottish Water. Consultation with SEPA.

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-W13	Throughout proposed scheme	Design	In relation to bank reinforcement, design principles and mitigation measures will adhere to good practice (SEPA, 2008), which will include, but may not be limited to: • non-engineering solutions and green engineering (e.g. vegetation, geotextile matting) to be the preference during options appraisal; • requirements for grey engineering to control/prevent scour (e.g. rock armour, rip-rap, gabion baskets) to be minimised; and • post project appraisal to identify if there are issues that can be investigated and addressed at an early stage.	To reduce impacts of in-channel structures on the water environment.	Consultation with SEPA
SMC-W14	Throughout proposed scheme	Design	In relation to outfalls, specimen and detailed design will ensure compliance with good practice (e.g. CIRIA, 2015; The Highways Agency et al., 2004; SEPA, 2008), which will include, but may not be limited to: • directing each outfall downstream to minimise impacts to flow patterns; • avoiding projecting the outfall into the watercourse channel; • avoid installation of outfalls at locations of known historical channel migration; • avoid positioning in flow convergence zones or where there is evidence of active bank erosion/instability; • directing an outfall away from the banks of a river to minimise any potential risk of erosion (particularly on the opposite bank); • minimising the size/extent of the outfall headwall where possible to reduce the potential impact on the banks; and • post project appraisal to identify if there are issues that can be investigated and addressed at an early stage	To reduce impacts of outfalls on the water environment.	Consultation with SEPA

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-W15	Throughout proposed scheme	Design	In relation to watercourse crossings, specimen and detailed design will ensure compliance with good practice (SEPA, 2010), which will include, but may not be limited to: • Detailed design will mitigate flood risk impacts through appropriate hydraulic design of culvert structures. Flood risk will be assessed against the 0.5%AEP (200-year) plus an allowance for climate change design flood event. Widening of the scheme footprint may lead to loss of existing floodplain storage volume. Detailed design will mitigate any loss of the existing floodplain storage volume, where required by appropriate provision of compensatory storage. Where culvert extension is not practicable or presents adverse impact on the water environment, appropriately designed replacement culverts may be installed. • Detailed design will mitigate impacts on the water environment through appropriate design of culvert structures and watercourse modifications (e.g. realignments) with respect to fluvial geomorphology, and both riparian and aquatic ecology. • Detailed design of culverts and associated watercourse modifications will incorporate wherever practical: ➢ adherence to design standards and good practice guidance (Section 11.2); ➢ allowance for the appropriate conveyance of water and sediment for a range of flows (including at low flow conditions); ➢ maintenance of the existing channel gradient to avoid erosion at the head (upstream) or tail (downstream) end of a culvert; ➢ avoidance of reduction of watercourse length through shortening of watercourse planform; ➢ minimisation of culvert length; ➢ close alignment of the culvert with the existing water feature; ➢ depressing the invert of culverts to allow for formation of a more natural bed (embedment of the culvert invert to a depth of at least 0.15m to 0.3m); and ➢ roughening of culvert inverts to help reduce water velocities. • Post project appraisal of watercourse crossings will be undertaken to identify if there are issues that can be investigated and addressed at an early stage	To reduce impacts of culverts on the water environment.	Consultation with SEPA

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-W16	Throughout proposed scheme	Design & Construction	In relation to channel realignments, specimen and detailed design will ensure compliance with good practice (Section 11.2), which will include, but may not be limited to: • minimising the length of the realignment, with the existing gradient maintained where possible; • design of the realignment in accordance with channel type and gradient; • if required, low flow channels or other design features to reduce the potential for siltation and provide an opportunity to improve the geomorphology of the water feature; • realignment designs will be led by a suitably qualified fluvial geomorphologist; • where realignments result in an increase or decrease of channel gradient, the following principles will be applied: ➢ an increased gradient within the channel (resulting in higher stream energies) will require mitigation in the form of energy dissipation, which could include the creation of a step-pool sequence; boulder bed-checks; plunge pools at realignment outfall; and/or; increased sinuosity; and ➢ a decrease in gradient within the channel will require mitigation in the form of the construction of a low flow channel to minimise the impacts on locally varying flow conditions and reduce the risk of siltation of the channel. • Post project appraisal to identify if there are issues that can be investigated and addressed at an early stage	To reduce impacts of channel realignment on the water environment.	Consultationwith SEPA
SMC-W17	Throughout proposed scheme	Design & Construction	In relation to SuDS, the following mitigation measures will be implemented: • detailed design to adhere to design standards and good practice guidance (Section 11.2 of Chapter 11 Road Drainage and the Water Environment), including The SuDS Manual (CIRIA, 2015) and SuDS for Roads (SCOTS, 2010); • for each drainage run, a minimum of two levels of SuDS treatment within a ‘treatment train’ (see Table 1 of Appendix 11.2 for further details) to limit the volume of discharge and risk to water quality; • management of vegetation within ponds and drains through grass cutting, pruning of any marginal or aquatic vegetation (as appropriate to the SuDS component) and removal of any nuisance plants, especially trees; • SuDS retention ponds will be designed with an impermeable liner to maintain a body of standing water and provide treatment volume; • inspect inlets, outlets, banksides, structures and pipework for any blockage and/or structural damage and remediate where appropriate; and • regular inspection and removal of accumulated sediment, litter and debris from inlets, outlets, drains and ponds to avoid sub-optimal operation of SuDS; and • adherence to the maintenance plans specific to each SuDS component type as detailed within The SuDS Manual (CIRIA, 2015)	To reduce impacts of drainage discharges on the water environment.	Where required, authorisation for the road drainage discharge under CAR 2011 (as amended) would be obtained from SEPA

5.2 Operational Impacts - Embedded Mitigation

5.2.1 Mitigation for the long term operational impacts of the Proposed Scheme have been identified and incorporated into the design where possible to give the Assessment Design (**Drawing 5.1-5.7, Volume 3**). These have been identified as embedded mitigation. This mitigation is documented below for each of the identified impacts. The assessment has been re-run with the embedded mitigation in place (based on the Design Fix) and the significance assigned to each catchment is summarised in **Table 8**. There is no change in the significance of the impacts with the mitigation in place for most waterbodies. This is because the significance is largely determined by the extent (length) of the impact, and in most cases while the mitigation lessens the extent of the impact, it does not fully remove it or change it to the category down.

Loss of Natural Bed Form and Sediment Inputs

5.2.2 The following mitigation is required to compensate for the loss of natural bed form and sediment inputs to the channel caused by the various elements of the works. This has been embedded into the design for all watercourses:

- Use bridges or arch culverts where feasible to allow existing natural bed formation and vertical adjustment of the channel
- Depress the invert of pipe and box culverts to allow for the formation of a more natural bed (300mm thick) on medium, high and very high sensitively channels
- For steep culverts (over 4%) put in pools at the upstream and downstream end to dissipate energy into and out of the culvert, to reduce the extent of hard engineering required to the channel bed
- Ensure that the natural bed is retained under bridges

Loss of Natural Bank Form and Sediment Inputs

5.2.3 The following mitigation is required to compensate for the loss of natural bank form and sediment inputs to the channel caused by the various elements of the works. This has been embedded into the design:

- Set back bridge abutments away from bank tops to reduce the extent of hard engineering within the channel, and to allow natural channel adjustment to occur
- Ensure that minimal bank erosion protection is installed on the watercourse through sustainable design and positioning of bridges, channel realignments, embankments (mainline and track) and SuDS basins, to ensure minimal disturbance to the channel banks

Fixing Channel Position

5.2.4 The following mitigation is required to minimise the extent to which it position of the watercourses are fixed by the scheme:

- Minimise the size/ extent of the outfall headwall where possible to reduce potential impacts on the bed and banks
- Design outfalls and diversions to take into account changes in bank and bed position at their confluence with the “main river”. Use green engineering and design to allow for adjustments in channel positon for both the main channel they are feeding into, and the outfall/ diversion channel

- Ensure that minimal bank erosion protection is installed on the watercourse through sustainable design and positioning of bridges, channel realignments, embankments (mainline and track) and SuDS basins, to ensure channels can move laterally across their floodplain

Change in Flow Conditions

5.2.5 The following mitigation is required to ensure minimal changes in flow conditions are caused by the various elements of the works. This mitigation has been embedded into the design:

- Allow for the passage of water and sediment for a range of flows (including at low flow conditions) by creating or ensuring the retention of a low flow channel/ slot within culverts and bridges, to ensure a suitable depth of flow in all conditions
- Avoid a change in river length through change in planform
- Design culverts, bridges and realignments to maintain appropriate flows and velocities by retaining channel length and slope

Change in Continuity of Sediment Transfer

5.2.6 The following mitigation is required to ensure minimal changes in sediment transfer are caused by the various elements of the works. This mitigation has been embedded into the design:

- Allow for the passage of water and sediment for a range of flows (including at low flow conditions) by creating a low flow channel within the culvert in all locations, to ensure a suitable depth of flow in all conditions through the culvert
- For steep culverts (over 4%) put in pools at the upstream and downstream end to dissipate energy, and reduce the extent of excessive erosion of and sediment supply to the channel
- Resection channel 107 that is currently experiencing excessive incision to create a more sustainable channel and reduce excessive downstream sediment supply

Change in Sediment Dynamics

5.2.7 The following mitigation is required to ensure minimal changes in sediment dynamics that are caused by the various elements of the works. This mitigation has been embedded into the final Proposed Scheme design:

- Maintain a channel gradient to avoid erosion at the head or tail (downstream) end of the culvert and any realignments at all locations, to ensure stability of the culvert and to reduce the likely hood of a change in sediment transport
- Limit changes in channel length due to alteration in channel planform, potentially impacting on channel gradient and consequentially flow and sediment dynamics at all locations;
- Avoid a change in river length through change in planform
- Keep the length of culvert to a minimum and align the culvert with the existing watercourse at all locations, to ensure stability of the culvert and to reduce the likely hood of a change in sediment transport
- Areas of erosion protection to embankment toe at 104 to prevent long term excessive sediment supply

- Erosion protection to the channel or infrastructure, where this has been deemed to be a medium or high risk from fluvial erosion (**Annex 11.4.2**)
- Areas of erosion protection to bridge abutments where these are within the 1:200 year floodplain to prevent excessive erosion and sediment supply to the channel

5.3 Operational Impacts – Additional Project Specific Mitigation

5.3.1 Additional Project Specific mitigation has then been identified following assessment of the Assessment Design and the assessment has been re-run for a third time, assuming this additional mitigation is in place for hydromorphology and from other disciplines. The significance of impacts for each watercourse is summarised in **Table 8** within **Section 3** of this appendix giving the residual significance. While in the case of this project the additional mitigation does not greatly change the significance of impact, it will be required in order to ensure that a CAR licence for the works is granted. This additional mitigation is outlined below and shown on **Drawings 11.18-11.25** (contained in **Volume 3** of this report).

Loss of Natural Bed Form and Sediment Inputs

5.3.2 The following additional Project Specific mitigation is required to compensate for the loss of natural bed form and sediment inputs to the channel caused by the various elements of the works:

- Incorporate varied bed profiles in all channel realignments to help create diverse morphological form and resultant flow, processes and habitats in medium, high and very high sensitivity channels. This variety will also help create more sustainable and stable channels, less likely to have a negative impact on the stability of the A9 embankments and crossings. **Annex 11.4.4.3** outlines the river morphology that should be included for each channel diversion, with the details of these channel types in **Annex 11.4.6.** These realignments should be designed on a channel by channel basis by a suitably qualified Hydromorpholoist, and they should ensure that natural channel widths are used for realignments, through bridge and culverts and that these are designed to take the 1:2 year flow
- Remove the existing concreate bed and replace with a natural bed where possible with in the extents of the Proposed Scheme
- Ensure all channel realignments have natural bed material, ideally from the bed of the channel that has been diverted, to allow for varied flow and sediment transport regime that help to support a wide range of habitats. Having bed material in the channel also helps to dissipate energy, creating a more sustainable channel
- Ensure that any imported bed material is of the same size and geology of that existing, and is detailed at specimen design stage, and where possible use material from the existing bed to ensure the continuation of downstream movement of sediment. The calibre and quantity of material should be determined on a site by site basis and this should take into account changes in the energy regime within the watercourse
- Minimise the size/ extent of hard engineering on the outfall headwall to that which is absolutely required to and use green engineering reduce potential impact on the bed and banks. Ensure that outfalls on High sensitivity and active watercourses are designed with anticipation for erosion and bed level change over time as the channel they feed into changes position

- Increase the roughness of the culvert inverts to help reduce water velocities and keep bed material in the culverts using baffles or embedded cobbles on medium, high and very high sensitively channels
- Ensure that the natural bed is retained under bridges and remove the existing concreate bed and replace with natural bed were possible where this has been replaced with hard engineering in the past
- Restore a more natural planform and morphology to channels previously straightened as part of the construction of the A9

Loss of Natural Bank Form and Sediment Inputs

5.3.3 The following additional Project Specific mitigation is required to compensate for the loss of natural bank form and sediment inputs to the channel caused by the various elements of the works:

- Incorporate varied bank profiles and varied channel widths in channel realignments to allow the dissipation of energy through the creation of a range of form and flow conditions in all medium and high sensitivity channels and in low sensitivity channels where feasible. This will create varied habitat as well as creating a suitable and stable channel
- Remove existing concreate banks and replace with reprofiled varied banks where possible
- Minimise the size/extent of hard engineering on the outfall headwall to that which is absolutely required to reduce potential impact on the bed and banks

Fixing Channel Position

5.3.4 The following additional Project Specific mitigation is required to reduce the degree to which the channel is fixed by engineering and to create a more stable and sustainable system of watercourses:

- Design stable channel realignments with a suitable slope and form for that slope, that allow channel adjustment and reduce the need for hard engineering for example on steep realignments ensure energy dissipation through the incorporating of larger clasts and step-pool sequences, on lower slopes create plane bed and plane-riffle channels (**Annex 11.4.4.3**).
- Design outfalls (SuDS, drains and realignments) and diversions to take into account changes in bank and bed position at their confluence with the “main river”. Use green engineering and design to allow for adjustments in channel positon for both the main channel they are feeding into, and the outfall/diversion channel This ensures that the engineering is not damaged as well as allowing the channel to migrate across its floodplain
- Ensure the confluences of realigned channels are designed to allow a degree of adjustment (vertical and lateral), as the receiver channel moves across its floodplain
- Ensure bridges allow lateral and vertical channel change, in order to reduce the need for erosion protection and minimise damage to the structures
- Restore a more natural planform and morphology to channels previously straightened as part of the construction of the original A9
- Use green bank protection works were feasible as per SEPA’s ‘*Reducing River Bank erosion-A Best Practice Guide for Farmers’*

Change in Flow Conditions

5.3.5 The following additional mitigation is required to limit the impacts on flow conditions from the works:

- Direct the flow from outfalls downstream to minimise impacts to flow patterns and to reduce the risk of erosion to the structure
- Direct the flows from outfalls away from the banks of the river to minimise any potential risk of erosion (particularly the opposite bank)
- Ensure bridges have a low flow channel and natural bed material in order to allow a suitable depth of flow under a range of flow conditions

Change in Continuity of Sediment Transfer

5.3.6 The following additional mitigation is required to allow the continuity of downstream sediment transfer:

- Ensure a natural bed in culverts, under bridges and in channel realignments for all channels, to ensure the continued downstream movement of sediment, as well as allowing damaged habitat to repair.
- Add buried bed checks under steep channel realignments, through erodible material to reduce the risk of incision of the channel undermining and damaging the road, and production of excess sediment.
- Resection channels that are currently experiencing excessive incision to create a more sustainable and stable channel and reduce excessive downstream sediment supply and reducing the risk of damage to the scheme

Change in Sediment Dynamics

5.3.7 The following additional mitigation is required to limit negative changes in sediment dynamics:

- Add buried bed checks under steep channel realignments, through erodible material to reduce the risk of incision of the channel undermining and damaging the road, and production of excess sediment
- Backfill channels and valleys after they have been diverted to reduce the risk of high flows entering into old channel causing scour
- Ensure scour pools are designed on a site by site basis at the end of all culverts to dissipate excess energy
- Design in energy dissipation measures in culverts on a site by site basis to help retain bed material and reduce downstream scour and increased sediment supply

6 Residual Impacts

6.1.1 Residual impacts are those which remain following the implementation of all mitigation measures. **Table 8** gives the significance of the residual impacts for the construction phase of the scheme, and this shows the scheme to have neutral or beneficial impacts. As with the embedded mitigation there are few watercourses where the additional project specific mitigation changes the significance of the impacts, however it follows best practice and will reduce the risk of damage to the infrastructure from the water environment and will be required inorder to obtain a CAR licence for the works to the channels.

7 Combined Effects

7.1.1 Within this appendix the impacts of the works on each catchment have been assessed together to give the combined effects of the Proposed Scheme on each waterbody considered. However, further combined effects within Project 8 will affect the hydromorphology of the channels. There will be multiple small changes to sediment transfer, discharge and velocity within the tributaries that flow into the River Truim and to a lesser extent to the Garry and Allt Coire Dhomhain. These have the potential to impact the form and processes of the Rivers Truim, Garry and potentially the Spey and Tay over long timescales.

7.1.2 Many of the proposed works (increasing culvert capacity, providing a natural bed within culverts and under bridges and removing catchpits) will be increasing the discharge and potential volume of sediment from the tributaries to the River Truim, creating more natural conditions than the baseline by returning the systems to something closer to those that were present before the A9 was originally constructed. This will have a beneficial combined effect on the hydromorphology of the tributaries and the River Truim. However, these increases in sediment and water supply may cause change to the location of erosion and deposition within the River Truim, and ultimately the size, shape and location of the channel as it adjusts to these changes.

7.1.3 The magnitude of the increases in sediment and water are unlikely to be great, and any adjustment of the River Truim are likely to be limited as left bank tributaries are unaffected by the existing A9 and the Proposed Scheme will still be adding water and sediment to the River Truim. The magnitude of these inputs will also become reduced proportionally as downstream watercourses continue to input more sediment and water.

8 Monitoring Requirements

8.1.1 Geomorphological post-project monitoring is recommended on all watercourses where works have been undertaken to verify that the Proposed Scheme and mitigation are functioning as intended in relation to the watercourses, and to identify areas where the watercourse is having an unexpected negative impact on the Proposed Scheme and the Proposed Scheme may be at risk, as well as areas where the Proposed Scheme is having an unexpected negative impact on the waterbodies.

8.1.2 This monitoring should be undertaken in the form of repeat fixed point photography to provide a means to qualitatively assess geomorphological change in-channel and on the floodplain, between successive surveys. It also enables a rapid, factual, and low-cost method of verifying information.

8.1.3 The fixed point photograph locations should be chosen on completion of construction and should ensure generic coverage of the channel corridor and floodplain environment. Each fixed point photograph location should be recorded with a metal peg in the ground with a unique number at its location. The national grid reference (NGR) of this location should be recorded and entered into GIS, as well as the photo characteristics (i.e. bearing, landscape/ portrait orientation, field of view etc.). Photographs between surveys should be compared and incorporated into reporting to identify areas of excessive change where future management may be required.

8.1.4 Monitoring should be undertaken on completion of the Proposed Scheme and periodically thereafter (timing to be agreed with SEPA) as well as after high flow events (levels to be agreed with SEPA).

9 References

SEPA, 2011. Supporting Guidance (WAT-SG-21), Environmental Standards for River Morphology

SEPA, 2015. Supporting Guidance (WAT-SG-67), Assessing the Significance of Impacts - Social, Economic, Environmental

10 Annexes

10.1 Annex 11.4.1 Initial Hydromorphological Scoping Assessment

ID	Easting	Northing	Type	Upstream		At crossing		Downstream		Initial Screening (in or out)
				Erosion	Deposition	Erosion	Deposition	Erosion	Deposition	
65	263879	781747	minor	Med	Low	Low	Med	Low	Low	In
66	263898	781813	other	Med	Low	Low	Low	Med	Low	In
67	263931	781952	other	Low	Low	Low	Low	Low	Low	Out
68	263947	782025	other	High	Low	Med	Low	Low	Low	In
69	263953	782065	other	Low	Low	Low	Low	Low	Low	Out
70	263970	782125	other	Low	Low	Low	Low	Med	Med	In
71	263974	782219	other	Low	Low	Low	Low	Med	Low	In
72	263985	782359	major	Med	Med	Low	Med	Med	Low	In
74	263992	782479	other	Low	Low	Low	Med	Low	Low	In
75	263992	782602	other	Low	Low	Low	Low	Low	Med	In
76	263993	782953	minor	Low	Med	Low	Low	Low	Med	in
77	263986	783044	major	Med	Med	Low	Low	Med	Med	In
78	263989	783213	other	Low	High	Low	Low	Low	Med	In
79	263985	783360	minor	Low	Low	Low	Low	Low	Low	In
81	263997	783728	minor	Low	Low	Low	Low	Med	Low	In
82	264002	783832	major	Low	High	High	High	Low	High	In
83	264023	784004	other	Low	High	Low	Low	Low	Med	In
84	264062	784255	other	Low	Low	Low	Low	Low	Low	In
85	264081	784335	other	Low	Low	Low	Low	Low	Low	In
87	264120	784525	other	Low	Low	Med	Med	Low	Low	In
88	264258	784956	major	Low	Low	Low	Low	Low	Low	Out
89	264243	784929	major	Low	Med	Low	Med	Low	Low	In
90	264289	784986	other	Low	Low	Low	Low	Low	Low	Out
91	264303	785051	other	Low	Med	Low	Low	Med	Low	Out
92	264317	785128	other	Low	Low	Low	Low	Low	Low	Out
93	264347	785220	other	Low	Low	Low	Low	Low	Low	Out
94	264481	785491	other	Med	Low	Low	Low	Low	Low	In
95	264575	785639	other	Low	Med	Low	Low	Low	Low	In
96	264610	785689	other	Low	Low	Low	Low	Low	Low	Out
97	264815	785946	other	Low	Low	Low	Low	Low	Low	Out
98	264857	786002	other	Low	Low	Low	Low	Med	Med	In
99	265025	786198	minor	Low	Low	Low	Low	Med	Low	In
100	265381	786606	major	Med	Low	Low	Med	Low	Low	in
101	265465	786699	other	Low	Low	Low	Low	Low	Low	Out
102	265612	786905	minor	Low	Med	Low	Med	Low	Med	In
103_1	265672	787046	minor	Low	Low	Low	Low	Low	Low	In
103_2	265672	787046	minor	Low	Low	Low	Med	Low	Low	In
104	265699	787132	major	High	High	High	High	High	High	In
105	265728	787205	other	Low	Low	Low	Low	Low	Low	Out
106	265759	787279	minor	Low	Low	Low	Low	Low	Med	In
107	265953	787640	major	High	High	High	High	Med	Med	In
109	266137	787892	minor	Med	Med	Low	Med	Low	Med	In
110	266355	788129	other	Low	Low	Low	Low	Low	Low	Out
111	266525	788276	minor	Low	low	Low	Med	Low	Low	In
112	266730	788431	major	Med	Med	Low	Med	Low	Med	In
113	266821	788508	other	Low	Low	Low	Low	Low	Low	Out
114	266915	788590	major	Med	Low	Low	Med	Low	Low	In
115	266977	788649	minor	Med	Med	Med	Med	Med	Med	In
133	269009	794517	other	Med	Low	Low	Low	Low	Low	In
134	269167	795018	minor	Low	Low	Low	Low	Low	Low	In
136	269209	795239	minor	Low	Med	Low	Low	Low	Med	In
140	270935	797287	minor	Low	Low	Low	Low	Low	Low	In
142	271172	797403	minor	Low	Low	Low	Low	Low	Low	In
143	271530	797516	minor	Low	Low	Low	Med	Low	Med	In
148	275060	799008	minor	Low	Low	Low	Low	Low	Low	In
152	276440	800507	major	High	High	High	High	High	High	In
155	276859	801499	major	Low	Med	Low	Med	Low	Med	In
156	277042	801637	minor	Low	Low	Low	Low	Low	Low	In
157	277280	801734	major	Low	High	Low	Low	Low	High	In
159	278203	801961	minor	Low	Low	Low	Low	Low	Low	In
161	278414	802016	minor	Low	Low	Low	Low	Low	Low	In

ID	Easting	Northing	Type	Upstream		At crossing		Downstream		Initial Screening (in or out)
				Erosion	Deposition	Erosion	Deposition	Erosion	Deposition	
162	278960	802188	major	Low	Med	Low	High	Low	High	In
165	279673	802834	minor	Low	Low	Low	Low	Low	Low	In
166	280367	803311	minor	Low	Low	Low	Low	Low	Low	In
168	280671	803470	minor	Low	Low	Low	Low	Low	Low	In
138_1	269416	795971	other	Low	Low	Low	Low	Low	Med	In
138_2	269711	796518	minor	Med	Med	Low	Med	Med	Med	In
144_1	271686	797649	minor	Low	Low	Low	Low	Low	Low	In
145_1	272808	798256	major	Med	Med	Med	Med	Med	Med	In
146_1	273135	798428	minor	Med	Med	Med	High	Med	Med	In
147_1	274403	798827	major	Med	Med	Med	Med	Med	Med	In
30	263126	776109	other	Low	Low	Low	Low	Low	Low	Out
17	263404	774996	minor	No data	No data	No data	High	No data	No data	Out
3	264497	773399	other	Low	Low	Med	Low	Med	Low	Out
11	263699	774399	other	Low	Low	Low	Low	Low	Low	Out
15	263565	774745	other	Low	Low	Low	Low	Low	Low	Out
18	263434	775054	other	Low	Low	Low	Low	Low	Low	Out
21	263346	775295	other	Low	Low	Low	Low	Low	Low	Out
22	263318	775369	other	Low	Low	Low	Low	Low	Low	Out
25	263228	775676	other	Low	Low	Low	Low	Low	Low	Out
33	263052	776331	other	Low	Low	Low	Low	Low	Low	Out
35	262997	776496	other	Low	Low	Low	Low	Low	Low	Out
36	262920	776708	other	Low	Low	Low	Low	Low	Low	Out
37	262870	776844	other	Low	Low	Low	Low	Low	Low	Out
38	262842	776937	other	Low	Low	Low	Low	Low	Low	Out
42	262636	777349	other	Low	Low	Low	Low	Low	Low	Out
45	262718	778814	other	Low	Low	Low	Low	Low	Low	Out
47	262797	779035	other	Low	Low	Low	Low	Low	Low	Out
50	262860	779182	other	Low	Low	Low	Low	Low	Low	Out
53	263004	779548	other	Low	Low	Low	Low	Low	Low	Out
54	263009	779563	other	Low	Low	Low	Low	Low	Low	Out
55	263052	779710	other	Low	Low	Low	Low	Low	Low	Out
56	263108	779909	other	Low	Low	Low	Low	Low	Low	Out
58	263265	780459	other	Low	Low	Low	Low	Low	Low	Out
60	263407	780771	other	Low	Low	Low	Low	Low	Low	Out
116	267144	788828	minor	Low	Low	Low	Low	Low	Low	In
117	267236	788943	other	Low	Low	Low	Med	Low	Low	In
118	267305	789031	minor	Low	Low	Low	Low	Med	Low	In
119	267435	789243	minor	Low	Low	Low	Low	Low	Low	In
120	267566	789502	other	Low	Low	Low	Low	Low	Low	Out
121	267596	789578	major	High	High	High	High	High	High	In
122	267670	789745	other	Low	Low	Low	Low	Low	Low	Out
123	267694	789816	minor	Med?	Low	Med	Med	Low	Low	In
124	267710	789897	minor	Low	Med	Low	Med	Low	Med	In
125	267730	789975	minor	Low	Low	Low	Low	High	Low	In
126	267741	790051	other	Med	Med	Low	Low	Med	Low	In
127	267797	790574	other	Low	Low	Med	Med	Low	Low	In
128	267794	790649	other	Low	Med	Low	Low	Low	Low	In
129	267779	790894	major	Low	Low	Low	Low	Low	Low	In
130	267763	791051	major	Low	Low	Low	Low	Low	Low	In

10.2 Annex 11.4.2 Erosion Risk Assessment

Introduction

The watercourses within Project 8 drain small, steep catchments, are high energy systems and are often laterally and vertically dynamic. They adjust their position (vertical and lateral) and channel shape, size and slope overtime due to changes in water and sediment supply and move across their floodplains over time. This ongoing adjustment of the river channel has the potential to damage the infrastructure associated with the A9. A review of the erosion risk from the watercourses was therefore undertaken during the Environmental Impact Assessment (EIA) and is documented in this note. This guidance has then been provided to the design team and incorporated into the Assessment Design.

Methodology

A review of channel change along the 4th and 6th iteration designs was undertaken by a Hydromorphologist using OS mapping, aerial photography and the proposed design (6th Iteration) in GIS to highlight areas where the channel has recently migrated across its floodplain and where it is in close proximity to the existing and proposed infrastructure, or where the channel is eroding vertically (lowering) and this could undermine the infrastructure.

A risk assessment has been undertaken for these locations based on the Assessment Design as follows:

- A channel stability score between 1 and 3 has been assigned to each area of infrastructure as per **Table 1**, with 3 being an area of the least stable channel. Note that a score of 1 still indicates some instability in the channel.
- A Proximity of infrastructure score be score between 1 and 3 has been assigned to each area of infrastructure as per **Table 1**. The distance is based on the distance of the infrastructure to the bank top of the channel with measurements taken from the 2015 aerial photography (as the most recent dataset).
- A consequence of damage score has then been assigned to each area as per **Table 1** based on the infrastructure at risk and its importance to the ongoing function of the A9.
- Likelihood of erosion at asset location has been calculated based on 1/2 x (Channel stability score + Proximity of infrastructure). This is ½ to ensure equal weighting in the risk calculation between the likelihood and consequence).
- A risk score has then been calculated based on Likelihood x Consequence, and these have been grouped as follows. Results and scoring are demonstrated in **Table 2**:
    - High risk- 6.1-9
    - Medium risk-3.1-6
    - Low Risk- 2-3

Table 1- Scoring and reasoning for the difference elements of the risk assessment

Risk assessment element	Score	Reason
Channel stability		
Very unstable	3	Evidence of channel change between current OS 1:10K and AP or evidence of instability from AP's (large bars and hillside erosion)
Unstable	2	Some change likely to have occurred but not mapped or change expected due to works (i.e. removal of hard bed)
Relatively stable	1	Little/ no evidence of channel change but potential for future change
Proximity of infrastructure to channel		
	3	Less than 5m to bank top
	2	5-10m to bank top
	1	10m+ to bank top
Consequence of damage		
High	3	Will involve road being shut/ high cost to fix
Medium	2	Some impact on function of the road/ scheme but will require some cost to fix
Low	1	Little impact on function of the road

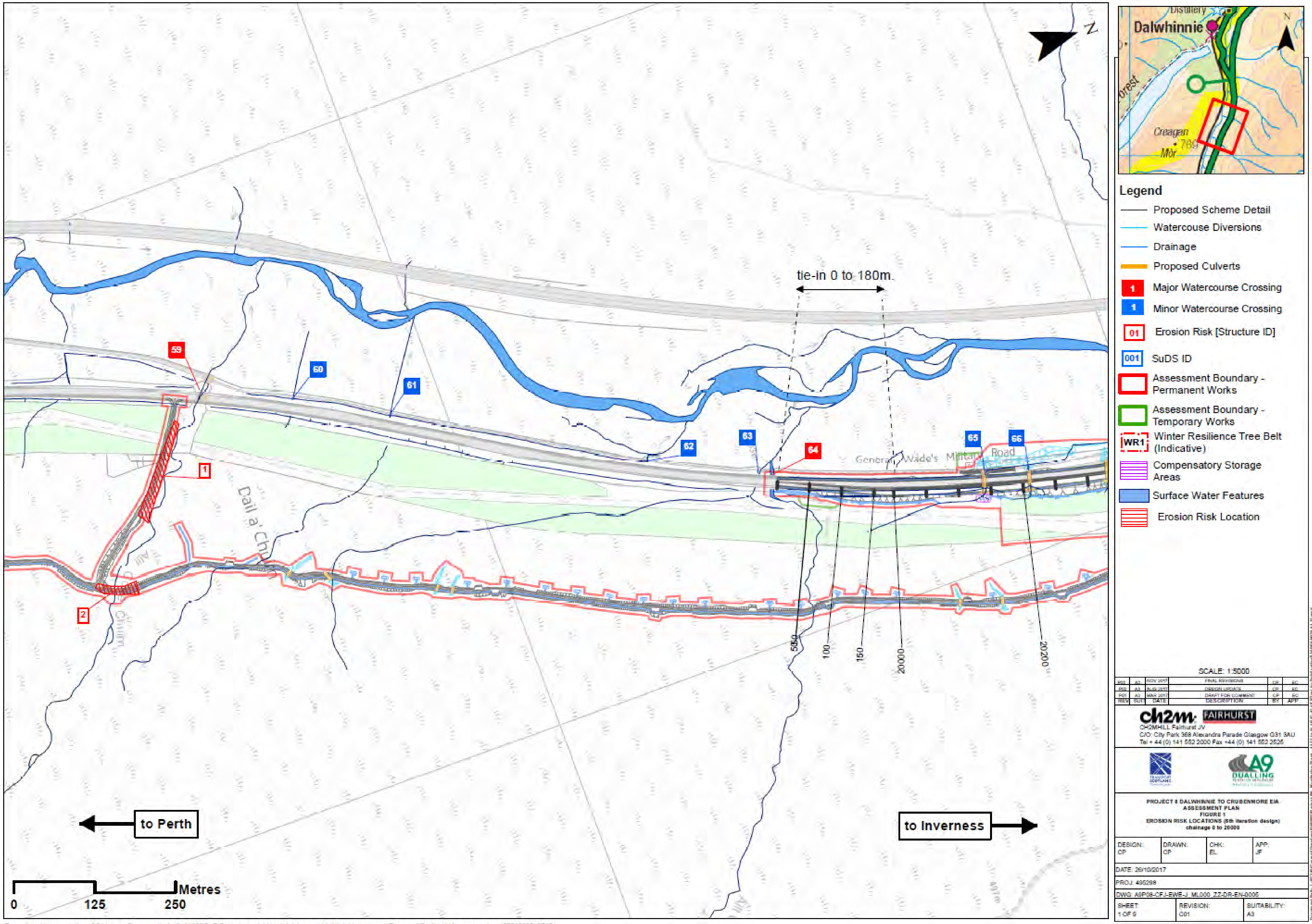
Results

28 areas of at risk infrastructure (including bridges, outfalls and embankments) were identified in the 6th iteration design, where the ongoing movement of a watercourse has the potential to impact the infrastructure (during the design life of the project). These areas are presented in **Figures 1 to 9** and in **Table 2** along with high level guidance as to how to mitigate the erosion risk. This information has then been taken by the design team and integrated into the Assessment Design.

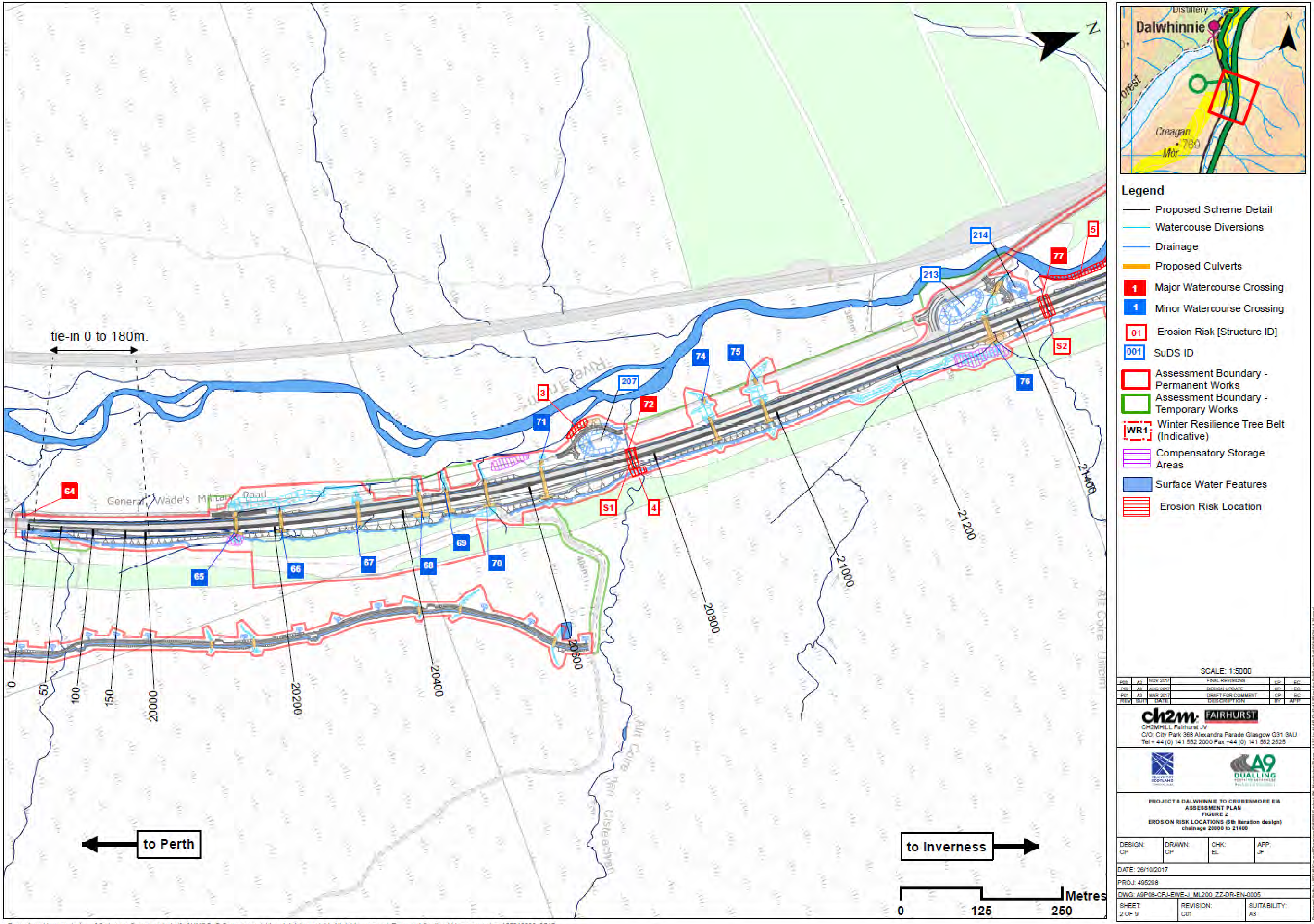
It should be noted that these areas all have a likelihood of erosion to the assets over the life of the project assuming that current processes and patterns continue to occur. The works associated with the Proposed Scheme also have the potential to initiate new areas of erosion over the life of the scheme and these have not been considered here. The extent of the areas identified highlighted the asset at risk and should not been seen as the full extent of intervention required.

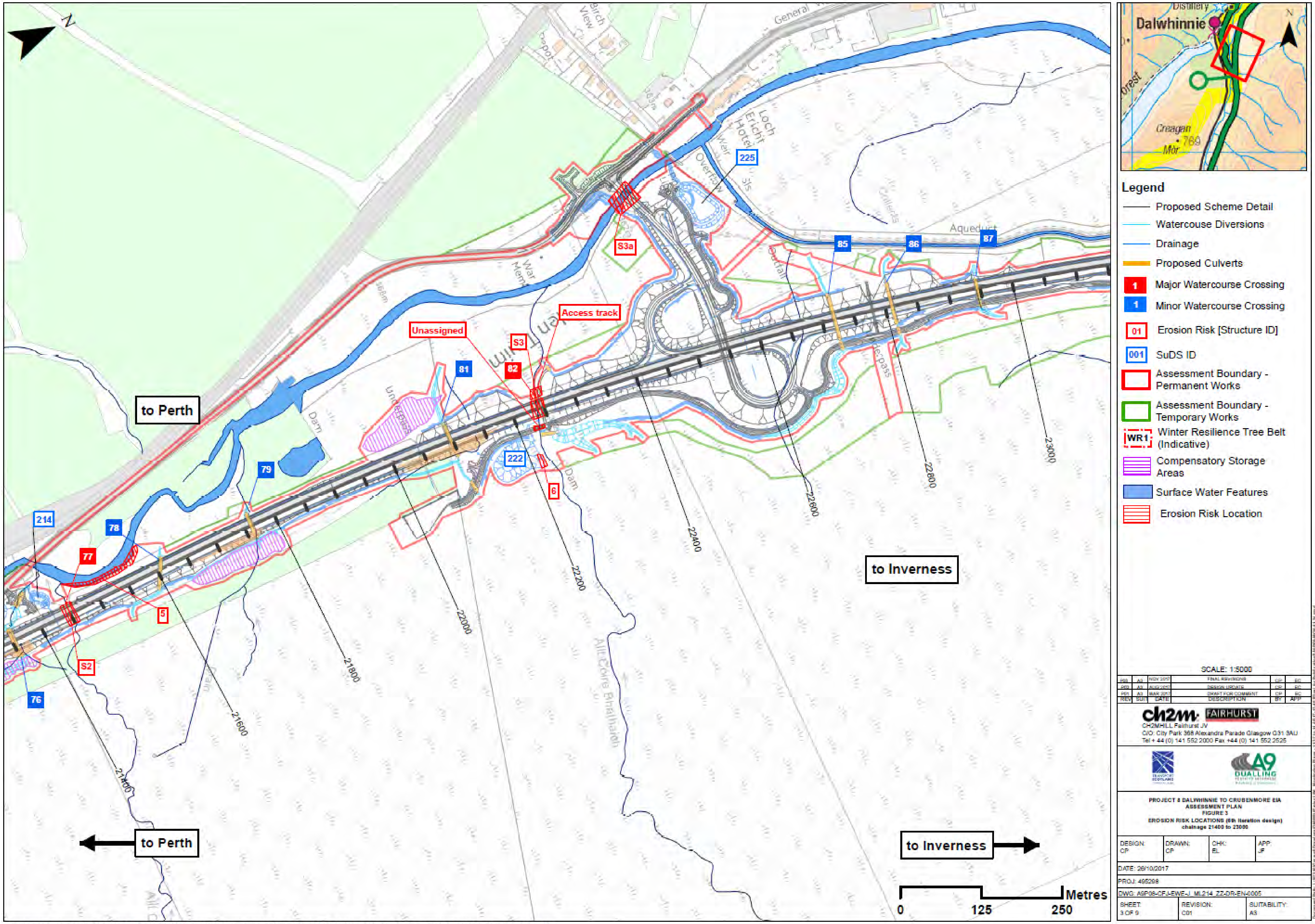
The following hierarchy should be used when considering the management options:

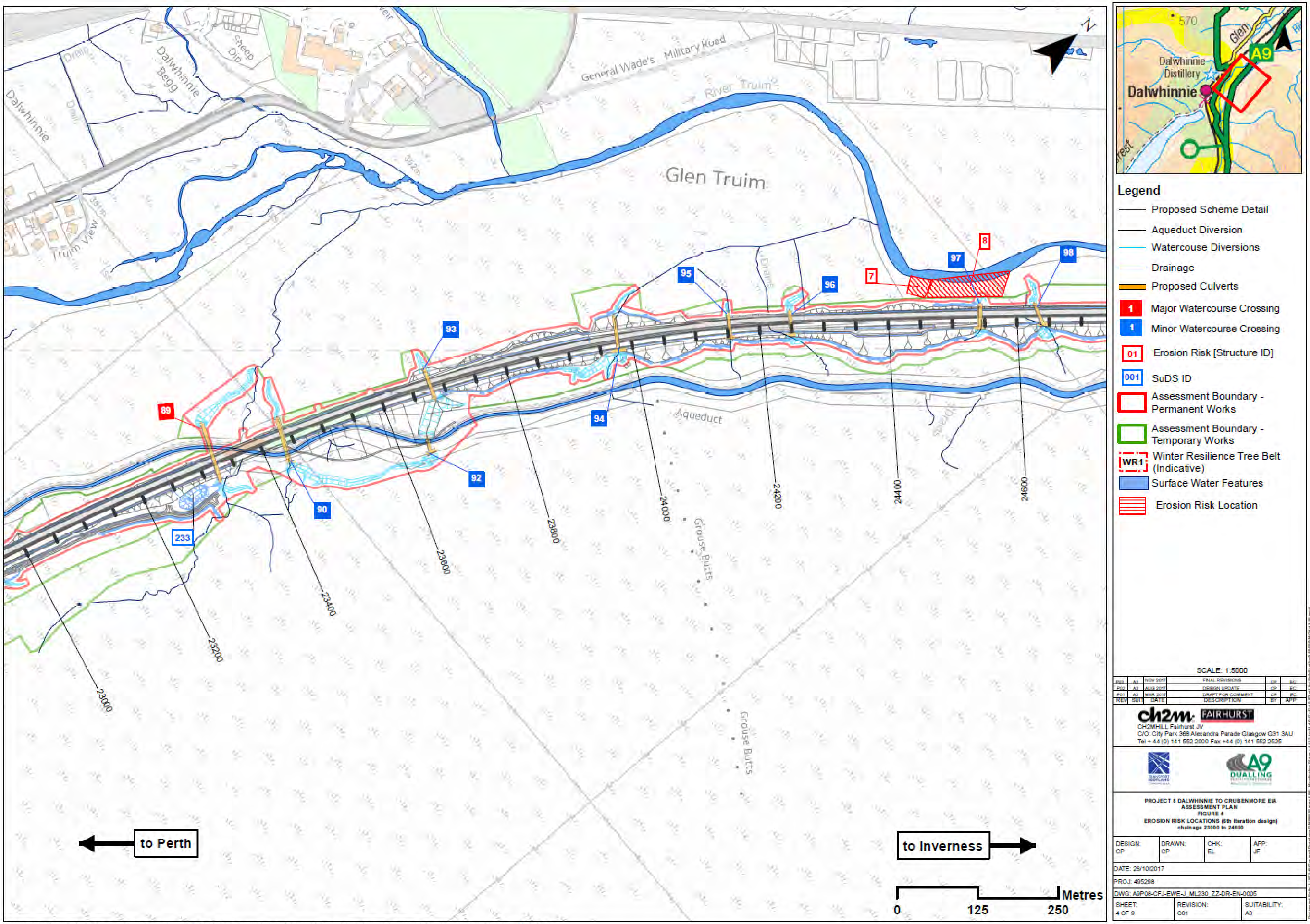
- Move infrastructure back from the watercourse where possible
- Set back protection from the watercourse e.g. protect toe of embankment from scour rather than stopping the bank from moving
- Use green engineering techniques for in channel stabilisation
- Use hard engineering techniques for in channel stabilisation



Dalwhinnie
Creagan Mòr
Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Winter Resilience Tree Belt (Indicative)
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
tie-in 0 to 180m
Dail a' Chuirn
General Wade's Military Road
59
60
61
62
63
64
65
66
1
2
to Perth
to Inverness
0
125
250
Metres
SCALE: 1:5000
ch2m FAIRHURST
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
A9 DUALLING
PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 1
EROSION RISK LOCATIONS (6th iteration design)
chainage 0 to 20200
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495298
DWG: A9P08-CFJ-EWE-J_ML000_ZZ-DR-EN-0005
SHEET: 1 OF 9
REVISION: C01
SUITABILITY: A3


Dalwhinnie
Creagan Mòr
Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Winter Resilience Tree Belt (Indicative)
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
tie-in 0 to 180m.
General Wade's Military Road
to Perth
to Inverness
0
125
250
Metres
SCALE: 1:5000
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 2
EROSION RISK LOCATIONS (6th iteration design)
chainage 20000 to 21400
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495298
DWG: A9P08-CFJ-EWE-J_ML200_ZZ-DR-EN-0005
SHEET: 2 OF 9
REVISION: C01
SUITABILITY: A3


to Perth
to Inverness
Unassigned
Access track
S3a
S3
S2
81
82
79
78
77
76
214
222
225
85
86
87
5
6
21400
21600
21800
22000
22200
22400
22600
22800
23000
Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Winter Resilience Tree Belt (Indicative)
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
Dalwhinnie
Metres
0
125
250
SCALE: 1:5000
CH2MHILL Fairhurst JV
PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 3
EROSION RISK LOCATIONS (6th iteration design)
chainage 21400 to 23000
DATE: 26/10/2017
PROJ: 495298


Glen Truim
River Truim
General Wade's Military Road
Aqueduct
Grouse Butts
Dalwhinnie
Truim View
to Perth
to Inverness
23000
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23400
23600
23800
24000
24200
24400
24600
7
8
89
90
92
93
94
95
96
97
98
233
0
125
250
Metres
Dalwhinnie Distillery
Dalwhinnie
A9
Legend
Proposed Scheme Detail
Aqueduct Diversion
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Winter Resilience Tree Belt (Indicative)
Surface Water Features
Erosion Risk Location
SCALE: 1:5000
P03 A3 NOV 2017 FINAL REVISIONS CP EC
P02 A3 AUG 2017 DESIGN UPDATE CP EC
P01 A3 MAR 2017 DRAFT FOR COMMENT CP EC
REV SUIT DATE DESCRIPTION BY APP
CH2MHILL Fairhurst JV
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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 4
EROSION RISK LOCATIONS (6th iteration design)
chainage 23000 to 24600
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
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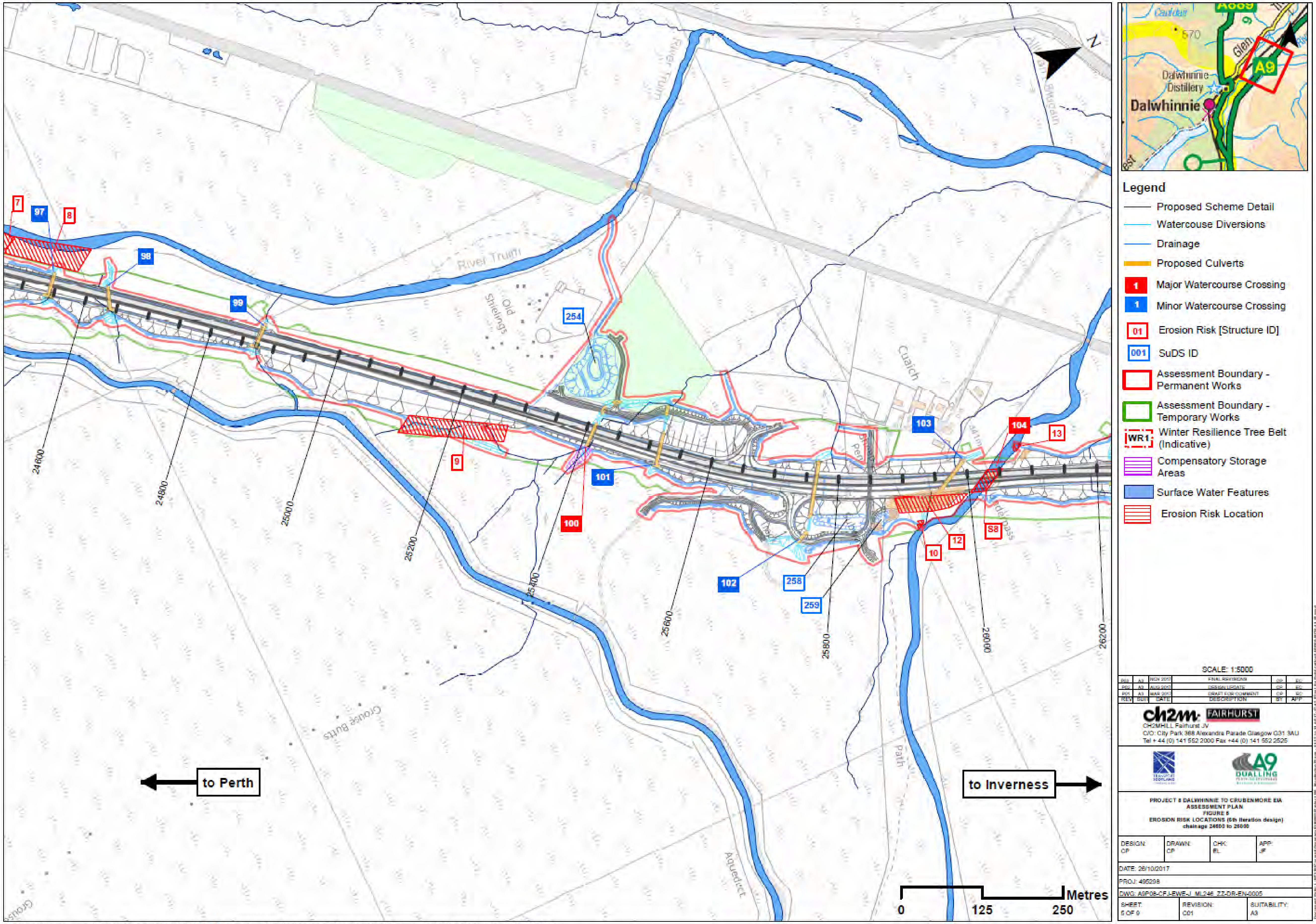
DWG: A9P08-CFJ-EWE-J_ML230_ZZ-DR-EN-0005
SHEET: 4 OF 9
REVISION: C01
SUITABILITY: A3


River Truim
Old Shielings
Cuaich
Grouse Butts
Aqueduct
Path
24600
24800
25000
25200
25400
25600
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26000
26200
7
97
8
98
99
254
9
100
101
102
258
259
103
104
13
12
10
S8
to Perth
to Inverness
0
125
250
Metres
Dalwhinnie Distillery
Dalwhinnie
A9
Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Winter Resilience Tree Belt (Indicative)
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
SCALE: 1:5000
REV
SUIT
DATE
DESCRIPTION
BY
APP
CH2MHILL Fairhurst JV
C/O: City Park 368 Alexandra Parade Glasgow G31 3AU
Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 5
EROSION RISK LOCATIONS (6th iteration design)
chainage 24600 to 26000
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495298
DWG: A9P08-CFJ-EWE-J_ML246_ZZ-DR-EN-0005
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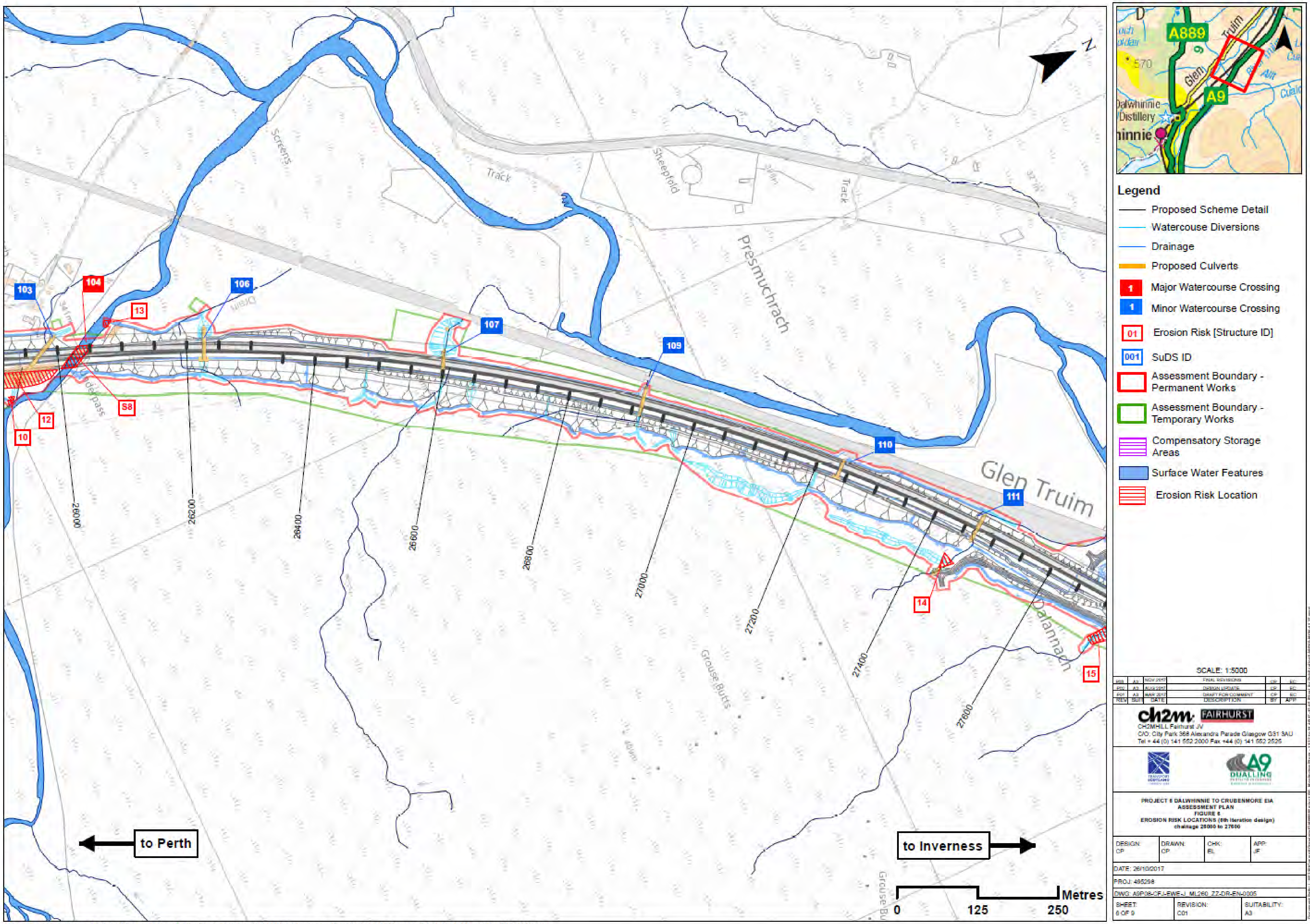
REVISION: C01
SUITABILITY: A3


Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
A889
A9
Glen Truim
Presmuchrach
Sheepfold
Track
Grouse Butts
Allt an t-Sluic
to Perth
to Inverness
26000
26200
26400
26600
26800
27000
27200
27400
27600
103
104
106
107
109
110
111
10
12
13
14
15
S8
0
125
250
Metres
SCALE: 1:5000
P03 A3 NOV 2017 FINAL REVISIONS CP EC
P02 A3 AUG 2017 DESIGN UPDATE CP EC
P01 A3 MAR 2017 DRAFT FOR COMMENT CP EC
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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 6
EROSION RISK LOCATIONS (8th iteration design)
chainage 26000 to 27600
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495298
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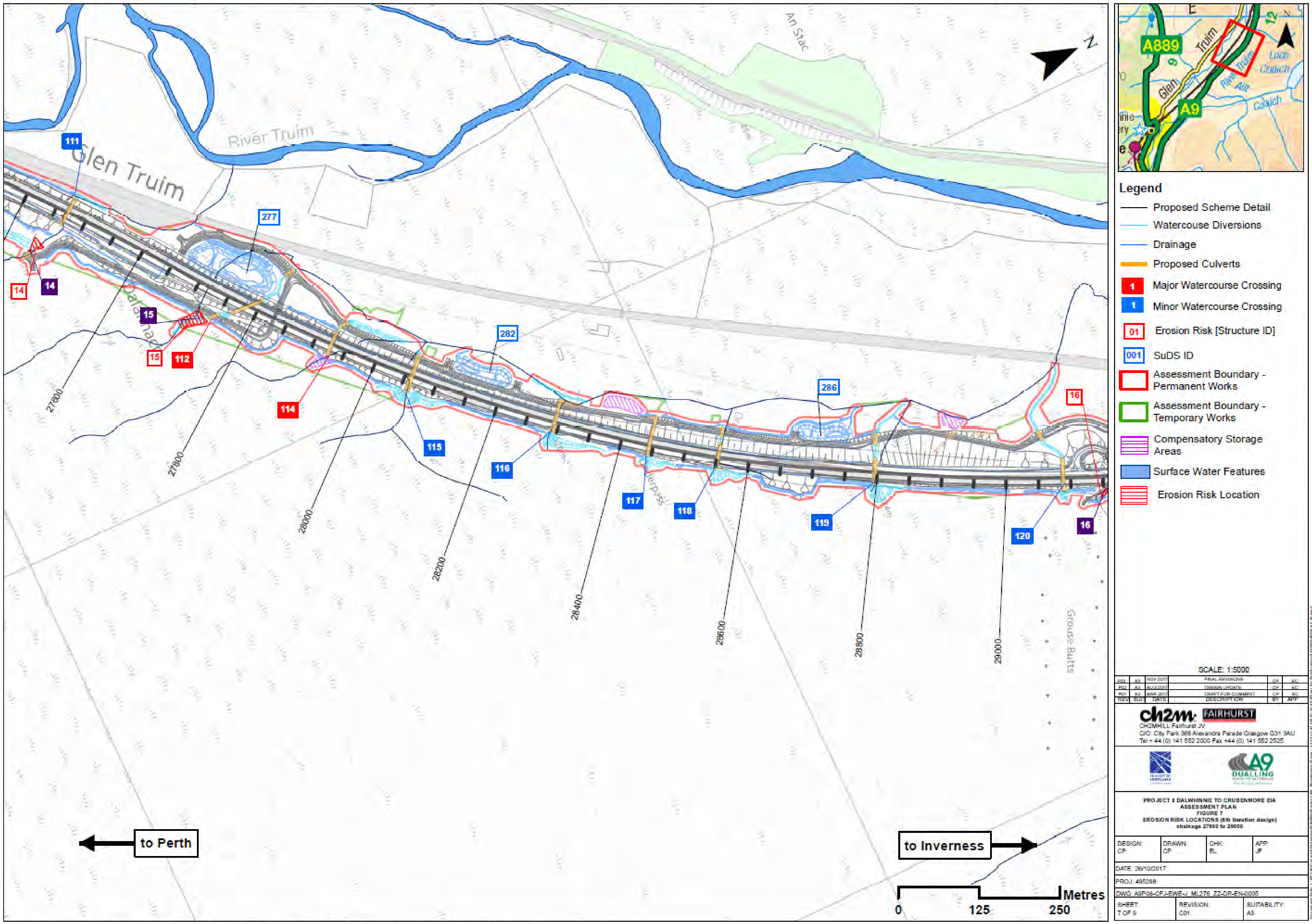
REVISION: C01
SUITABILITY: A3


River Truim
Glen Truim
An Stac
Grouse Butts
N
A889
A9
111
277
282
286
14
15
16
112
114
115
116
117
118
119
120
27600
27800
28000
28200
28400
28600
28800
29000
to Perth
to Inverness
0
125
250
Metres
Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
SCALE: 1:5000
P03 A3 NOV 2017 FINAL REVISIONS CP EC
P02 A3 AUG 2017 DESIGN UPDATE CP EC
P01 A3 MAR 2017 DRAFT FOR COMMENT CP EC
REV SUIT DATE DESCRIPTION BY APP
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Tel + 44 (0) 141 552 2000 Fax +44 (0) 141 552 2525
PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 7
EROSION RISK LOCATIONS (8th iteration design)
chainage 27600 to 29000
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495298
DWG: A9P08-CFJ-EWE-J_ML276_ZZ-DR-EN-0006
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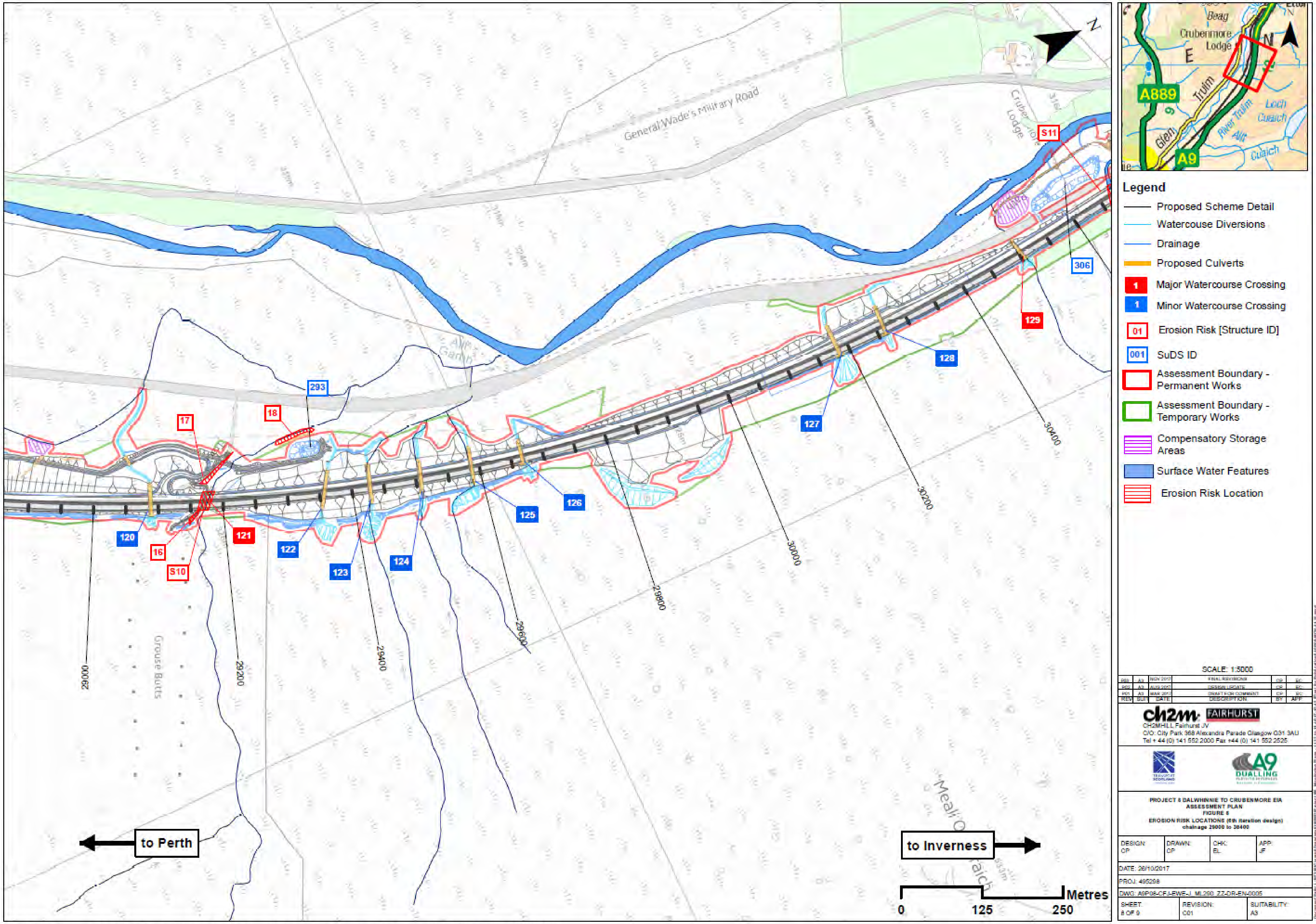
REVISION: C01
SUITABILITY: A3


General Wade's Military Road
Allt Garbh
Cruben Lodge
Grouse Butts
Meall
to Perth
to Inverness
0
125
250
Metres
29000
29200
29400
29600
29800
30000
30200
30400
S10
S11
16
17
18
120
121
122
123
124
125
126
127
128
129
293
306
Beag
Crubenmore Lodge
A889
A9
Glen
Truim
River Truim
Loch Cuaich
Allt Cuaich
Legend
Proposed Scheme Detail
Watercouse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
SCALE: 1:5000
REV
SUIT
DATE
DESCRIPTION
BY
APP
FINAL REVISIONS
DESIGN UPDATE
DRAFT FOR COMMENT
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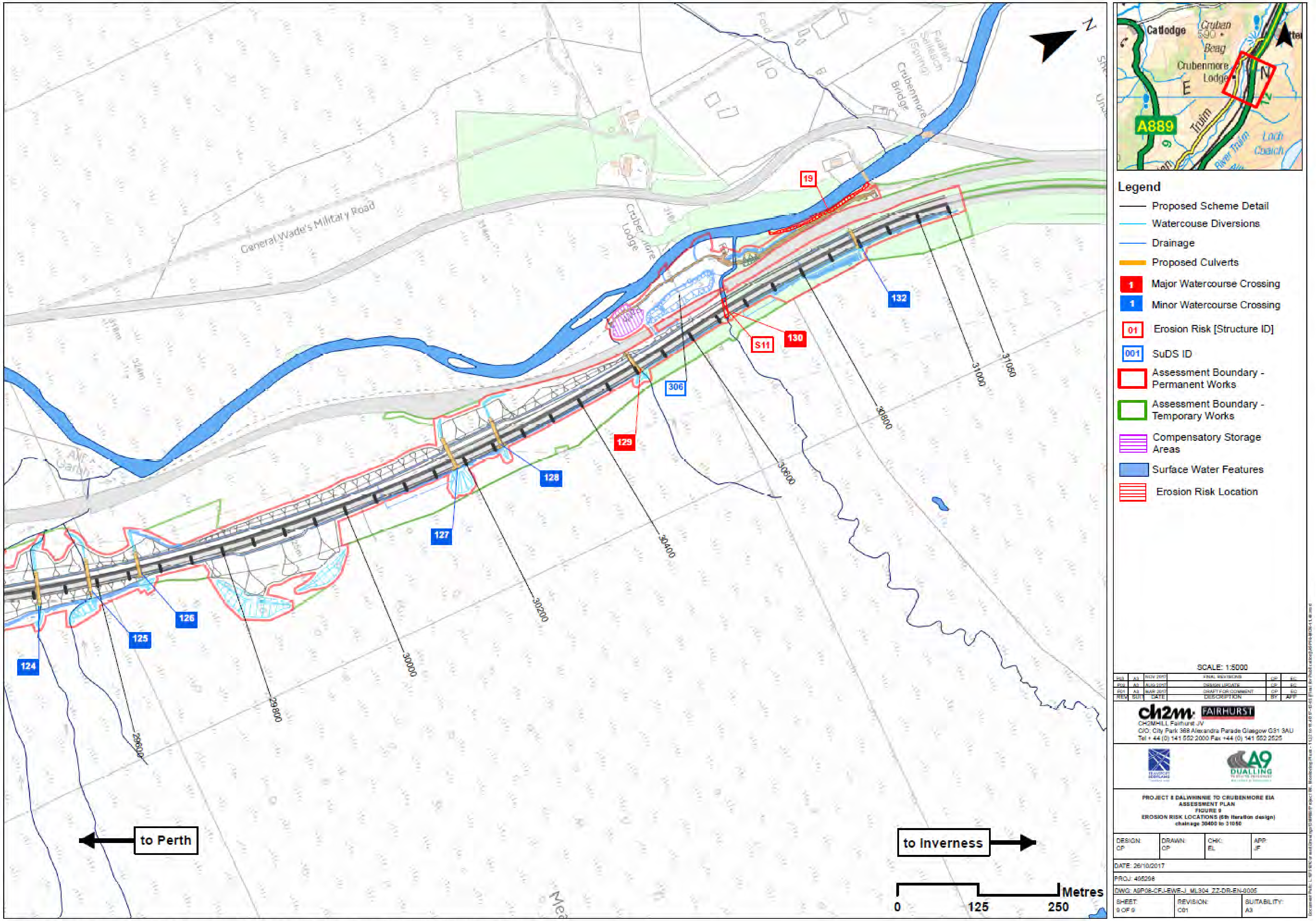
PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 8
EROSION RISK LOCATIONS (6th iteration design)
chainage 29000 to 30400
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495208
DWG: A9P08-CFJ-EWE-J_ML290_ZZ-DR-EN-0005
SHEET: 8 OF 9
REVISION: C01
SUITABILITY: A3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Crubenmore Lodge
Crubenmore Bridge
19
129
130
S11
124
125
126
127
128
132
306
29600
29800
30000
30200
30400
30600
30800
31000
31050
N
to Perth
to Inverness
0
125
250
Metres
Catlodge
Cruban Beag
Crubenmore Lodge
A889
Truim
Loch Coach
Legend
Proposed Scheme Detail
Watercourse Diversions
Drainage
Proposed Culverts
Major Watercourse Crossing
Minor Watercourse Crossing
Erosion Risk [Structure ID]
SuDS ID
Assessment Boundary - Permanent Works
Assessment Boundary - Temporary Works
Compensatory Storage Areas
Surface Water Features
Erosion Risk Location
SCALE: 1:5000
P03 A3 NOV 2017 FINAL REVISIONS CP EC
P02 A3 AUG 2017 DESIGN UPDATE CP EC
P01 A3 MAR 2017 DRAFT FOR COMMENT CP EC
REV SUIT DATE DESCRIPTION BY APP
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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA
ASSESSMENT PLAN
FIGURE 9
EROSION RISK LOCATIONS (6th iteration design)
chainage 30400 to 31050
DESIGN: CP
DRAWN: CP
CHK: EL
APP: JF
DATE: 26/10/2017
PROJ: 495298
DWG: A9P08-CFJ-EWE-J_ML304_ZZ-DR-EN-0005
SHEET: 9 OF 9
REVISION: C01
SUITABILITY: A3

Table 2. Erosion risk assessment results

Risk assessment ID	Infrastructure age	Infrastructure type	Channel stability	Distance to asset from bank top (based on AP)	Consequence of damage	Channel stability score	Distance score	Likelihood score (Distance+ Channel stability/2)	Consequence score	Risk (Likelihood x Consequence)	Risk	Comments	Potential management options	Engineering response
1	Existing	Track	Very unstable	4m	Low	3	3	3	1	3	Low	Track not considered critical infrastructure and only temporary	Routine inspection	Routine inspection- Area of existing track
2	New	Bridge	Very unstable	In channel	High	3	3	3	2	6	Medium	Track bridge not considered critical infrastructure	Further set back bridge from channel or Protect abutments or Routine inspection of structure	LMA boundary subsequently extended to include erosion protection
3	New	SUDs track	Unstable	4m	Medium	2	3	2.5	2	5	Medium	SUDs track close to small channel	Routine inspection and/or Reinforce toe of track	Erosion protection to be provided along embankment toe, but avoid SAC boundary
4	New	Outfall	Relatively stable	In channel	Low	1	3	2	1	2	Low	Outfalls are designed to accommodate change in river position	Routine inspection of structure	Routine inspection-Outfalls designed to accommodate channel change
5	Existing	Mainline	Unstable - Has existing bank protection	8m	High	2	2	2	3	6	Medium	No change from existing risk but opportunity to add toe protection to embankment during works Embankment is 10m from bank top May be existing bank protection in channel	Continue current management practice or Protect embankment toe or In channel bank protection or Reduce footprint of embankment	Existing rock armour identified as being in 'poor' condition so proposals assume that this will be replaced
6	New	SUDs pond	Relatively stable	7m	Medium	1	2	1.5	2	3	Low	SUDs pond at risk of erosion. On top of river terrace	Routine inspection and/or Reinforce cutting slope	
7	New	Mainline	Relatively stable	40m	High	1	1	1	3	3	Low	Opportunity to add toe protection to embankment during works but seems unlikely to be required	Routine inspection and/or Protect embankment toe	
8	Existing	Mainline	Relatively stable	37m	High	1	1	1	3	3	Low	No change from existing risk but opportunity to add toe protection to embankment during works May be existing bank protection in channel	Continue current management practice or Protect embankment toe and/or Routine inspection	
9	New	Mainline	Relatively stable	3m	High	1	3	2	3	6	Medium	Current channel runs very close to the top of cutting-could move and flow straight down cutting. Note that channel instability may occur during works. Override to High.	Divert channel away from cutting or install bank protection to channel land/or Routine inspection for signs of erosion	Watercourse channel (hydro ID 100) has been moved away from the top of the proposed cutting slope – minimum distance approx. 7m – to remove/reduce erosion risk to cutting
10	New	Drain	Very unstable	In channel	Low	3	3	3	1	3	Low	Outfalls are designed to accommodate change in river position	Routine inspection of structure	Routine inspection-Outfalls designed to accommodate channel change
11	New	Drain	Very unstable	In channel	Low	3	3	3	1	3	Low	Outfalls are designed to accommodate change in river position	Routine inspection of structure	Routine inspection-Outfalls designed to accommodate channel change
12	New	Mainline	Very unstable	5m	High	3	3	3	3	9	High	Embankment toe is 7m from actively eroding channel	Protect embankment toe or In channel bank protection or Reduce footprint of embankment	Erosion protection to be provided along embankment toe
13	New	Drain	Very unstable	In channel	Low	3	3	3	1	3	Low	Outfalls are designed to accommodate change in river position	Routine inspection of structure	Routine inspection-Outfalls designed to accommodate channel change
14	New	Drain	Unstable	In channel	Low	2	3	2.5	1	2.5	Low	Outfalls are designed to accommodate change in river position	Routine inspection of structure	Routine inspection-Outfalls designed to accommodate channel change
15	New	Track	Very unstable	38m	Medium	3	1	2	2	4	Medium	Current channel is actively eroding. Assume diversion will be designed to be stable, which may mean reprofiling upstream channel and additional land take	Routine inspection and/or Extend channel realignment upstream	Watercourse channel proposals updated to extend works upstream Final details for proposed channel to ensure stable and sustainable long-term solution to be developed during specimen design stage.

Risk assessment ID	Infrastructure age	Infrastructure type	Channel stability	Distance to asset from bank top (based on AP)	Consequence of damage	Channel stability score	Distance score	Likelihood score (Distance+ Channel stability/2)	Consequence score	Risk (Likelihood x Consequence)	Risk	Comments	Potential management options	Engineering response
16	New	Footpath	Very unstable	2m	Medium	3	3	3	1	3	Low	Footpath on top of valley and subject to damage from undercutting at river /landslide of valley side	Set back track and/or Protect valley side from erosion	
17	Existing	Track	Very unstable	4m	Medium	3	1	2	2	4	Medium	Track on top of valley and subject to damage from undercutting/landslide of valley side	Set back track or Protect valley side from erosion	Access track moved away from watercourse channel – minimum distance approx. 10m – to reduce/remove erosion risk to track by roads team in 7th iteration design. However, existing erosion protections within watercourse channel (gabion baskets/mattresses) are currently in very poor condition and are ineffective. Final details for proposed in-channel works to ensure stable and sustainable long-term solution to be developed during specimen design stage.
18	New	Track	Very unstable	9m	Medium	3	2	2.5	2	5	Medium	Track 7m from channel	Move track Routine inspection and/or Protect toe of track	Access track moved away from watercourse channel – minimum distance from LMA boundary around SUDS basin to watercourse approx. 10m – to reduce/remove erosion risk to track by roads team in 7th iteration design.
19	Existing	Track	Relatively stable	4m	Medium	1	3	2	2	4	Medium	Track 5m from channel, but channel currently appears stable	Routine inspection and/or Protect toe of track	Erosion protection works to be provided along the access track embankment
S3a	New structure	Bridge	Stable	8m	High	1	2	1.5	3	4.5	Medium	Infrastructure is set back from channel and in stable location	Consider depth of pier to ensure long term stability	Erosion protection provide to abutments in 7th iteration
S1	Replacement structure	Bridge	Very unstable	2m	High	3	3	3	3	9	High	Infrastructure in the 1:200-year floodplain but abutments are set back further than the existing situation	Consider the need for erosion protection of abutments	Erosion protection provide to abutments in 7th iteration
S2	Replacement structure	Bridge	Stable	2.5m	High	1	2	1.5	3	4.5	Medium	Infrastructure in the 1:200-year floodplain but abutments are set back further than the existing situation	Consider the need for erosion protection of abutments	Erosion protection provide to abutments in 7th iteration
S3	Replacement structure	Bridge	Unstable	2m	High	2	3	2.5	3	7.5	High	Infrastructure in the 1:200-year floodplain but abutments are set back further than the existing situation	Consider the need for erosion protection of abutments	Erosion protection provide to abutments in 7th iteration
S8	Replacement structure	Bridge	Very unstable	0m	High	3	3	3	3	9	High	Infrastructure in the 1:200-year floodplain and ongoing erosion upstream of structure	Consider the need for erosion protection of abutments	Erosion protection provide to abutments in 7th iteration
S10	Replacement structure	Bridge	Very unstable	1	High	3	3	3	3	9	High	No infrastructure in the 1:200-year floodplain, but channel unstable under current crossing and downstream	Consider the need for erosion protection of abutments	Erosion protection provide to abutments in 7th iteration
S11	Extension of existing structure	Bridge	Stable	0m	High	1	3	2	3	6	Medium	Will be hard engineered bed and banks as per existing channel	Will be hard engineered bed and banks as per existing channel	Erosion protection provide to abutments in 7th iteration

10.3 Annex 11.4.3 Hydromorphology Catchment Baselines

Annex 11.4.3 - Hydromorphological Catchment Assessment - 59

Catchment No.	**59**
Catchment Name	**-**

Channel Nature	Nature of water course	Natural	
	Size of water course	Major	
Quantitative Spatial Elements	Catchment Area (km^2)	3.49	
	Average slope in catchment (°)	15	
	% 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 11.4.3.1 a and b Catchment 59)	Gaick Psammite formation-Psammite	Resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	Yes	Major alluvial fan present in lower catchment (crossing cuts through it)
Environmental designations (see Drawing 11.4.3.1 c, Catchment 59)	Ramsar	No	
	SAC	River Spey	Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
		Drumochter Hills	Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, monntane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved
	SPA	Drumochter Hills	Dotterel breeding, merlin breeding
	SSSI	Drumochter Hills	Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 59	
	Is peat present in the catchment?	Yes	Some peat in upper catchment
	Is there a bog burst risk?	Yes	But unlikely. Risk small relative to other risks associated with high mineral sediment delivery and mobility
	Current valley side or terrace erosion	Yes	Supplying sediment to channel
	Potential valley side or terrace erosion	Yes	
	Hill slope failures (including peat slides and debris flows and slides)	Yes	
	Hill slope failures coupled to channel	Yes	High sediment supply to channel
	Vertical incision present in catchment	Yes	In steeper areas upstream
	Bank erosion/lateral migration	Yes	Laterally mobile channel on lower slopes
	Unvegetated bars	Yes	High sediment supply potential to crossing
	Wooded/forested areas in catchment	Yes	Potential for floating debris blocking crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 59)	Foot bridge near crossing	
	Comment on sediment source potential in catchment	High sediment source potential from coupled hillslope failure and valley side erosion in steep upper catchment	
	Comment on sediment supply potential to crossing	Steep confined channel delivers sediment to lower gradient area (alluvial fan) upstream of crossing, where deposition forming bars occurs	
Morphology and Process- Reach upstream of crossing	Channel morphology	Wandering	
	Predominant sediment size	Cobbles and gravels	
	Unvegetated bars	Yes	Extensive coarse sediment available
	Vertical incision	Low	
	Deposition	High	
	Lateral migration/bank erosion	Medium	Within confines of terraces
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 59)	Foot bridge	
	Impact of infrastructure	Fixing bank location	
	Channel realignment	Possible straightening upstream	
Morphology and Process- At crossing	Channel morphology	Plane bed	
	Predominant sediment size	Cobbles and gravels	
	Estimated discharge at 1:200 event (m^3/s)	16.42	
	Unvegetated bars	Yes	
	Vertical incision	Low	
	Deposition	High	
	Lateral migration/bank erosion	Medium	
	Damaged/unstable drains or armouring	None	
Morphology and Process- Reach downstream of crossing	Channel morphology	Wandering	
	Predominant sediment size	Cobbles and gravels	
	Unvegetated bars	Yes	
	Vertical incision	Medium	
	Deposition	High	
	Lateral migration/bank erosion	Medium	Within confines of terraces
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 59)	Yes	NMU route and structure of unknown purpose (possibly containing utilities)
	Impact of infrastructure	Yes	Fixes bank position. Restricts passage of sediment, particularly the 'unknown' structure (evidence in aerial photos for some dredging of channel u/s of this structure).
	Channel realignment	Channel straightened downstream	
Summary behaviour	Extensive sediment supply from upper catchment is transported through steep gradient channels and deposited where slope reduces on a major alluvial fan. Currently most of this is within the channel which contributes to the channel's lateral mobility. This in turn leads to reworking of the alluvial fan sediments and further sediment production. Structures across the channel create pinch points where the channel banks are more or less fixed and passage of sediment and debris is restricted, evidenced by the sediment which has needed to be dredged and placed either side of the channel to maintain flow under the structures. The majority of the alluvial fan formation probably took place during deglaciation in the early Holocene, but there is relatively recent morphological evidence for avulsion events and alternative major channels through the alluvial fan. Consideration needs to be given to the risk of flow taking an alternative route from the apex of the alluvial fan to the Truim particular a more northerly one (i.e. towards crossings 60, 61 and 62).		

Deposition
under
bridge

Photograph 11.4.3.1- Upstream towards crossing

Photograph 11.4.3.2- Erosion of right bank

Photograph 11.4.3.3 -Steep catchment upstream

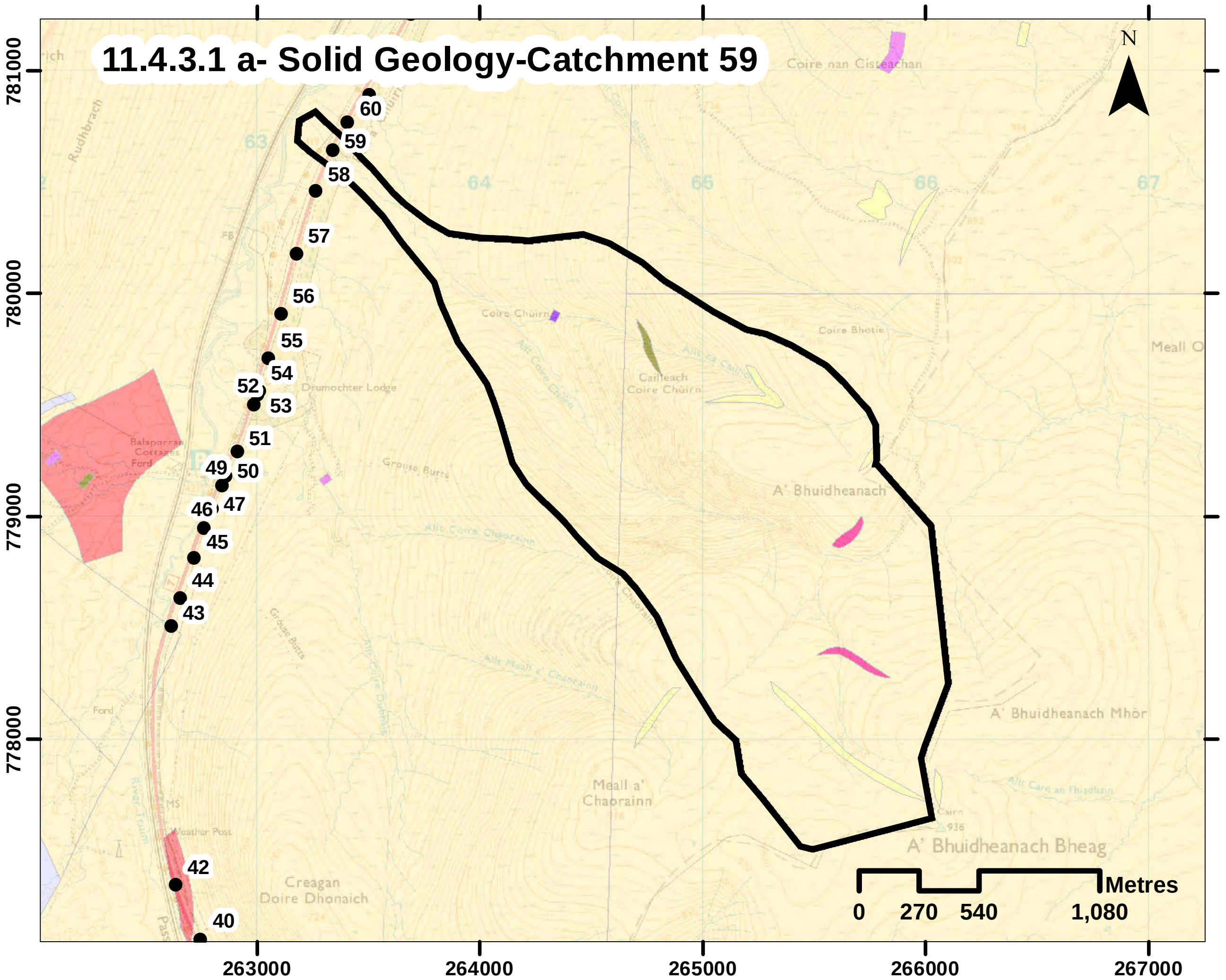
Deposition

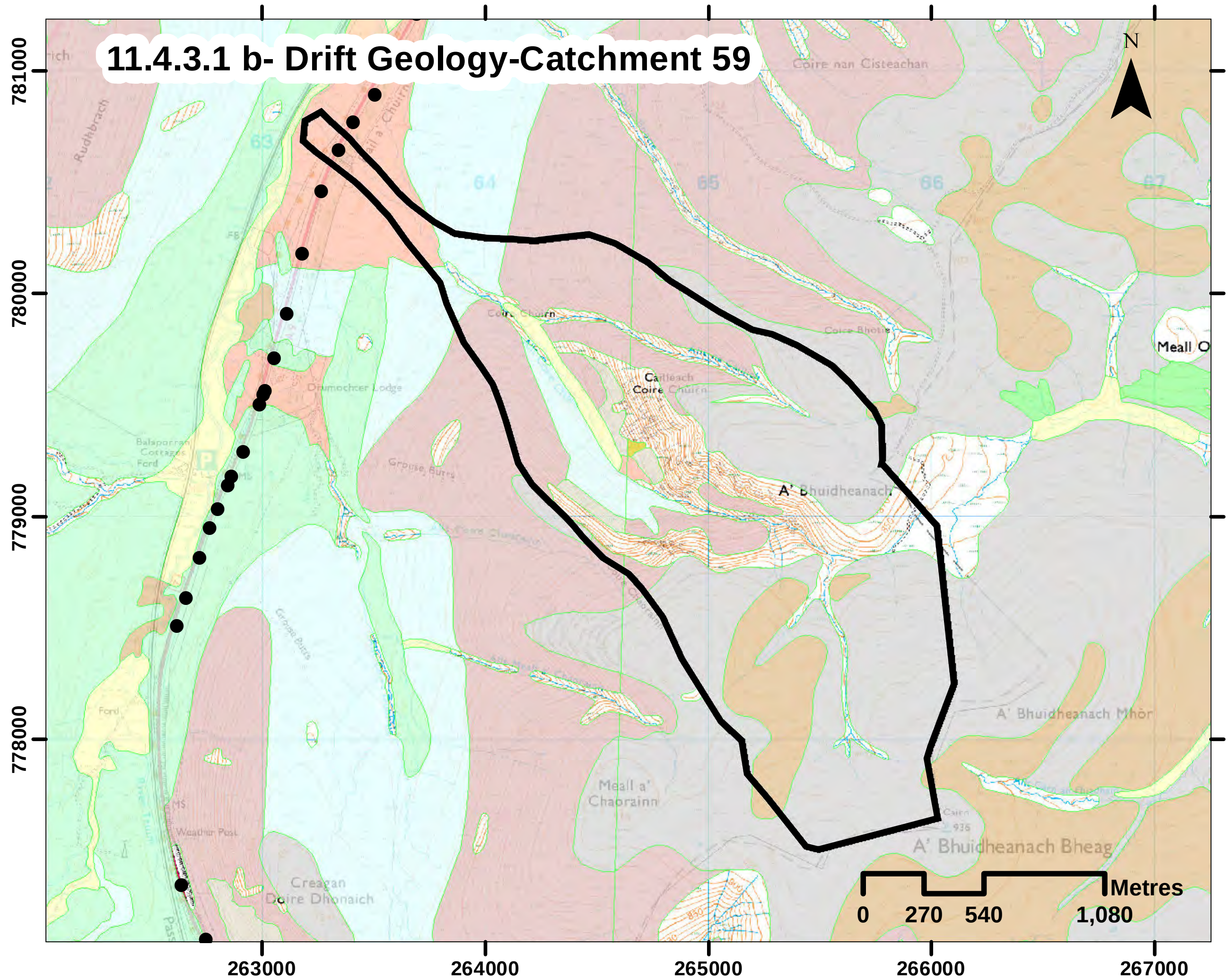
Photograph 11.4.3.4- Unknown structure crossing downstream

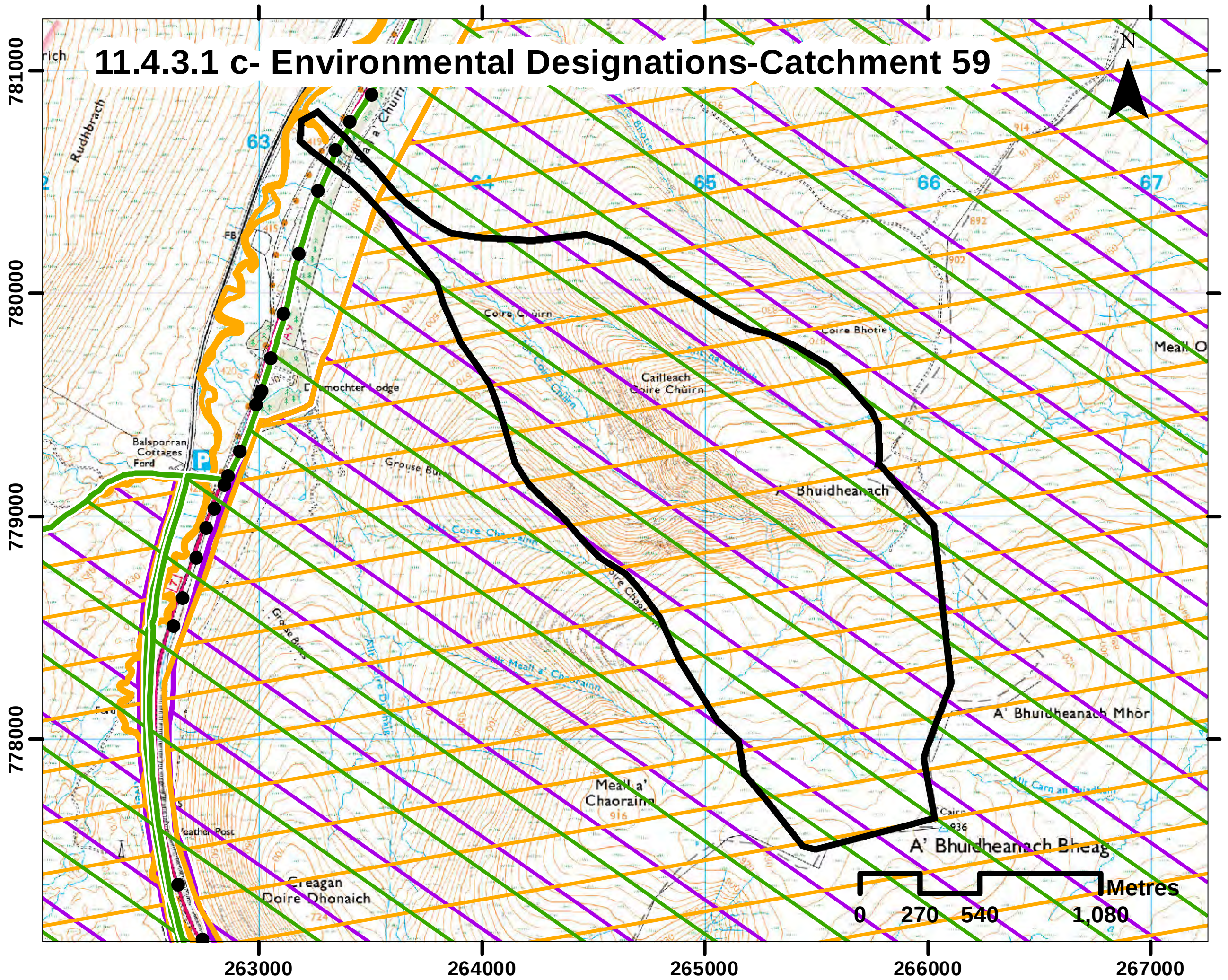
Photograph 11.4.3.5- Downstream to crossing

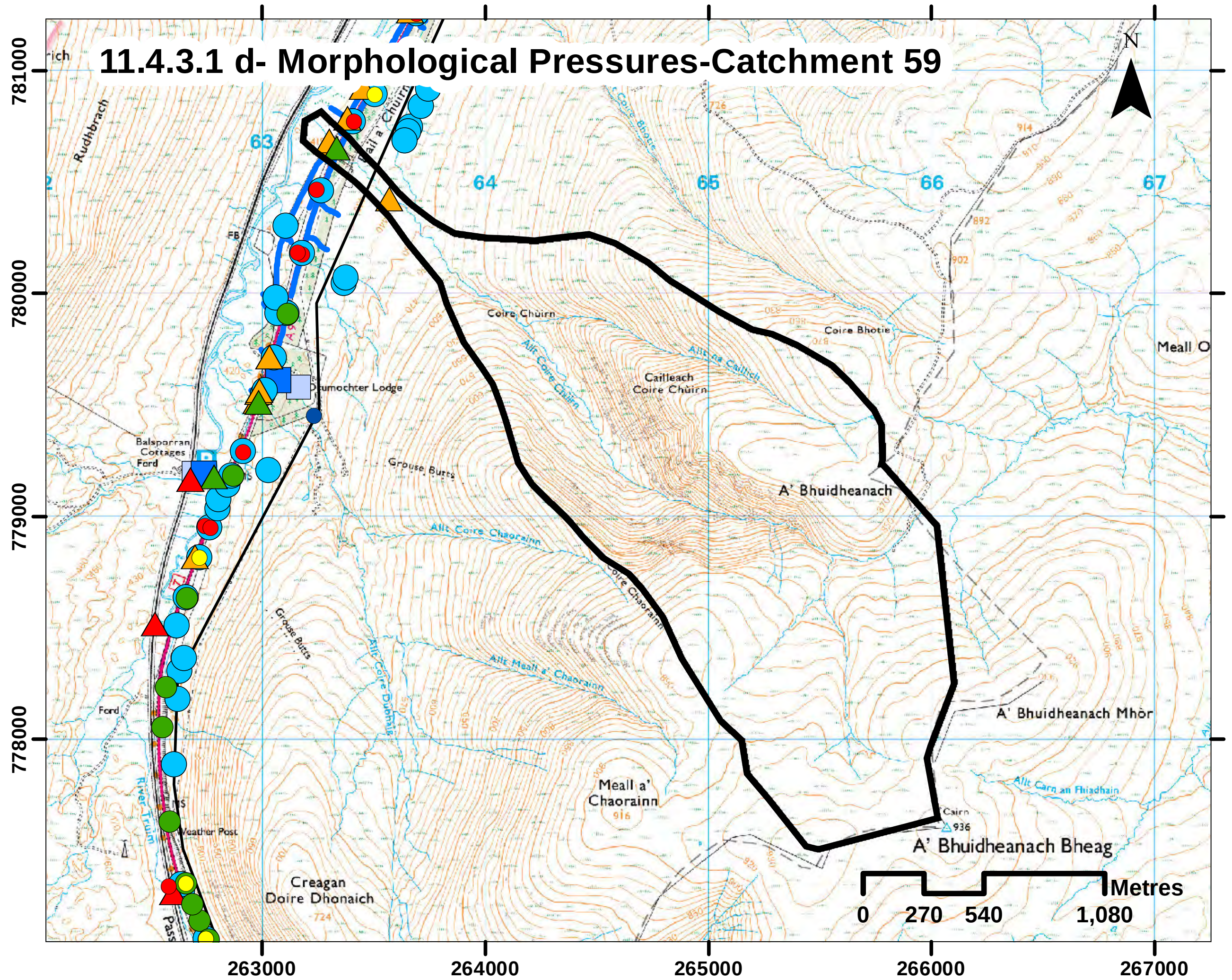
Photograph 11.4.3.6- Bed sediment (Cobbles and boulders)

Photograph 11.4.3.7- Deposition upstream of crossing









Legend

General

- Crossing location

Solid Geology

- Gaick Psammite Formation - Psammite
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite-Lamprophyres
- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite - Microdioritic-Rock
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite-Microgranite, Porphyritic
- Vein-Quartz

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
- Special Protection Area

Morphological Pressures

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

REV	SUIT	DATE	DESCRIPTION	BY	APP

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TRANSPORT SCOTLAND
A9 DUALLING PERTH TO INVERNESS

PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 59 Catchment Overview

DESIGN:	DRAWN:	CHK:	APP:
EL	EV	EL	EL

DATE: 14/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0001

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1 of 1	C01	A3

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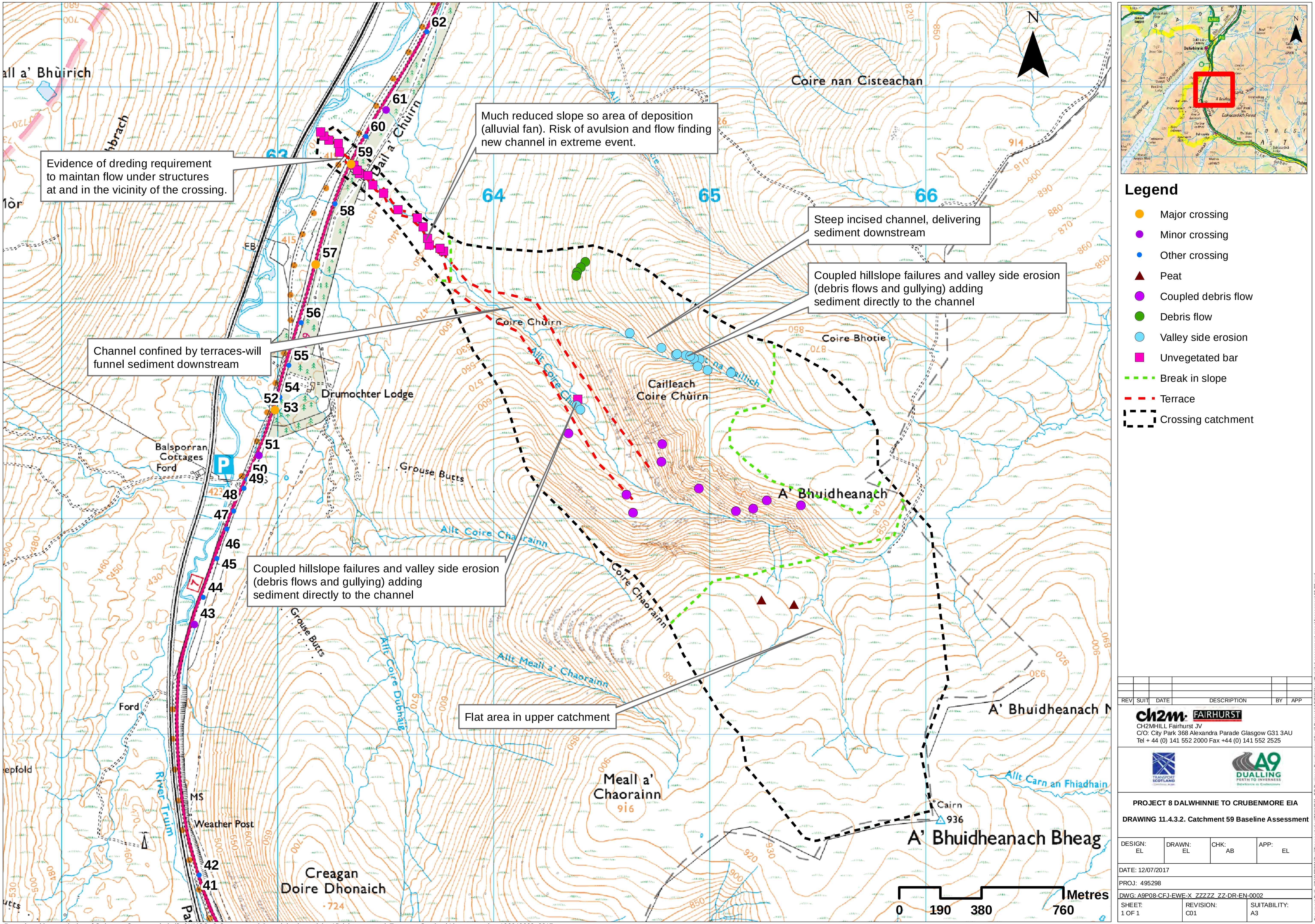

Legend

- Major crossing
- Minor crossing
- Other crossing
- Peat
- Coupled debris flow
- Debris flow
- Valley side erosion
- Unvegetated bar
- Break in slope
- Terrace
- Crossing catchment

REV	SUIT	DATE	DESCRIPTION	BY	APP

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TRANSPORT SCOTLAND

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2. Catchment 59 Baseline Assessment

DESIGN: EL	DRAWN: EL	CHK: AB	APP: EL

DATE: 12/07/2017

PROJ: 495298

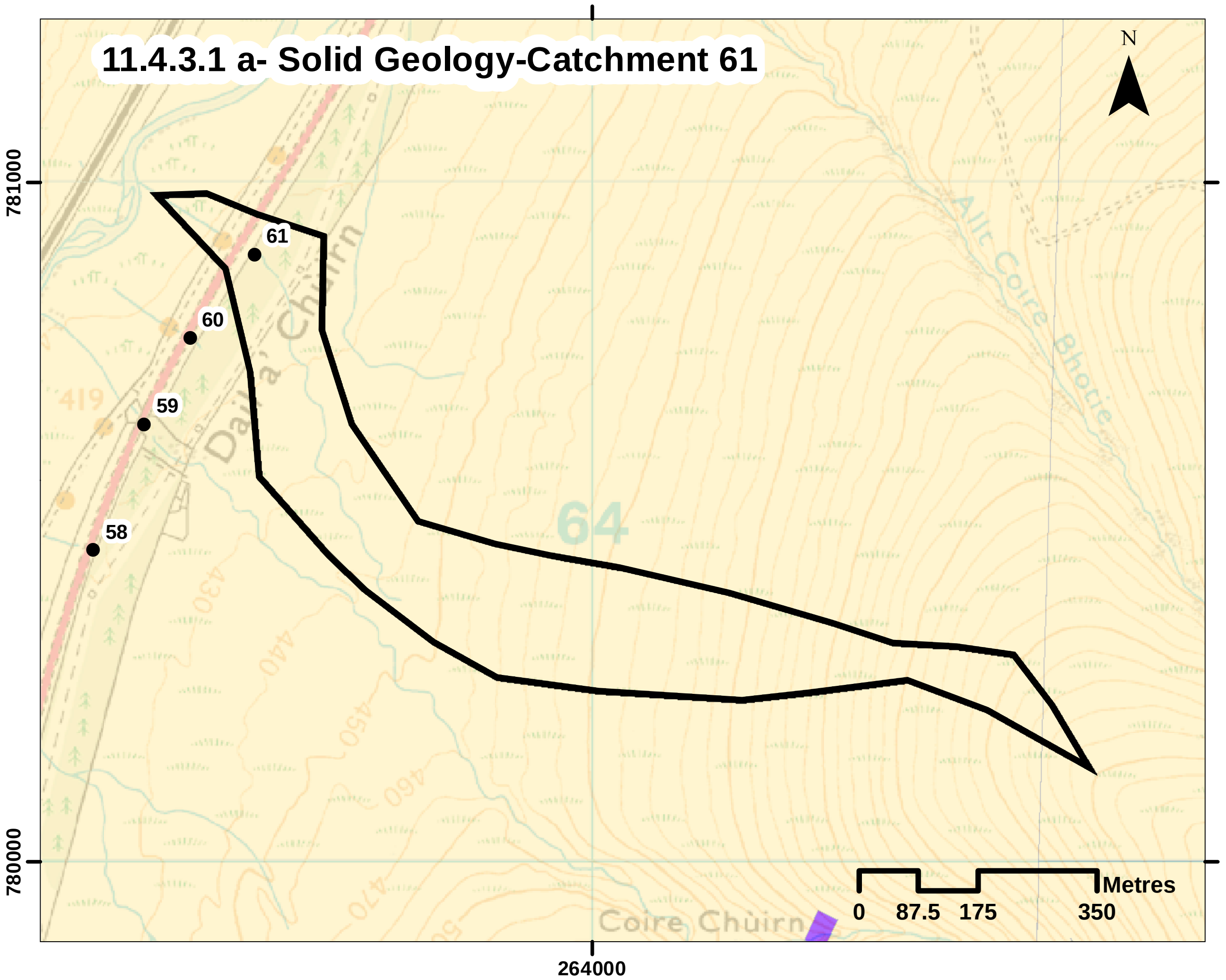
DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0002

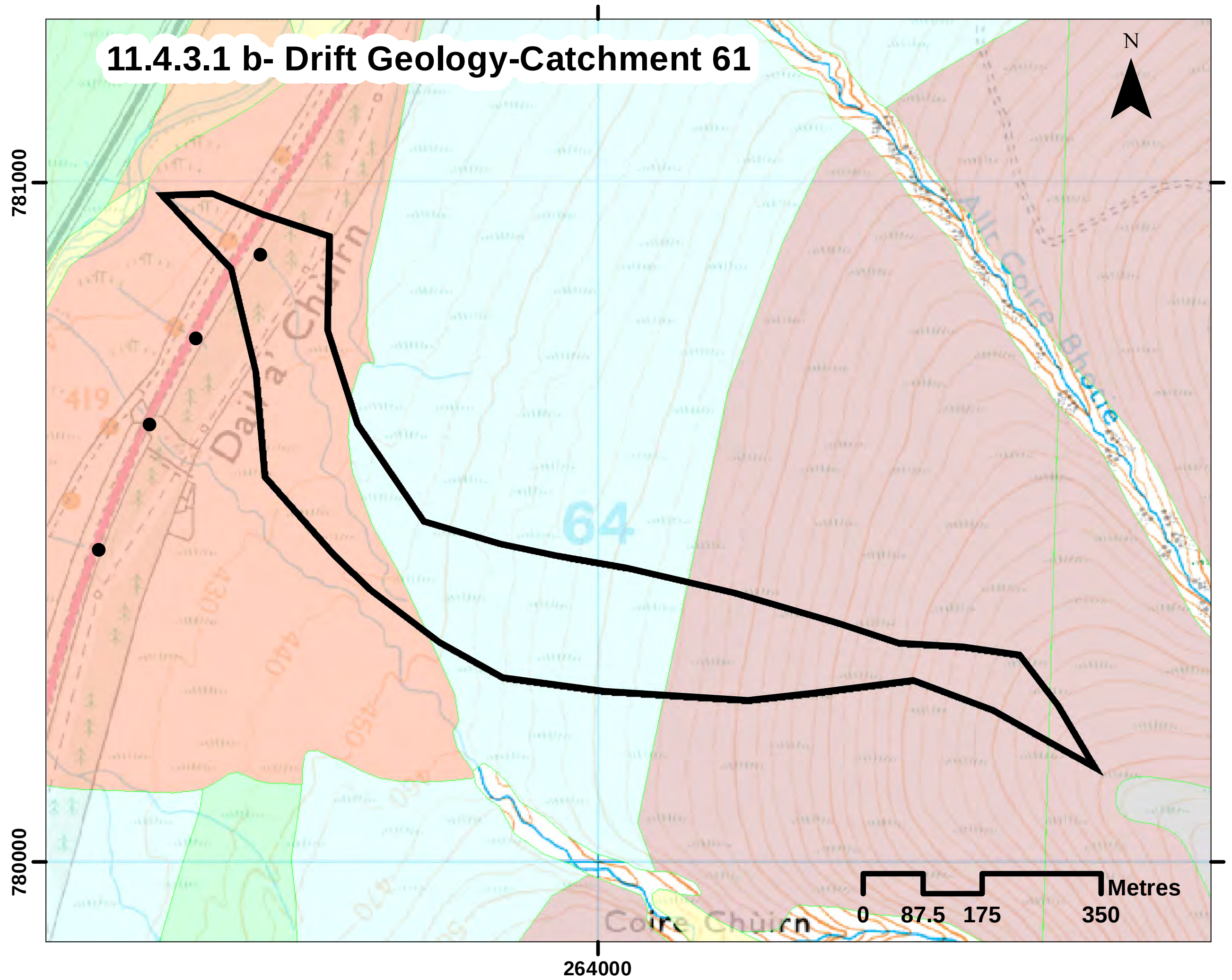
SHEET: 1 OF 1	REVISION: C01	SUITABILITY: A3

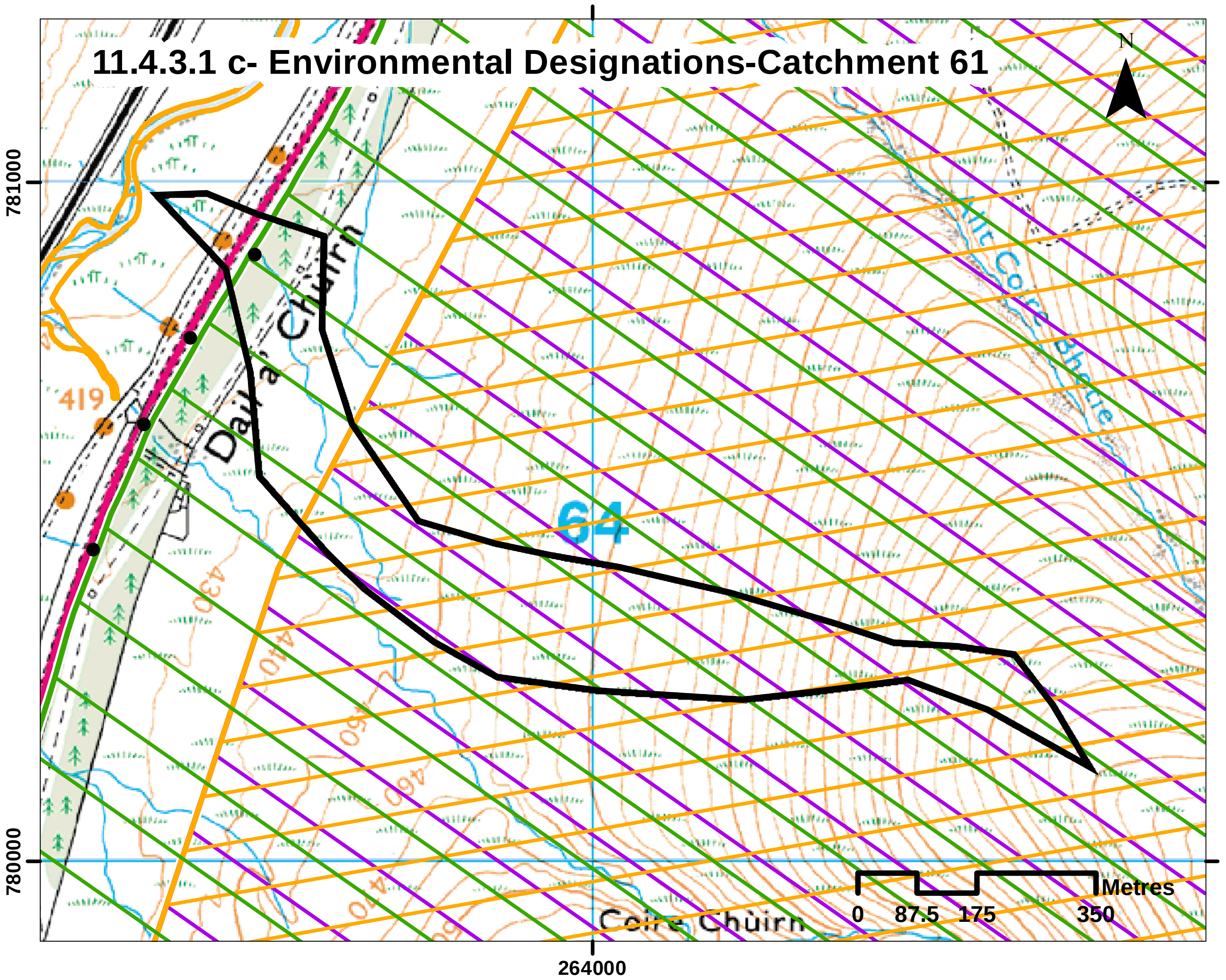
rphological Catchment Assessment - 61

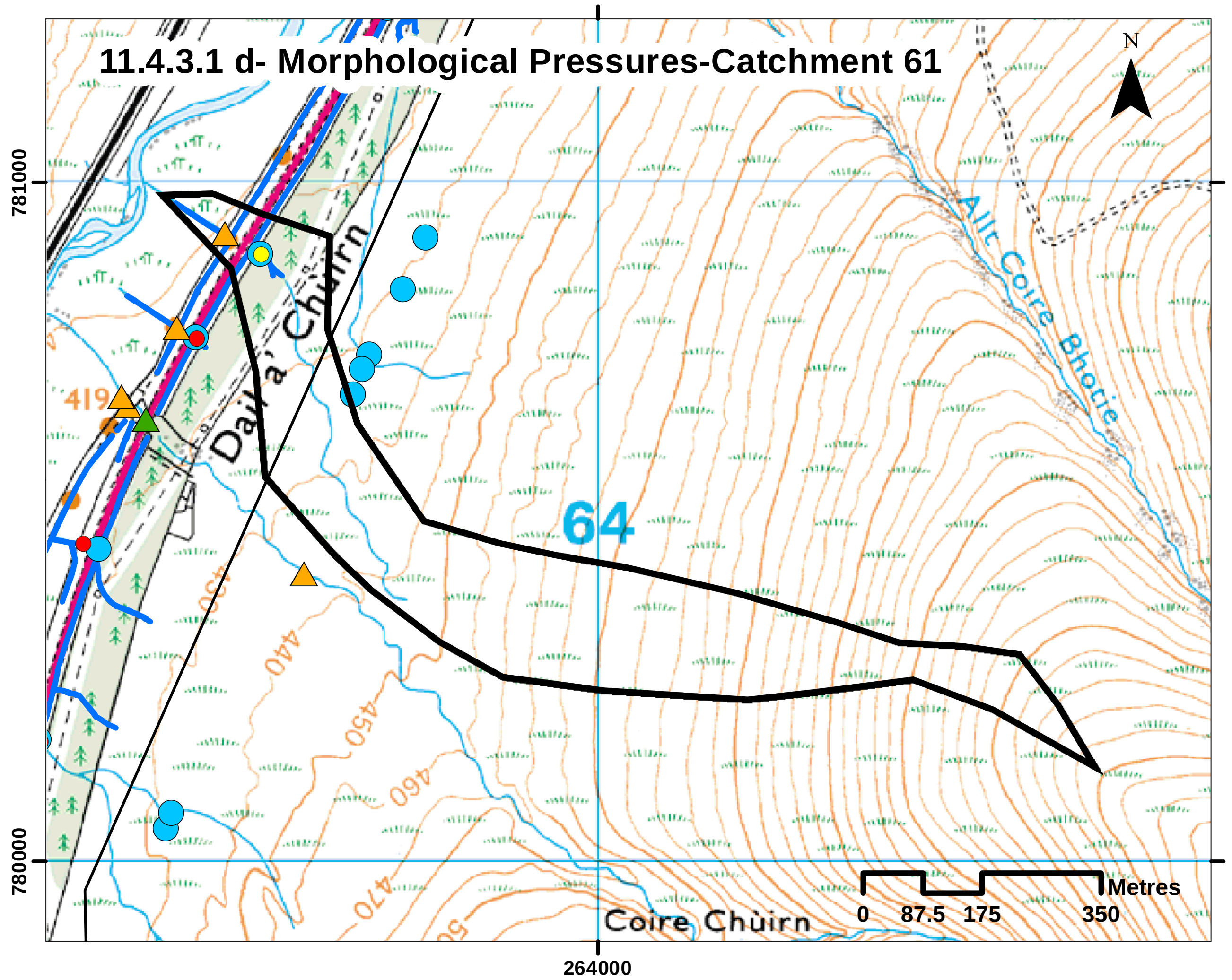
Catchment No.	61
Catchment Name	-

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 (°)	10	
	% 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 11.4.3.1 a and b Catchment 61)	Gaick Psammite formation-Psammite	Resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	Yes	Channel is effectively either high flow distributary or former course of the Allt a Chùirn (probably the former) which diverges from the main channel at the alluvial fan apex
Environmental designations (see Drawing 11.4.3.1 c, Catchment 61)	Ramsar	No	
	SAC	River Spey	Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
		Drumochter Hills	Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, monntane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved
	SPA	Drumochter Hills	Dotterel breeding, merlin breeding
	SSSI	Drumochter Hills	Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 61	
	Is peat present in the catchment?	None	
	Is there a bog burst risk?	None	
	Current valley side or terrace erosion	None	
	Potential valley side or terrace erosion	None	
	Hill slope failures (including peat slides and debris flows and slides)	Yes	
	Hill slope failures coupled to channel	None	
	Vertical incision present in catchment	None	
	Bank erosion/lateral migration	None	
	Unvegetated bars	None	
	Wooded/forested areas in catchment	Yes	Chance of floating debris reaching crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 61)	None	
	Comment on sediment source potential in catchment	Sediment is available within the catchment but its not coupled with the channel, slowing the speed to sediment delivery to the crossing.	
	Comment on sediment supply potential to crossing	Limited source in proximity of channel, channel is steep so will move sediment quickly should it enter. Possibility that channel will receive flow and sediment from Allt a Chùirn catchment at high flows	
Morphology and Process- Reach upstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	None	
	Unvegetated bars	No	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 61)	None	
	Impact of infrastructure	None	
	Channel realignment	Yes	Local
Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	N/A	
	Estimated discharge at 1:200 event (m^3/s)	0.94	Need to consider channel 62 acting as a high flow distributary channel for the Allt a Chùirn and therefore higher flow volumes and sediment
	Unvegetated bars	None	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Damaged/unstable drains or armouring	None	
Morphology and Process- Reach downstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	None visible	
	Unvegetated bars	None	
	Vertical incision	Low	Signs of some vertical incision, probably related to straightening.
	Deposition	None	
	Lateral migration/bank erosion	Low	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 61)	None	
	Impact of infrastructure	None	
	Channel realignment	Yes	Straightening
Summary behaviour	Signs of some vertical incision, probably related to straightening downstream of the crossing. Most important consideration is that the channel 'source' is at the apex of the Allt a Chùirn alluvial fan making it highly probably that in extreme events this channel could receive flows from the major Allt a Chùirn (crossing 59) catchment. The morphological evidence (clearly visible channel features with only short vegetation) in the upper part of the alluvial fan indicate it may have been active as such relatively recently. As such a crossing to accommodate higher discharges than might be suggested based on the size of catchment 61 are advisable.		









Legend

General

- Crossing location

Solid Geology

- Gaick Psammite Formation - Psammite

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
- Special Protection Area

Morphological Pressures

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

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 61 Catchment Overview

DESIGN:	DRAWN:	CHK:	APP:
EL	EV	EL	EL

DATE: 20/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0001

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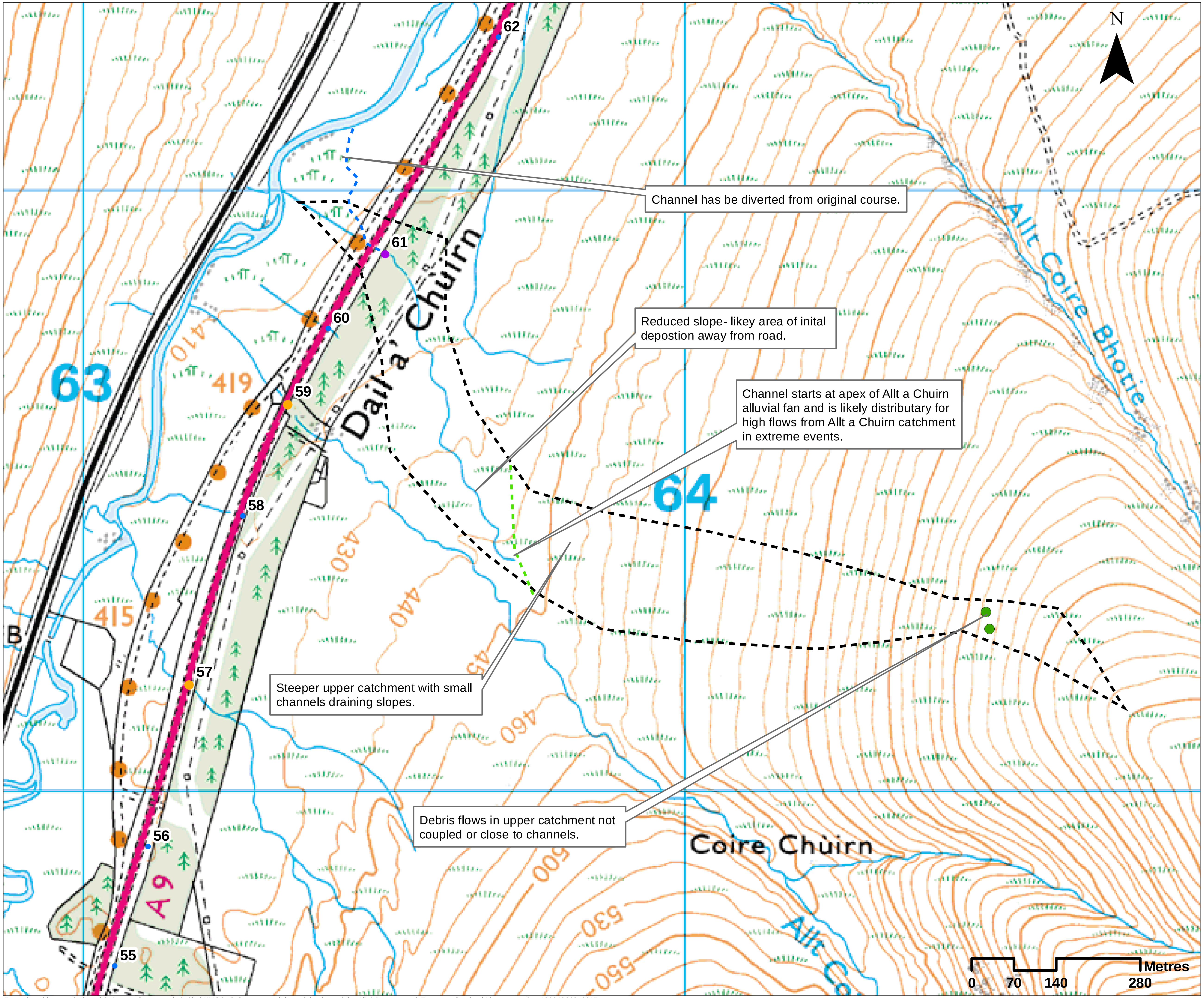

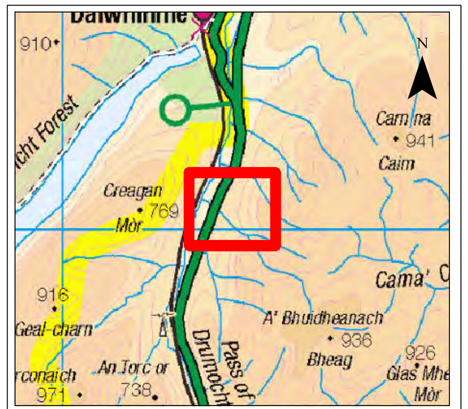

Legend

- Major crossing
- Minor crossing
- Other crossing
- Debris flow
- Break in slope
- Original channel
- Crossing catchment

REV	SUIT	DATE	DESCRIPTION	BY	APP

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2. Catchment 61 Baseline Assessment

DESIGN: EL	DRAWN: EL	CHK: AB	APP: EL

DATE: 12/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0002

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Annex 11.4.3 - Hydromorphological Catchment Assessment - 63

Catchment No.	**63**
Catchment Name	-

Channel Nature	Nature of water course	Natural	
	Size of water course	Minor	

Quantitative Spatial Elements	Catchment Area (km^2)	0.7	
	Average slope in catchment (°)	12	
	% 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 11.4.3.1 a and b Catchment 63)	Gaick Psammite formation-Psammite	Resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	Yes	Near the point where the alluvial fans from Allt Coire a Chùirn and Allt Coire Bhotie coalesce. Due to topography, risk of avulsion from either of these two major channels low.

Environmental designations (see Drawing 11.4.3.1 c, Catchment 63)	Ramsar	No	
	SAC	River Spey	Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
		Drumochter Hills	Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, monntane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved
	SPA	Drumochter Hills	Dotterel breeding, merlin breeding
	SSSI	Drumochter Hills	Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage

Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 63	
	Is peat present in the catchment?	None	
	Is there a bog burst risk?	None	
	Current valley side or terrace erosion	None	
	Potential valley side or terrace erosion	None	
	Hill slope failures (including peat slides and debris flows and slides)	Yes	
	Hill slope failures coupled to channel	None	
	Vertical incision present in catchment	None	
	Bank erosion/lateral migration	None	
	Unvegetated bars	None	
	Wooded/forested areas in catchment	Yes	Chance of floating debris to crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 63)	None	
	Comment on sediment source potential in catchment	Sediment is available within the catchment but its not coupled with the channel, slowing the speed to sediment delivery to the crossing	
	Comment on sediment supply potential to crossing	Limited source in proximity of channel, channel is not very steep so will move sediment slowly	

Morphology and Process- Reach upstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Cobbles and gravels	
	Unvegetated bars	None	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 63)	None	
	Impact of infrastructure	None	
	Channel realignment	Yes	

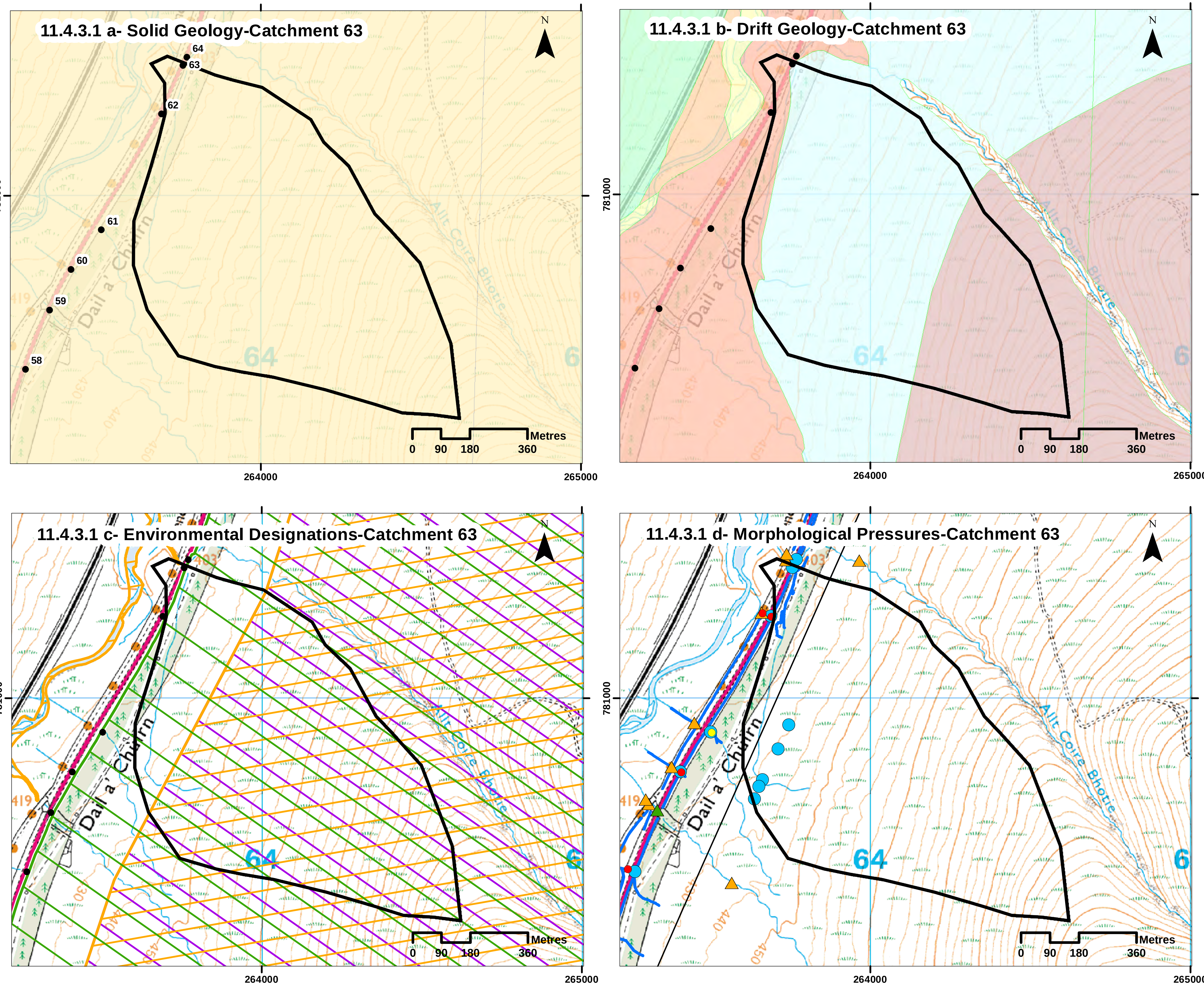
Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	None	
	Estimated discharge at 1:200 event (m^3/s)	6.93	This might be from combined 63 and 64 catchments.
	Unvegetated bars	None	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Damaged/unstable drains or armouring	Some damage to bed protection at downstream end	

Morphology and Process- Reach downstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Cobbles and gravels	
	Unvegetated bars	Yes	
	Vertical incision	High	Downstream of confluence with 64
	Deposition	Medium	Downstream of confluence with 64
	Lateral migration/bank erosion	Low	Downstream of confluence with 64
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 63)	None	
	Impact of infrastructure	None	
	Channel realignment	None	
Summary behaviour	Channel has been realigned u/s of the road, but channel length remains similar to original channel and little activity. Issues identified downstream of confluence with crossing 64 channel are attributable to crossing 64.		

Photograph 11.4.3.8- Upstream to pipe

Photograph 11.4.3.9- Downstream to confluence with crossing 64, failing channel banks

Photograph 11.4.3.10- Upstream of crossing, confined channel



Legend

General

- Crossing location

Solid Geology

- Gaick Psammite Formation - Psammite

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
- Special Protection Area

Morphological Pressures

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

REV	SUIT	DATE	DESCRIPTION	BY	APP

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TRANSPORT SCOTLAND
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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 63 Catchment Overview

DESIGN:	DRAWN:	CHK:	APP:
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DATE: 20/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0001

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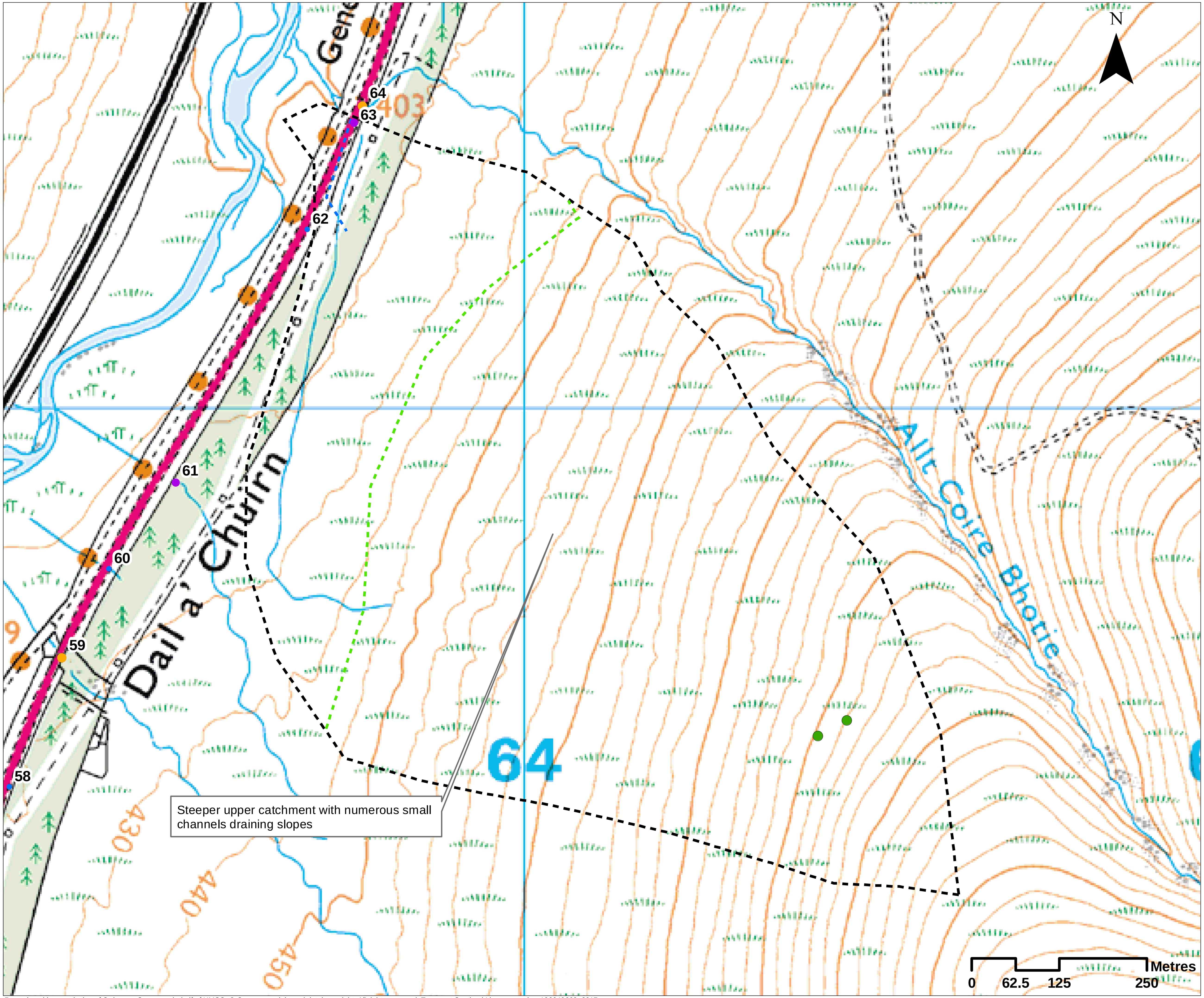

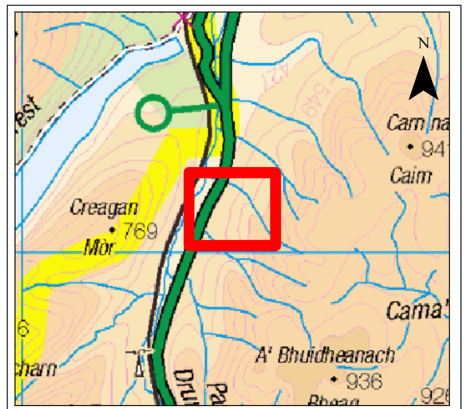

Legend

- Major crossing
- Minor crossing
- Other crossing
- Debris flow
- Break in slope
- Original channel
- Crossing catchment

REV	SUIT	DATE	DESCRIPTION	BY	APP

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2. Catchment 63 Baseline Assessment

DESIGN:	DRAWN:	CHK:	APP:
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DATE: 12/07/2017

PROJ: 495298

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Annex 11.4.3 - Hydromorphological Catchment Assessment - 64

Catchment No.	**64**
Catchment Name	**-**

Channel Nature	Nature of water course	Natural	
	Size of water course	Major	
Quantitative Spatial Elements	Catchment Area (km^2)	1.2	
	Average slope in catchment (°)	15	
	% Catchment over 750m (for snow melt risk)	56%	
WFD classification	Water, flows and levels	Good	
	Physical condition	Good	
	Overall ecological status	Good	
Geology	Majority Bedrock (see Drawing 11.4.3.1 a and b Catchment 64)	Gaick Psammite formation-Psammite	Resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	Yes	Some risk of channel avulsion, possibly exacerbated by channel realignment.
Environmental designations (see Drawing 11.4.3.1 c, Catchment 64)	Ramsar	No	
	SAC	River Spey	Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
		Drumochter Hills	Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, monntane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved
	SPA	Drumochter Hills	Dotterel breeding, merlin breeding
	SSSI	Drumochter Hills	Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 64	
	Is peat present in the catchment?	None	
	Is there a bog burst risk?	None	
	Current valley side or terrace erosion	Yes	
	Potential valley side or terrace erosion	Yes	
	Hill slope failures (including peat slides and debris flows and slides)	Yes	
	Hill slope failures coupled to channel	Yes	
	Vertical incision present in catchment	None	
	Bank erosion/lateral migration	Some	
	Unvegetated bars	Some	
	Wooded/forested areas in catchment	Yes	Chance of floating debris
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 64)	None	
	Comment on sediment source potential in catchment	Extensive hillslope failures, and valley side erosion provide a large sediment supply to the channel, with potential for more due to the confined naturel of the channel and steep valley sides	
	Comment on sediment supply potential to crossing	Catchment susceptible to flooding from snowmelt, increasing flood frequency therefore increased potential for sediment to mobilise downstream. Reduced slope due to realignment at crossing creates an area of deposition	
Morphology and Process- Reach upstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Cobbles and Gravels	
	Unvegetated bars	Yes	Available sediment supply close to crossing
	Vertical incision	Low	Some as channel adjusts
	Deposition	Medium	Some as channel adjusts
	Lateral migration/bank erosion	Medium	Some as channel adjusts
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 64)	None	
	Impact of infrastructure	None	
	Channel realignment	Yes	Substantial realignment- channel length has increased, reducing the energy gradient creating an area of deposition
Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	Cobbles and gravels	
	Estimated discharge at 1:200 event (m^3/s)	6.93	
	Unvegetated bars	None	
	Vertical incision	None	
	Deposition	High	
	Lateral migration/bank erosion	Low	
	Damaged/unstable drains or armouring	None	
Morphology and Process- Reach downstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Cobbles and gravels	
	Unvegetated bars	Yes	
	Vertical incision	High	
	Deposition	Medium	
	Lateral migration/bank erosion	Low	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 64)	None	
	Impact of infrastructure	None	
	Channel realignment	Yes	Substantial realignment and change in base level of Truim
Summary behaviour	Sediment supply from coupled hillslope failures upstream, transported along steep and confined channel. Realignment has increased channel length upstream of the crossing, reducing slope and increasing deposition here. Sediment drops out in this area causing lateral adjustment. Erosion downstream of the crossing (due to realignment and confluence with 63) causing incision and bank collapse. Some risk of channel avulsion through alluvial fan deposits. exacerbated by reduction in channel slope created through realignment..		

Photograph 11.4.3.11- Downstream of crossing

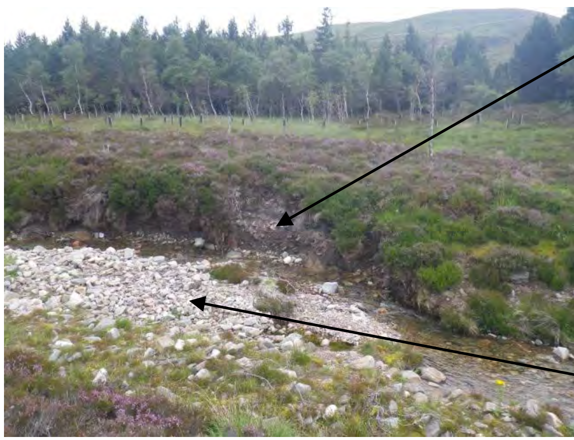
Photograph 11.4.3.12- Deposition in both pipes downstream of crossing

11.4.3.13 Upstream of crossing

11.4.3.14 – Deposition of coarse material in culvert entrance

Photograph 11.4.3.15-Upstream bank protection

Photograph 11.4.3.16-Looking South

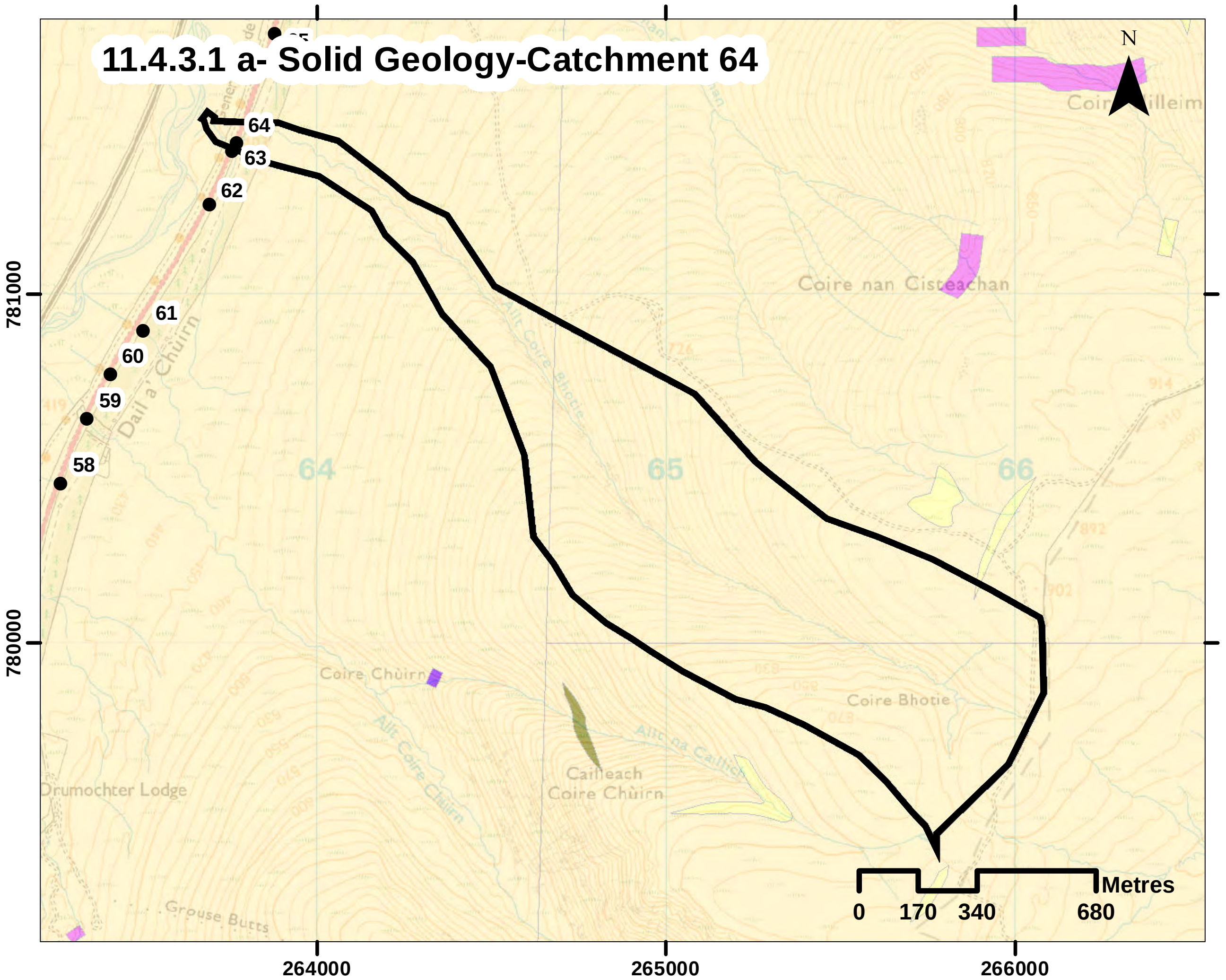


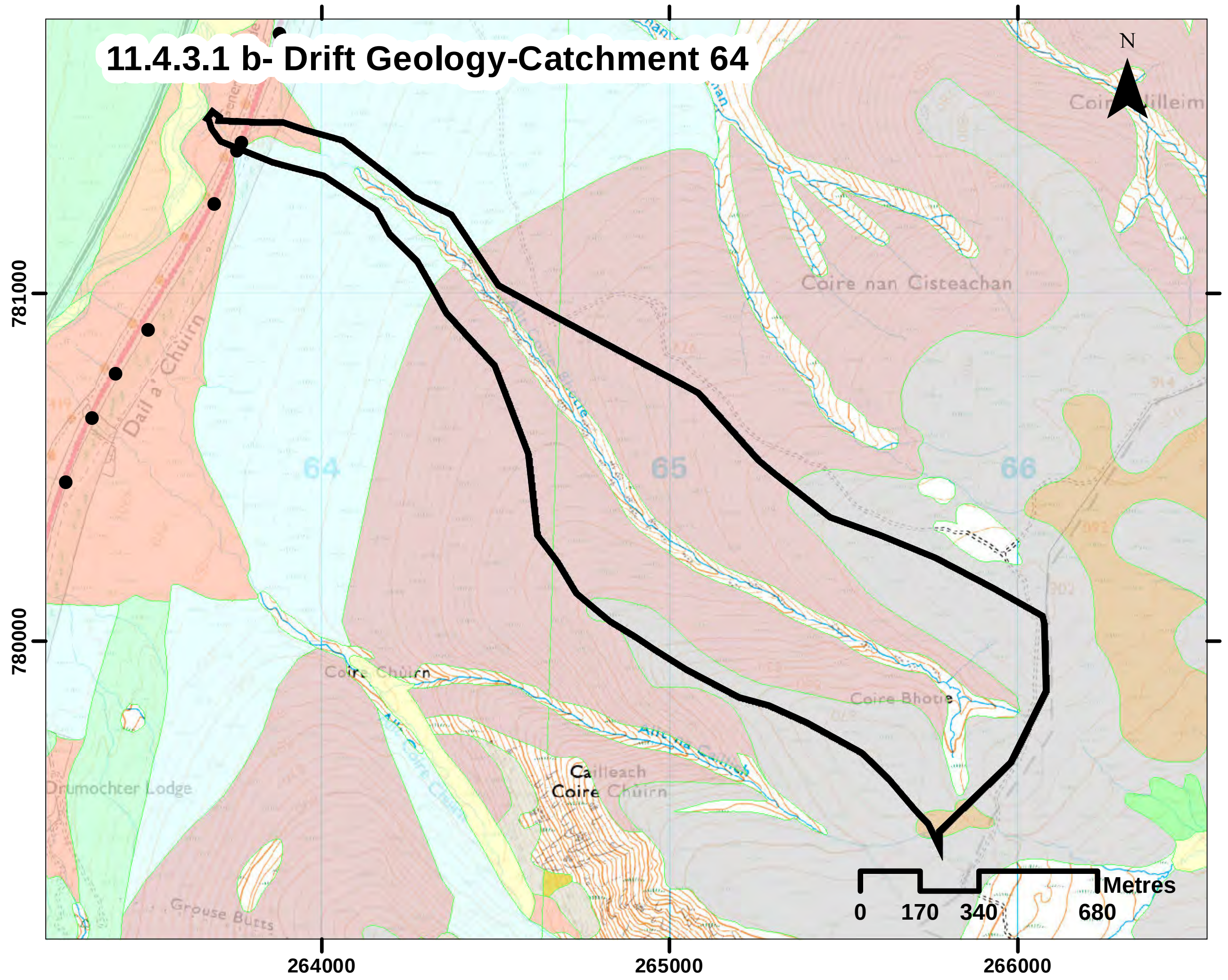
Photograph 11.4.3.17- Left bank

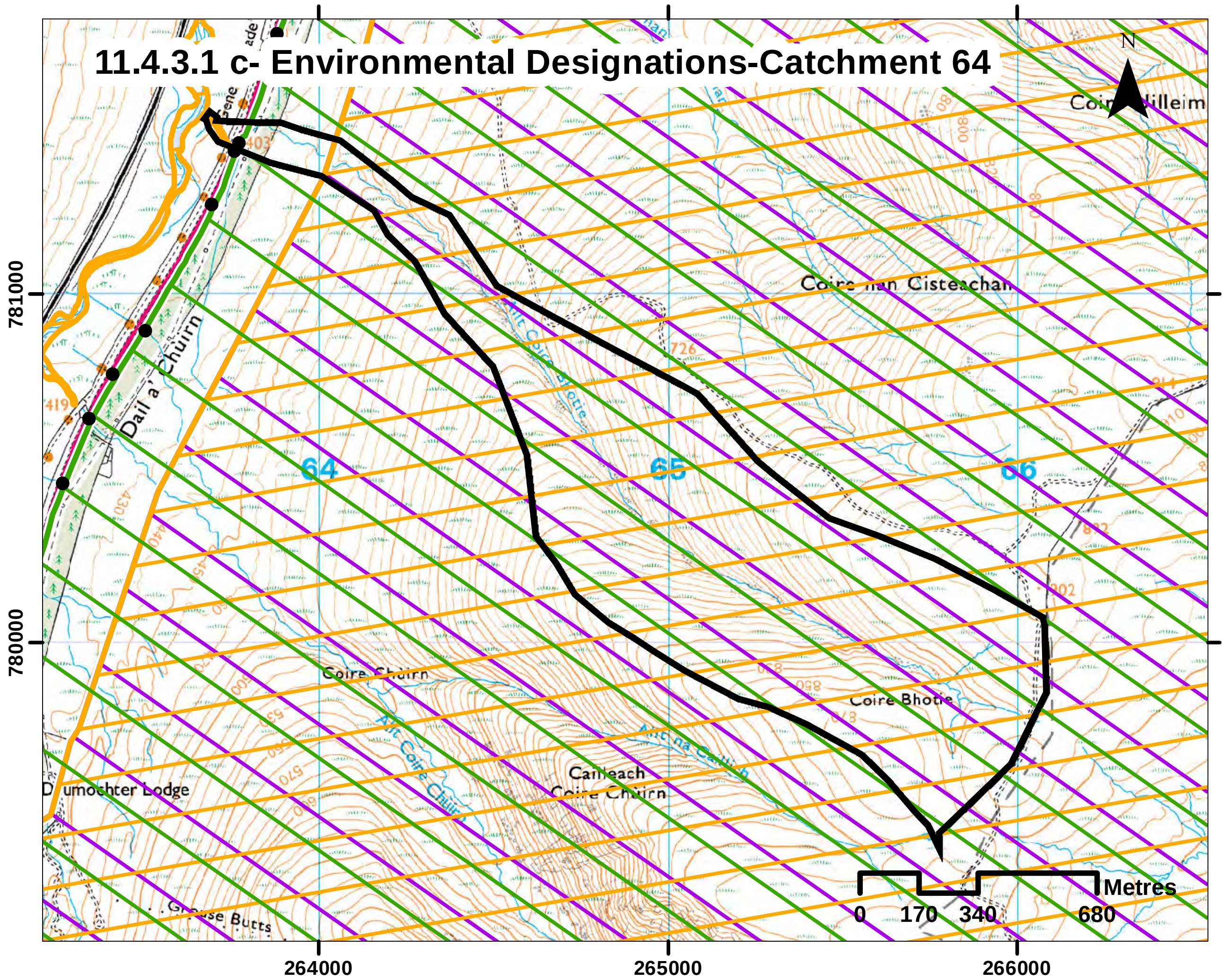
Photograph 11.4.3.18- Sediment rich channel

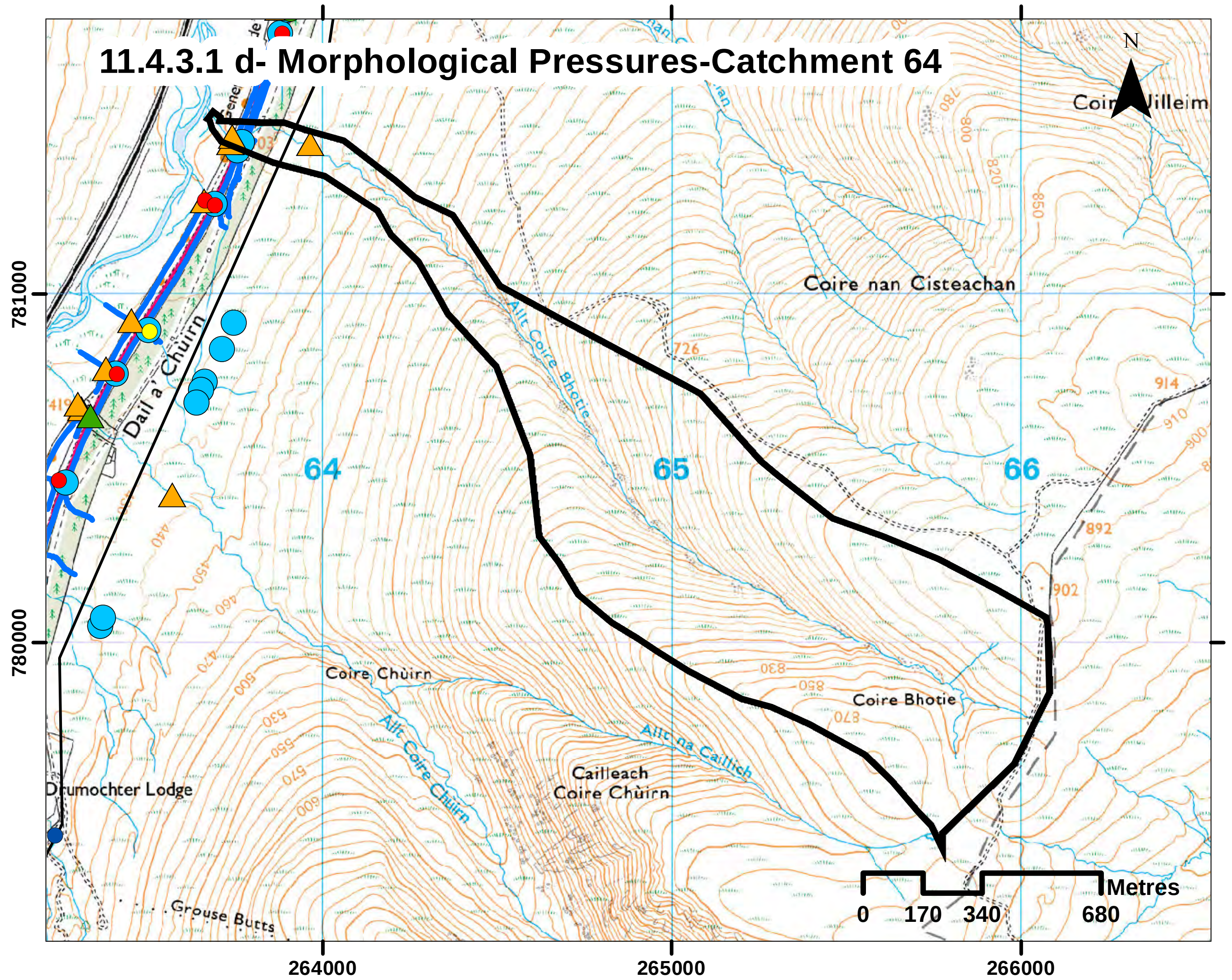
Photograph 11.4.3.19-Catchment upstream of crossing showing confined channel


Photograph 11.4.3.20-Downstream towards crossing









Legend

General

- Crossing location

Solid Geology

- Gaick Psammite Formation - Psammite

Drift Geology

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

Environmental Designations

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

Morphological Pressures

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

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TRANSPORT SCOTLAND

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 64 Catchment Overview

DESIGN:	DRAWN:	CHK:	APP:
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DATE: 20/07/2017

PROJ: 495298

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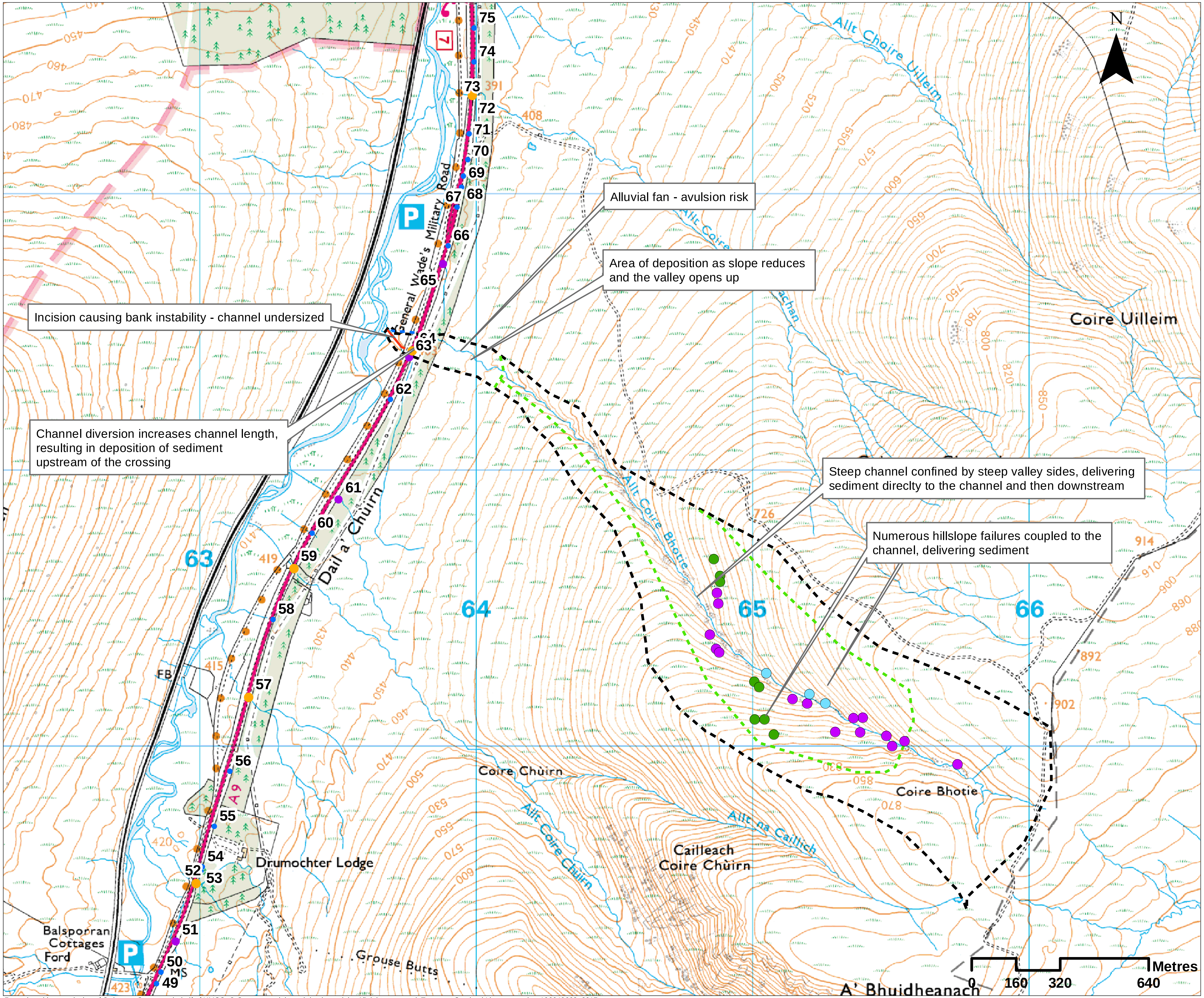
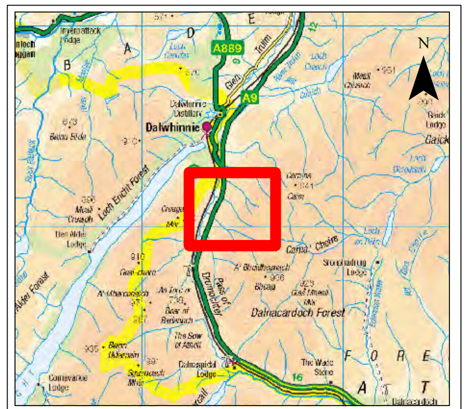
1 of 1	C01	A3





Legend

- Major crossing
- Minor crossing
- Other crossing
- Coupled debris flow
- Debris flow
- Valley side erosion
- Break in slope
- Original channel
- Incision
- Crossing catchment

REV	SUIT	DATE	DESCRIPTION	BY	APP

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TRANSPORT SCOTLAND

A9 DUALLING PERTH TO INVERNESS

PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2. Catchment 64 Baseline Assessment

DESIGN: EL	DRAWN: EL	CHK: AB	APP: EL

DATE: 12/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0002

SHEET: 1 OF 1	REVISION: C01	SUITABILITY: A3

Annex 11.4.3 - Hydromorphological Catchment Assessment - 65, 66

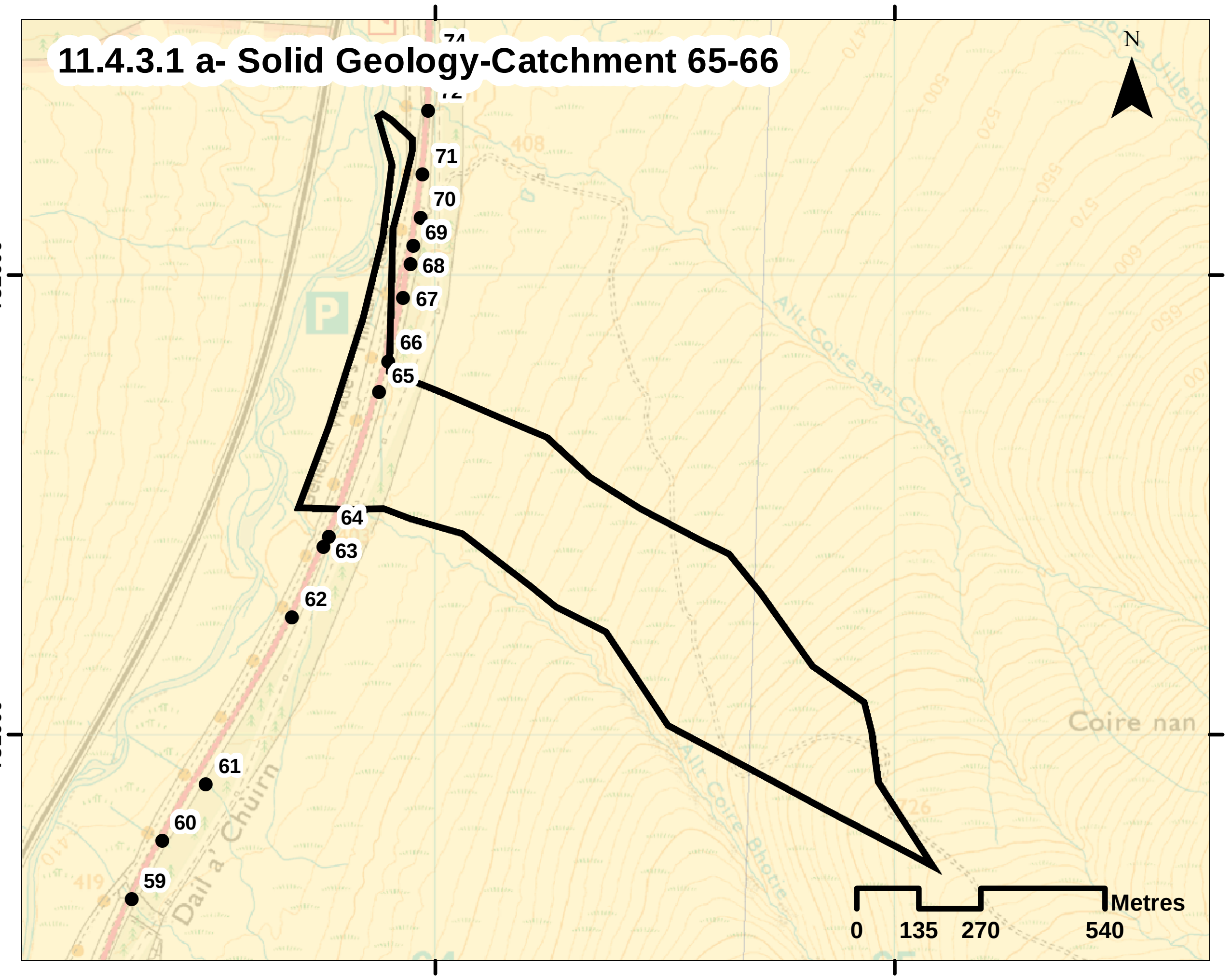
Catchment No.	**65, 66**
Catchment Name	**-**

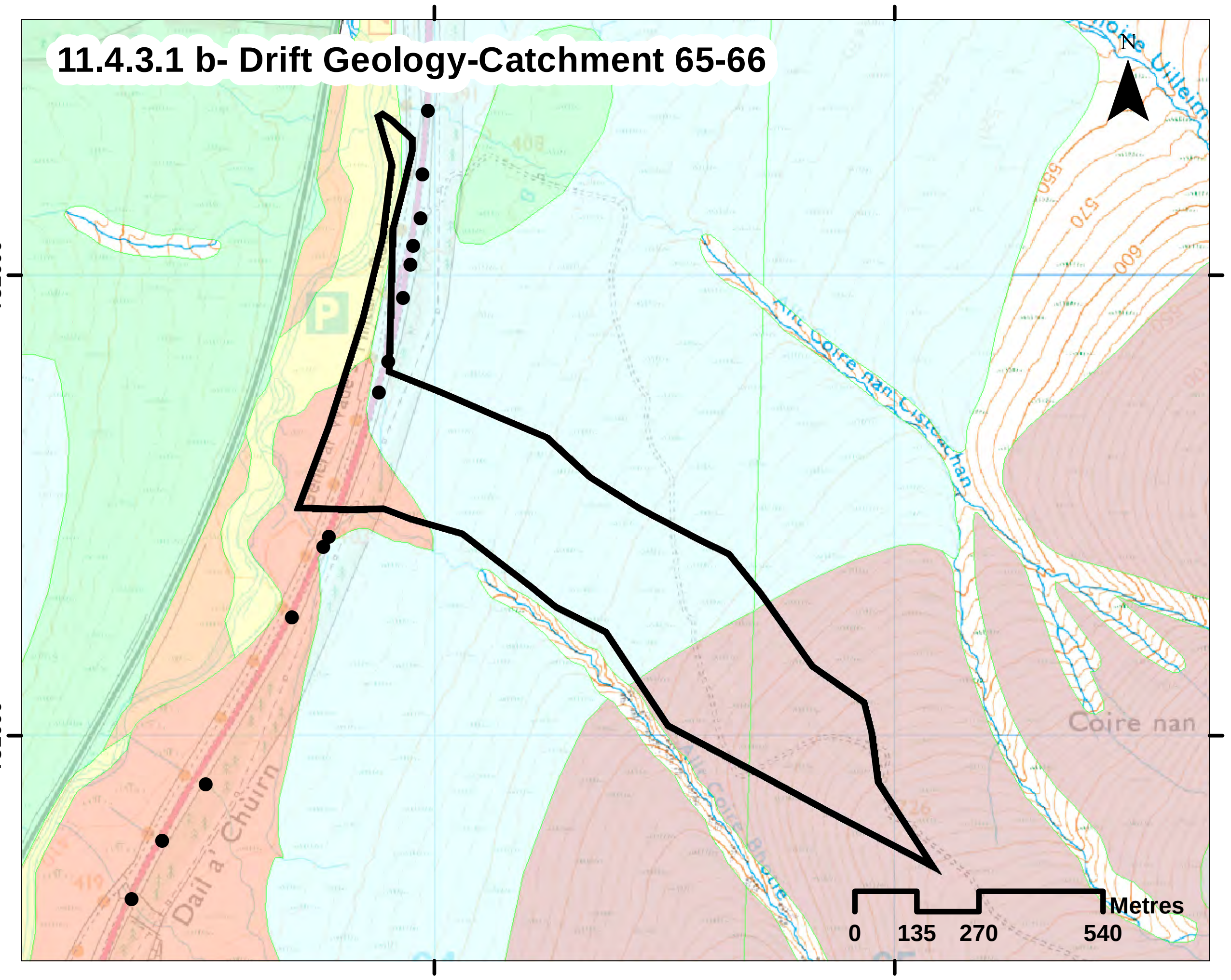
Channel Nature	Nature of water course	Drain	
	Size of water course	Minor	
Quantitative Spatial Elements	Catchment Area (km^2)	0.4	
	Average slope in catchment (°)	11.4	
	% Catchment over 750m (for snow melt risk)	0	
WFD classification	Water, flows and levels	Good	
	Physical condition	Good	
	Overall ecological status	Good	
Geology	Majority Bedrock (see Drawing 11.4.3.1 a and b Catchment 65, 66)	Gaick Psammite formation-Psammite	resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	Yes	Risk of avulsion of channel 64 into this catchment
Environmental designations (see Drawing 11.4.3.1 c, Catchment 65, 66)	Ramsar	No	
	SAC	Yes	**Drumochter Hills -** Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, montane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved heath. **River Spey** - Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
	SPA	Yes	**Drumochter Hills** - Dotterel breeding, merlin breeding
	SSSI	Yes	**Drumochter Hills** - Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 65, 66	
	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	Plantation forestry strip parallel to road
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 65, 66)	No	
	Comment on sediment source potential in catchment	Limited, likely fines. Drain cut cross slope to collect overland flow	
	Comment on sediment supply potential to crossing	Limited, some channel bed movement possible.	
Morphology and Process- Reach upstream of crossing	Channel morphology	Engineered	
	Predominant sediment size	Gravel	
	Unvegetated bars	No	
	Vertical incision	Medium	Channel appears incised, but most likely cut drain (based on cross-slope alignment)
	Deposition	Low	
	Lateral migration/bank erosion	None	
	Presence and nature of infrastructure (Map 1d)	No	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 65, 66)	No	
	Channel realignment	Yes	Cut drain
Morphology and Process- At crossing	Channel morphology	Engineered	Bank protection at culvert entrance, closed culvert crossing and gabion baskets protecting access road immediately d/s of crossing.
	Predominant sediment size	Gravel	
	Estimated discharge at 1:200 event (m^3/s)	2	
	Unvegetated bars	No	
	Vertical incision	Medium	Deposition of gravels in crossing
	Deposition	Low	
	Lateral migration/bank erosion	Low	
	Damaged/unstable drains or armouring	Yes	Paving slab armouring ripped up u/s of crossing
Morphology and Process- Reach downstream of crossing	Channel morphology	Engineered	
	Predominant sediment size	Gravel	
	Unvegetated bars	No	
	Vertical incision	Low	
	Deposition	Low	
	Lateral migration/bank erosion	Low	
	Presence and nature of infrastructure (Map 1d)	Yes	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 65, 66)	Yes	Access track requires 90° bend in channel alignment.
	Channel realignment	Yes	Channel must make 90° bend to parallel A9 and parallel access track. Flows northwards for c. 150m collecting flows from other channel 65 before turning again onto Truim floodplain.
Summary behaviour	Channel 65 appears to be drain cut to take hillslope overland flow from a c.300m wide section of hillside, however, OS mapping shows pre-existing channel d/s of the crossing. Drain is deep and appears incised with mobile bed. Near culvert entrance, flows seem to have been sufficient to have ripped up some of the armouring in the drain near to the crossing. Bank protection is present upstream and downstream of the crossing, to pass under which the channel must make nor 90° turns on its entrance to and exit from the culvert. On the exit this is due to the presence of an access road parallel to the A9, which the channel follows for ca. 150m before joining . In this 150m section, into which crossing 66 also feeds there are numerous ripped up paving slabs, indicating energy is higher than anticipated.		

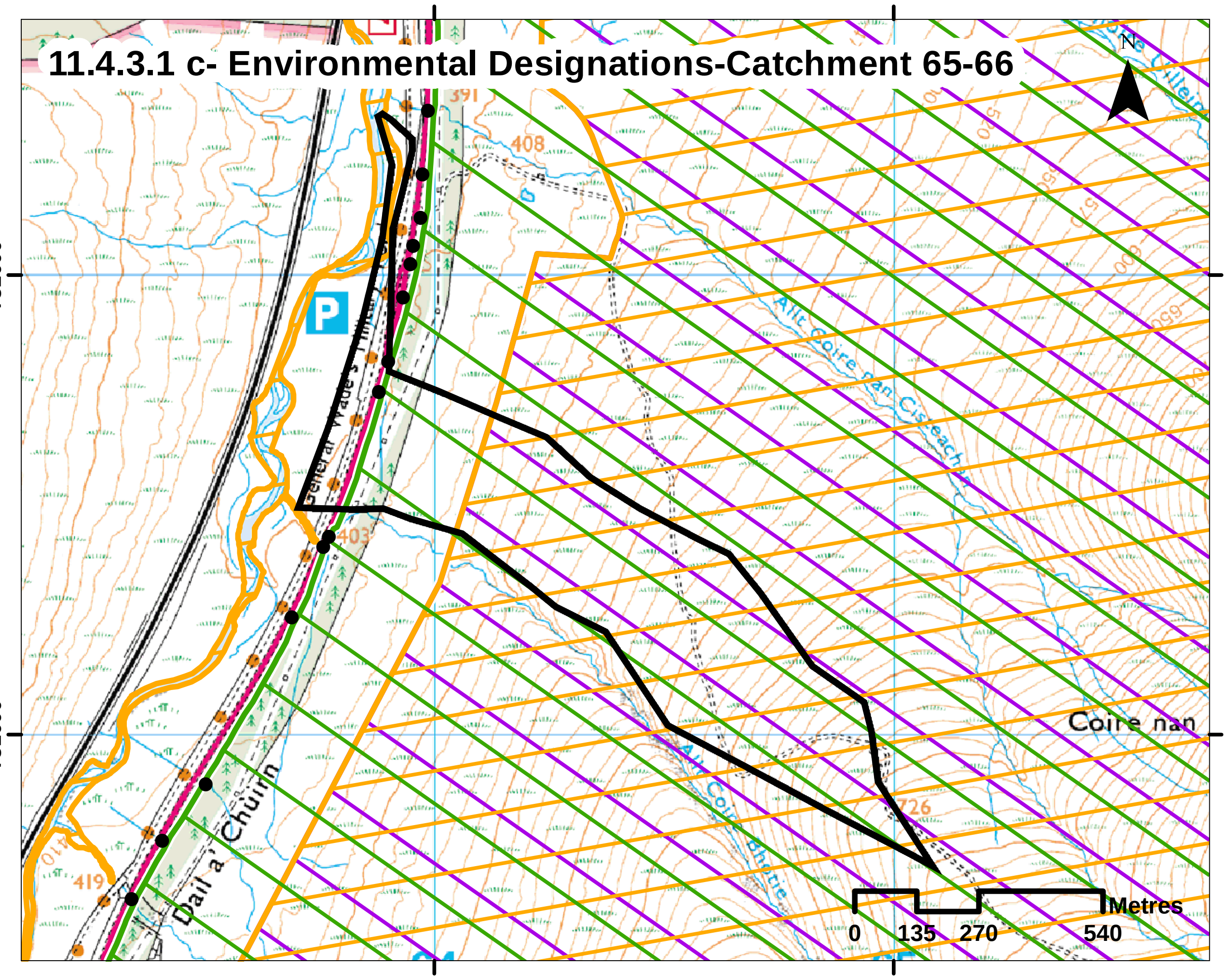
Photograph 11.4.3.21 – Gabions on left bank of channel have been undercut. Channel is undersized for high flows

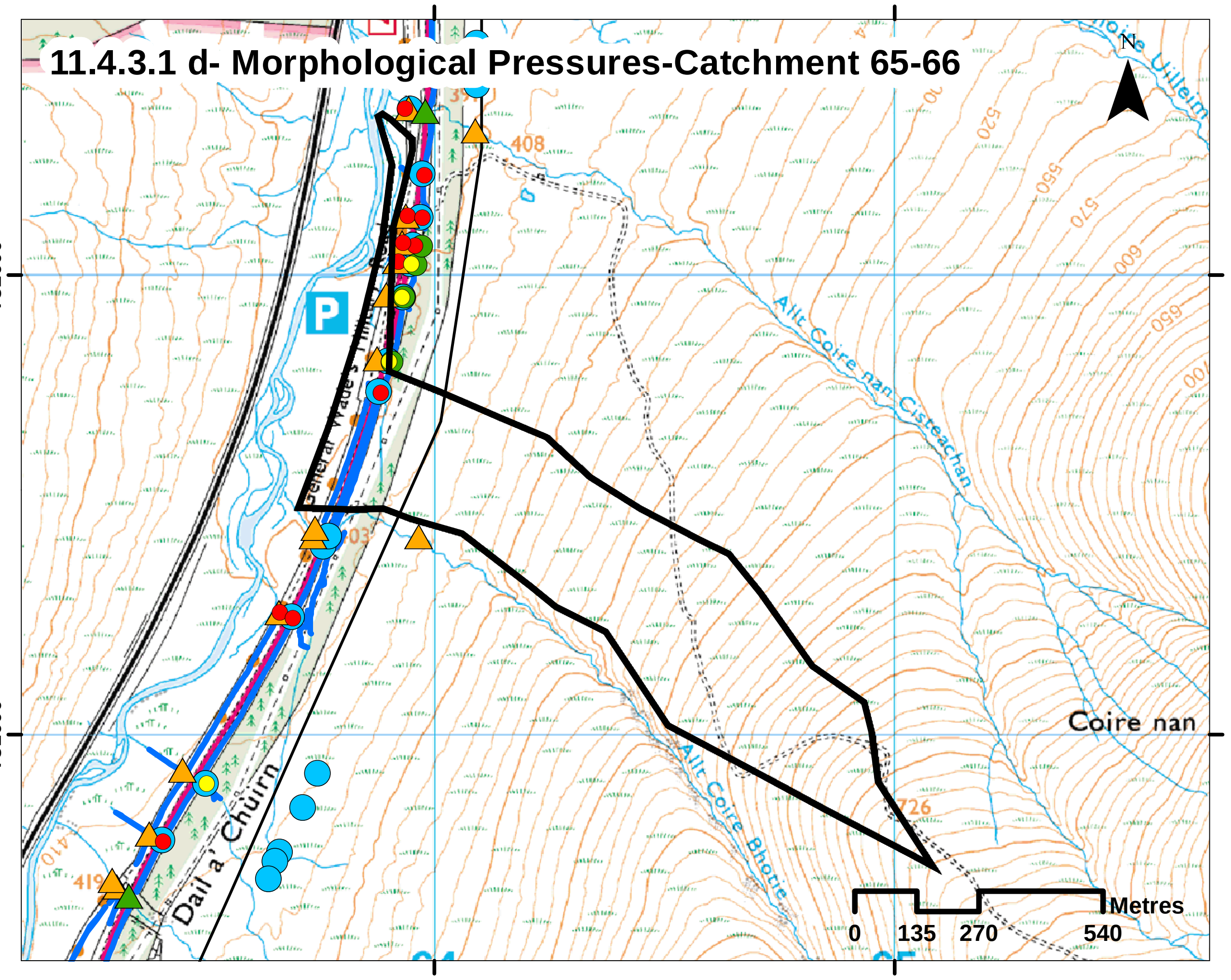
Photograph 11.4.3.22 – Downstream exit of pipe crossing

Photograph 11.4.3.23 – Erosion of concreate slabs in bed of drainage channel. High energy system despite lower bed slope than upstream channels









Legend

General

- Crossing location

Solid Geology

- Gaick Psammite Formation - Psammite

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
- Special Protection Area

Morphological Pressures

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

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 65-66 Catchment Overview

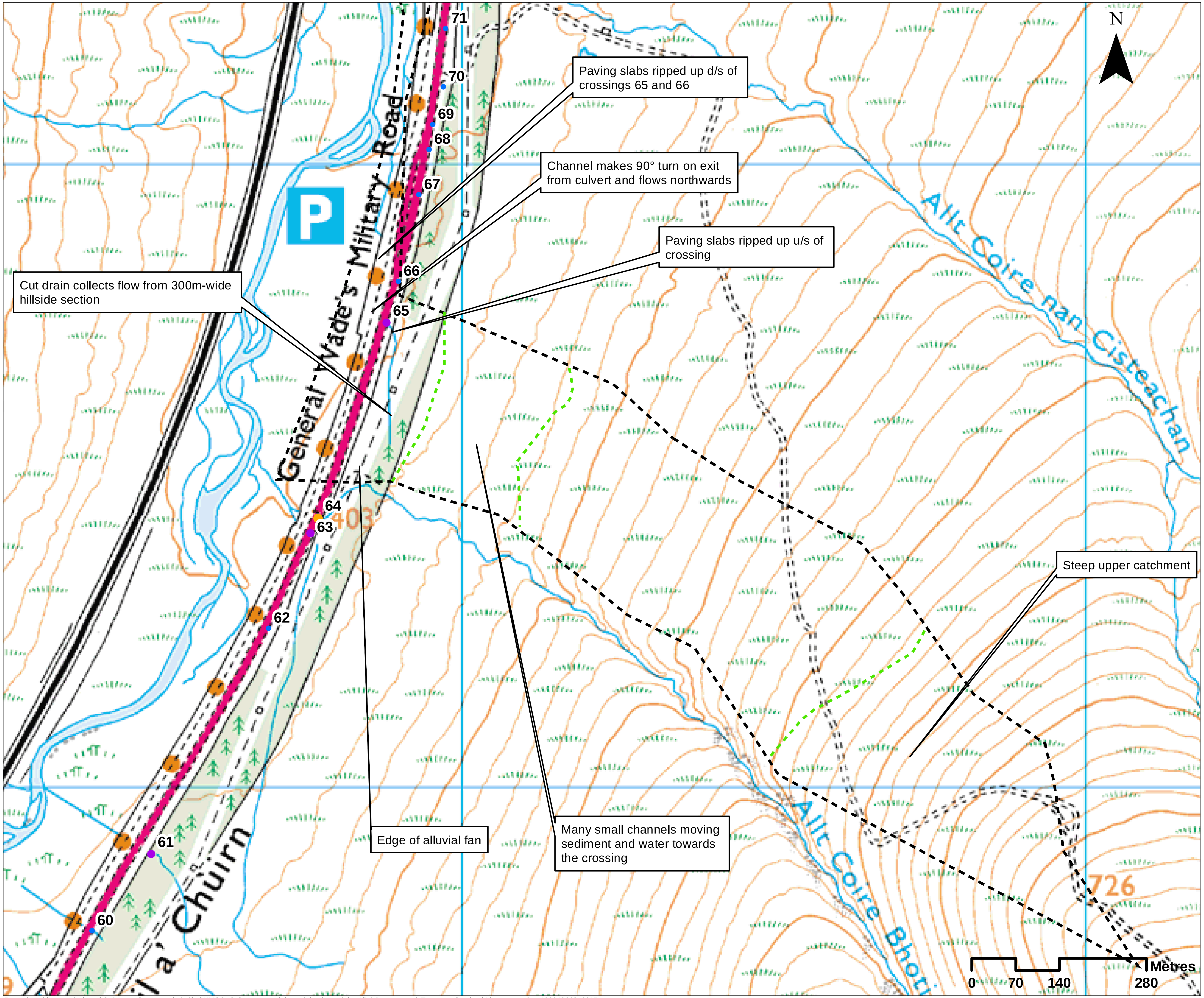
DESIGN: EL	DRAWN: EV	CHK: EL	APP: EL

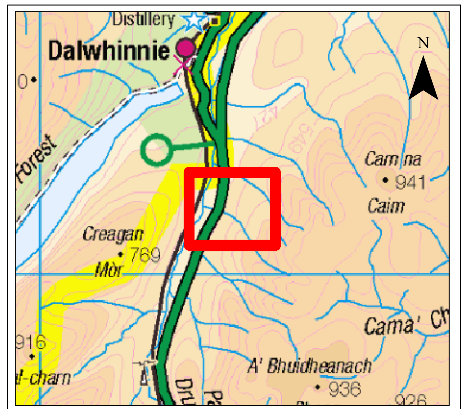
DATE: 20/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0001

SHEET: 1 of 1	REVISION: C01	SUITABILITY: A3





Legend

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

REV	SUIT	DATE	DESCRIPTION	BY	APP

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2.
Catchment 65 and 66 Baseline Assessment

DESIGN:	DRAWN:	CHK:	APP:
EL	EL	AB	EL

DATE: 11/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0002

SHEET:	REVISION:	SUITABILITY:
1 of 1	C01	A3

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Annex 11.4.3 - Hydromorphological Catchment Assessment - 68

Catchment No.	**68**
Catchment Name	-

Channel Nature	Nature of water course	Drain	
	Size of water course	Other	
Quantitative Spatial Elements	Catchment Area (km^2)	Small unmapped catchment	
	Average slope in catchment (°)	8.99	
	% 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 11.4.3.1 a and b Catchment 68)	Gaick Psammite formation-Psammite	resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	No	
Environmental designations (see Drawing 11.4.3.1 c, Catchment 68)	Ramsar	No	
	SAC	Yes	**Drumochter Hills** - Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, montane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved heath. **River Spey** - Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
	SPA	Yes	**Drumochter Hills -** Dotterel breeding, merlin breeding
	SSSI	Yes	**Drumochter Hills -** Breeding bird assemblage, **fluvial geomorphology of Scotland**, montane assemblage, vascular plant assemblage
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 68	
	Is peat present in the catchment	Yes	
	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	Yes	Limited
	Bank erosion/lateral migration	No	
	Unvegetated bars	No	
	Wooded/forested areas in catchment	Yes	Potential for blockage of the crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 68)	No	
	Comment on sediment source potential in catchment	Limited source in catchment	
	Comment on sediment supply potential to crossing	Limited supply potential in catchment	
Morphology and Process- Reach upstream of crossing	Channel morphology	Engineered	Drain
	Predominant sediment size	Fine	
	Unvegetated bars	None	
	Vertical incision	Low	
	Deposition	Low	
	Lateral migration/bank erosion	None	
	Presence and nature of infrastructure (Map 1d)	Yes	Armouring and cascade- Fixing bed and bank position
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 68)	Yes	
	Channel realignment	Yes	
Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	Fine	
	Estimated discharge at 1:200 event (m^3/s)	2.5	
	Unvegetated bars	None	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Damaged/unstable drains or armouring	Yes	
Morphology and Process- Reach downstream of crossing	Channel morphology	Engineered	
	Predominant sediment size	Fine	
	Unvegetated bars	No	
	Vertical incision	Low	
	Deposition	Low	
	Lateral migration/bank erosion	None	
	Presence and nature of infrastructure (Map 1d)	No	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 68)	No	
	Channel realignment	No	
Summary behaviour	Low source and supply of sediment but some evidence of damage to the armouring in place at the crossing. Is a drain but has potential to capture reasonable amount of overland flow. Ensure suitable sizing and check energy levels.		

Photograph 11.4.3.24 - Crossing exit

Some damage to
apron from high
energy flows

Low gradient
channel

Photograph 11.4.3.25 - Downstream of crossing-
Small channel

Photograph 11.4.3.26 – Looking upstream-
Stepped cascade into crossing

Annex 11.4.3 - Hydromorphological Catchment Assessment - 70

Catchment No.	70
Catchment Name	-

Channel Nature	Nature of water course	Natural	
	Size of water course	Other	

Quantitative Spatial Elements	Catchment Area (km^2)	No Data	
	Average slope in catchment (°)	No Data	
	% Catchment over 750m (for snow melt risk)	No Data	

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

Geology	Majority Bedrock (see Drawing 11.4.3.1 a and b Catchment 70)	Gaick Psammite formation-Psammite	resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	No	

Environmental designations (see Drawing 11.4.3.1 c, Catchment 70)	Ramsar	No	
	SAC	Yes	**Drumochter Hills -** Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, montane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved heath. **River Spey** - Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
	SPA	Yes	**Drumochter Hills** - Dotterel breeding, merlin breeding
	SSSI	Yes	**Drumochter Hills** - Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage

Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 70	
	Is peat present in the catchment	Yes	
	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 planation parallel to road u/s of crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 70)	Yes	Access track on right bank Access track in headwaters
	Comment on sediment source potential in catchment	Fines likely supplied from hillside. Coarse sediment possibly supplied from mobile channel	
	Comment on sediment supply potential to crossing	Some coarse sediment supply evident at crossing from photos, so is occurring.	

Morphology and Process- Reach upstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Large gravel-cobble	
	Unvegetated bars	No	
	Vertical incision	Low	Through overlying soils to substrate
	Deposition	Low	
	Lateral migration/bank erosion	Low	
	Presence and nature of infrastructure (Map 1d)	Yes	Access track on right bank
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 70)	Yes	Limiting channel migration
	Channel realignment	Yes	Effectively in drain alongside access track

Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	Large gravel-cobble	
	Estimated discharge at 1:200 event (m^3/s)	2.5	
	Unvegetated bars	No	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Damaged/unstable drains or armouring	None	

Morphology and Process- Reach downstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Large gravel-cobble	
	Unvegetated bars	No	
	Vertical incision	Low	
	Deposition	Low	
	Lateral migration/bank erosion	Low	
	Presence and nature of infrastructure (Map 1d)	Yes	NMU route
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 70)	No	
	Channel realignment	No	
Summary behaviour	Channel was originally a natural channel but has been incorporated into a drain due to access track on left bank just u/s of crossing. Engineered bed and banks at crossing (pipe culvert under road). Relatively low gradient at crossing has caused coarse sediment to deposit on entrance and exit of culvert. Channel gradient steepens again d/s of road and is incised through the soils to substrate, with coarse bed.		


Photograph 11.4.3.27 - Crossing exit


Photograph 11.4.3.28-Low gradient channel downstream of crossing

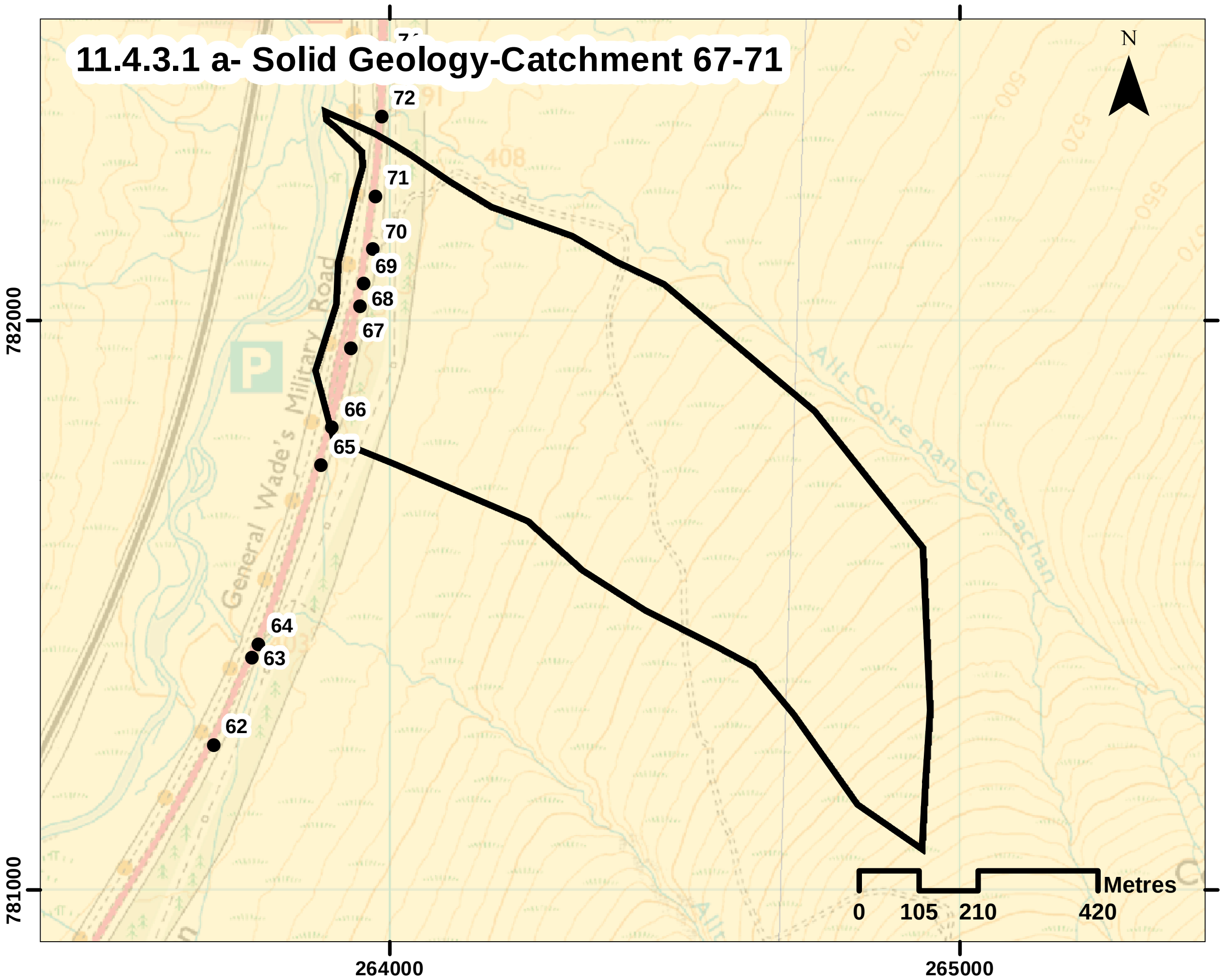
Photograph 11.4.3.29- Downstream of crossing

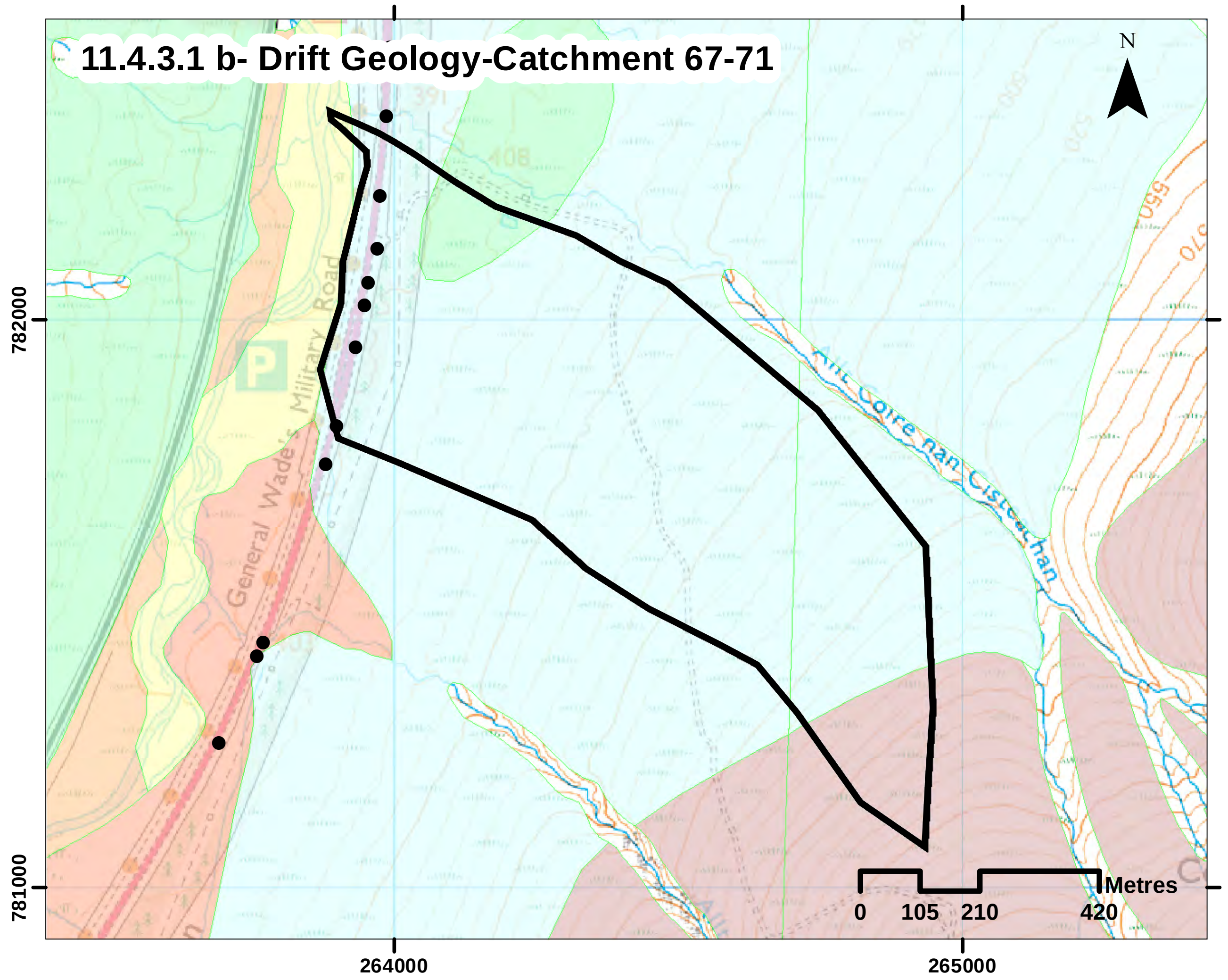
Annex 11.4.3 - Hydromorphological Catchment Assessment - 71

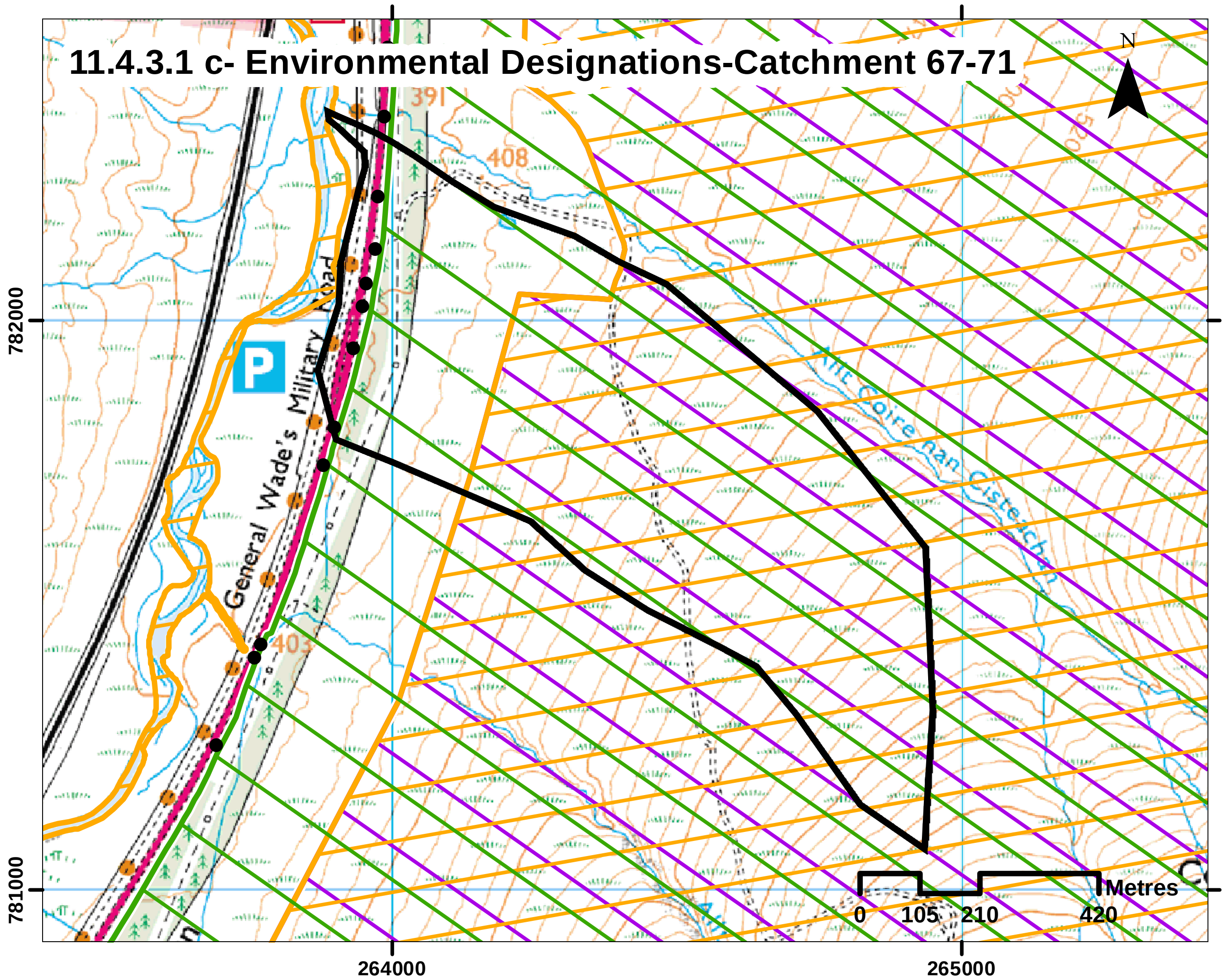
Catchment No.	**71**
Catchment Name	**-**

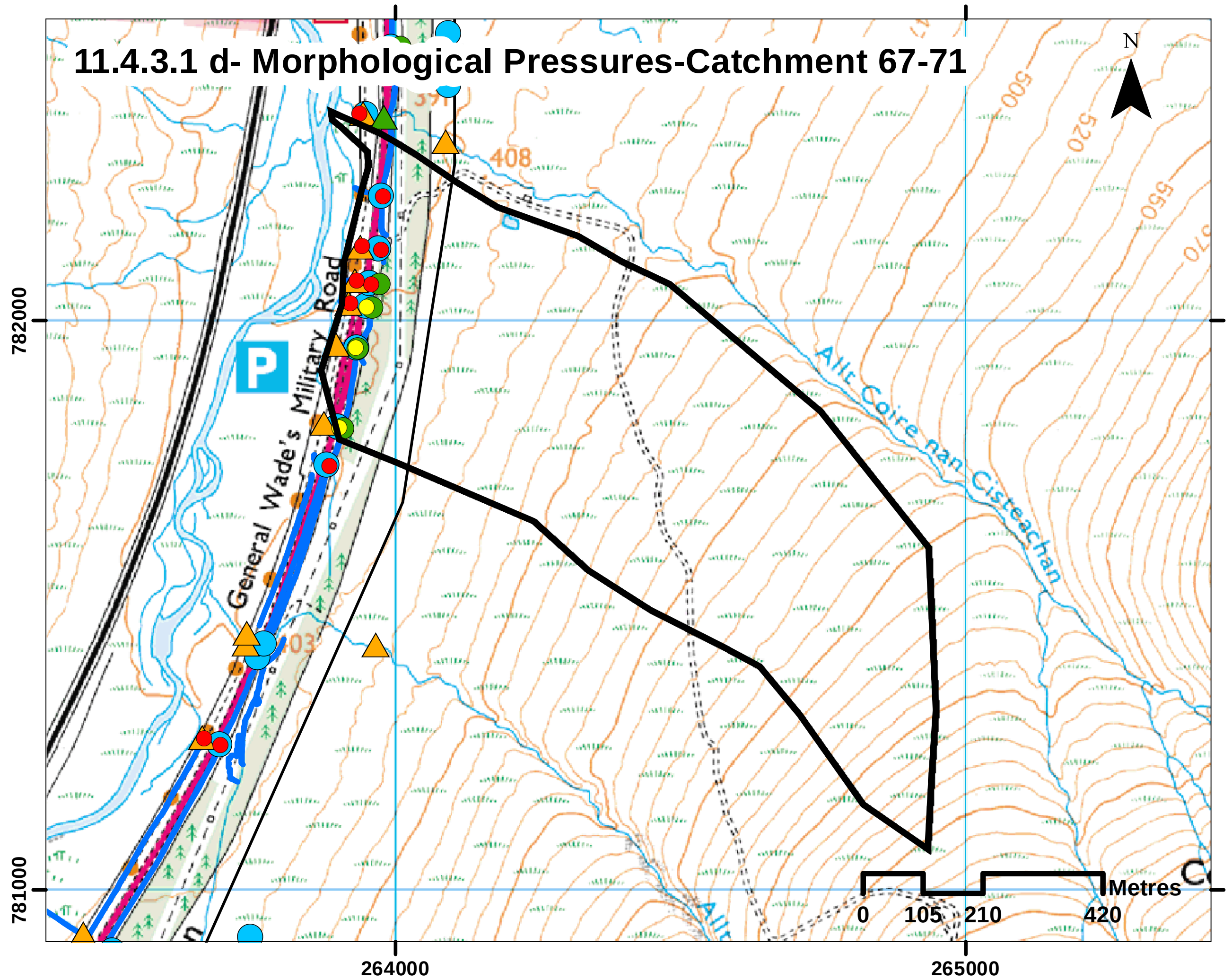
Channel Nature	Nature of water course	Natural	
	Size of water course	Other	
Quantitative Spatial Elements	Catchment Area (km^2)	No Data	
	Average slope in catchment (°)	No Data	
	% Catchment over 750m (for snow melt risk)	0	
WFD classification	Water, flows and levels	Good	
	Physical condition	Good	
	Overall ecological status	Good	
Geology	Majority Bedrock (see Drawing 11.4.3.1 a and b Catchment 71)	Gaick Psammite formation-Psammite	resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	No	
Environmental designations (see Drawing 11.4.3.1 c, Catchment 71)	Ramsar	No	
	SAC	Yes	**Drumochter Hills -** Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, montane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved heath. **River Spey - A**tlantic salmon, freshwater pearl mussel, otter, sea lamprey
	SPA	Yes	**Drumochter Hills -** Dotterel breeding, merlin breeding
	SSSI	Yes	**Drumochter Hills -** Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 71	
	Is peat present in the catchment	Yes	Possible, thin
	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 plantation forestry u/s of road
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 71)	Yes	ETL access track and compound
	Comment on sediment source potential in catchment	Limited, but possible input from access track and ETL compound	
	Comment on sediment supply potential to crossing	Limited, channel length and catchment both short so unlikely to generate sufficiently high flows to transport large sediment vols.	
Morphology and Process- Reach upstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Large gravel with fine drape	
	Unvegetated bars	No	
	Vertical incision	Medium	Incision has previously occurred u/s, of crossing but now stabilised i.e. all adjustment has now occurred.
	Deposition	Low	
	Lateral migration/bank erosion	Low	
	Presence and nature of infrastructure (Map 1d)	Yes	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 71)	Yes	In culvert underneath gravel access track
	Channel realignment	No	
Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	-	
	Estimated discharge at 1:200 event (m^3/s)	2.5	
	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		No Photos
	Predominant sediment size		No Photos
	Unvegetated bars		No Photos
	Vertical incision		No Photos
	Deposition		No Photos
	Lateral migration/bank erosion		No Photos
	Presence and nature of infrastructure (Map 1d)	Yes	NMU track
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 71)		No Photos
	Channel realignment	No	
Summary behaviour	Channel network is short, starting only 200m u/s of crossing. Natural channel existed previously and this has been taken under ETL access track in plastic pipe culvert, probably restricting flows to the crossing. Some incision appears to have occurred us/ of the crossing, a possible 'historic' adjustment to the installation of the crossing which has effectively lowered the base level. However, this now appears stable. Crossing itself is heavily engineered and armoured with a catch pit/drop where two road-parallel drains join the channel immediately u/s of the culvert. No photos are available for the d/s of the crossing but aerial photos indicate the channel passes under the NMU track before joining the natural northwards flowing channel which also collects flow from crossings 65-70.		

Photograph 11.4.3.30 – Ephemeral channel-No flow at time of survey









Legend

General
- Crossing location

Solid Geology
- Gaick Psammite Formation - Psammite

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
- Special Protection Area

Morphological Pressures
- Road Bridge
- Track/Footbridge
- Culvert
- Cascade
- Step in Bed
- Catchpit
- Drainage Ditch
- Power Lines

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TRANSPORT SCOTLAND
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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 67-71 Catchment Overview

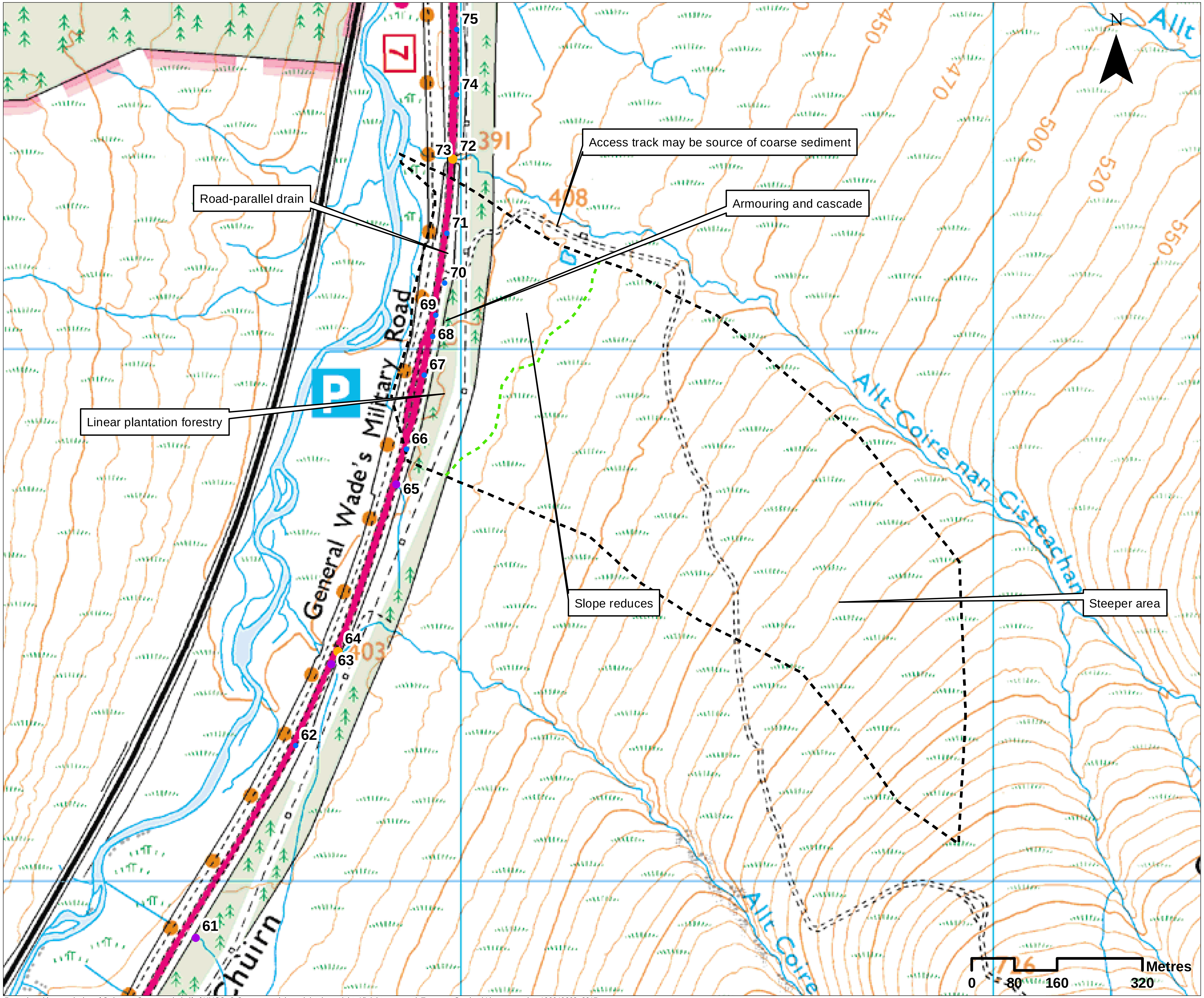
DESIGN: EL	DRAWN: EV	CHK: EL	APP: EL

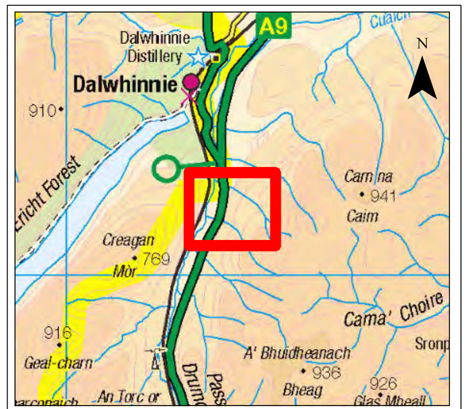
DATE: 20/07/2017

PROJ: 495298

DWG: A9P08-CFJ-EWE-X_ZZZZZ_ZZ-DR-EN-0001

SHEET:	REVISION:	SUITABILITY:
1 of 1	C01	A3





Legend

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

REV	SUIT	DATE	DESCRIPTION	BY	APP

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2.
Catchment 68 to 71 Baseline Assessment

DESIGN:	DRAWN:	CHK:	APP:
EL	EL	AB	EL

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Annex 11.4.3 - Hydromorphological Catchment Assessment - 72

Catchment No.	**72**
Catchment Name	**Allt Coire nan Cisteachan**

Channel Nature	Nature of water course	Natural	
	Size of water course	Major	

Quantitative Spatial Elements	Catchment Area (km^2)	1.7	
	Average slope in catchment (°)	13.2	
	% Catchment over 750m (for snow melt risk)	53.4	

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

Geology	Majority Bedrock (see Drawing 11.4.3.1 a and b Catchment 72)	Gaick Psammite formation-Psammite	resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	No	

Environmental designations (see Drawing 11.4.3.1 c, Catchment 72)	Ramsar	No	
	SAC	Yes	**Drumochter Hills -** Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, montane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved heath. **River Spey -** Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
	SPA	Yes	**Drumochter Hills -** Dotterel breeding, merlin breeding
	SSSI	Yes	**Drumochter Hills -** Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage

Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 72	
	Is peat present in the catchment	Yes	Possible. Limited on left bank terrace in mid catchment and on plateau. Substantial erosion
	Is there a bog burst risk	No	
	Current valley side or terrace erosion	Yes	10+
	Potential valley side or terrace erosion	Yes	1km
	Hill slope failures (including peat slides and debris flows and slides)	No	
	Hill slope failures coupled to channel	Yes	Terrace bluff failures as debris slides into channel
	Vertical incision present in catchment	Yes	
	Bank erosion/lateral migration	No	
	Unvegetated bars	No	
	Wooded/forested areas in catchment	Yes	Linear forest stand c.50m u/s of crossing. Some large woody debris noted u/s of crossing.
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 72)	No	
	Comment on sediment source potential in catchment	Significant. Evidence of gullying in uppermost catchment and terrace bluff failure/erosion in mid-catchment	
	Comment on sediment supply potential to crossing	Supply to crossing is mitigated by a lower-slope area in the lower catchment (with its u/s end c.600mu/s of crossing). Where river begins to meander across a flood plain (albeit at a relatively steep angle meaning the bed morphology is still a cascade). This wider, less steep area is likely to store sediment delivered from upper catchment and limit supply to crossing itself in all but catastrophic flooding.	

Morphology and Process- Reach upstream of crossing	Channel morphology	Cascade	
	Predominant sediment size	Cobble	
	Unvegetated bars	Yes	Evidence of bars u/s of crossing
	Vertical incision	Low	
	Deposition	Medium	Unvegetated bars developed with channel u/s of crossing
	Lateral migration/bank erosion	Low	
	Presence and nature of infrastructure (Map 1d)	No	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 72)	No	
	Channel realignment	Yes	Bend removed to take channel under road at right angles

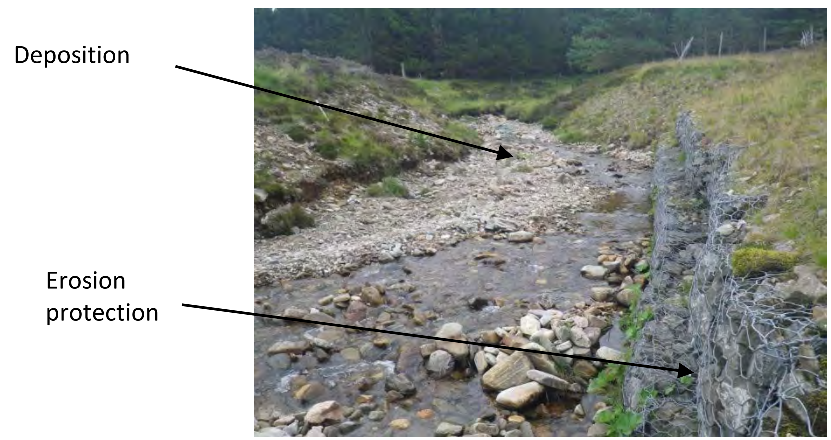
Morphology and Process- At crossing	Channel morphology	Plane bed	
	Predominant sediment size	cobble-boulder	
	Estimated discharge at 1:200 event (m^3/s)	9.87	
	Unvegetated bars	Yes	Unvegetated bar actually in crossing
	Vertical incision	None	
	Deposition	Medium	
	Lateral migration/bank erosion	Medium	Left bank protected with gabion baskets immediately u/s of crossing
	Damaged/unstable drains or armouring	No	Gabion baskets appear in reasonable condition

Morphology and Process- Reach downstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	cobble-boulder	
	Unvegetated bars	No	
	Vertical incision	Low	
	Deposition	Medium	
	Lateral migration/bank erosion	Medium	Some undercutting causing bank failure
	Presence and nature of infrastructure (Map 1d)	Yes	NMU crossing d/s
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 72)	No	Scour on d/s side of NMU crossing
	Channel realignment	Yes	Straight channel through to NMU crossing. Possibly natural alignment d/s of NMU crossing.
Summary behaviour	Upper catchment very steep with several tributaries incising into bedrock or superficial deposits. Some gullying and terrace failure will supply large amounts of sediment to mid and lower catchment. C.600m long relatively steeply (longitudinally) sloping floodplain with incipient meander development will act (to an extent) to an extent as a buffer to sediment arriving from sources upstream. However, very large (cobble-small boulder) sediment evident as deposited in bars immediately u/s of the crossing indicates that at the highest flows, some of this large sediment will eventually be transmitted to the crossing. Crossing may experience deposition and lateral change.		

Photograph 11.4.3.31 –Downstream to confluence-Geotechnical bank failures downstream

Photograph 11.4.3.32- Downstream to cycle crossing-Cobbel bed

Photograph 11.4.3.33 - Deposition in A9 crossing, creating low flow channel

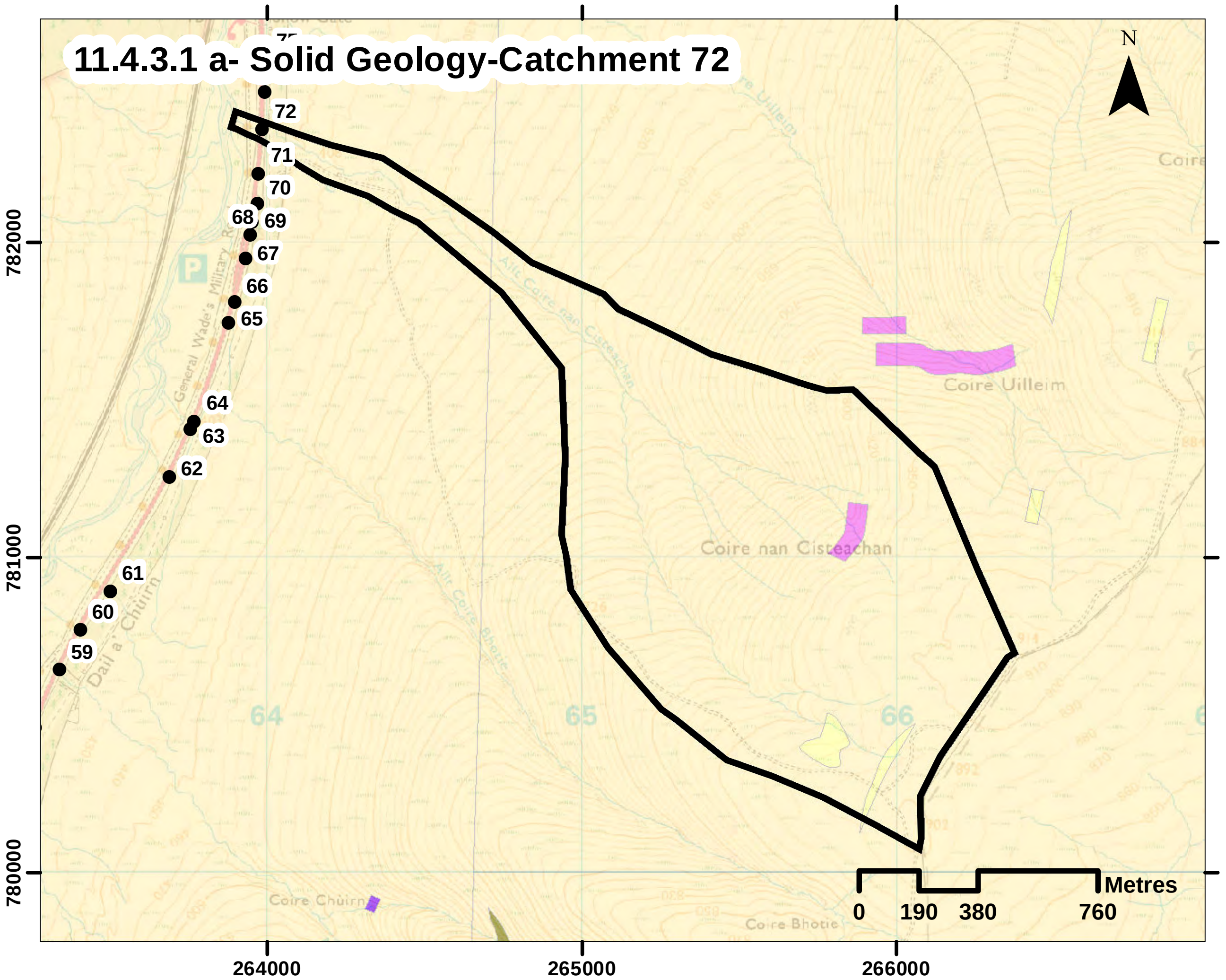


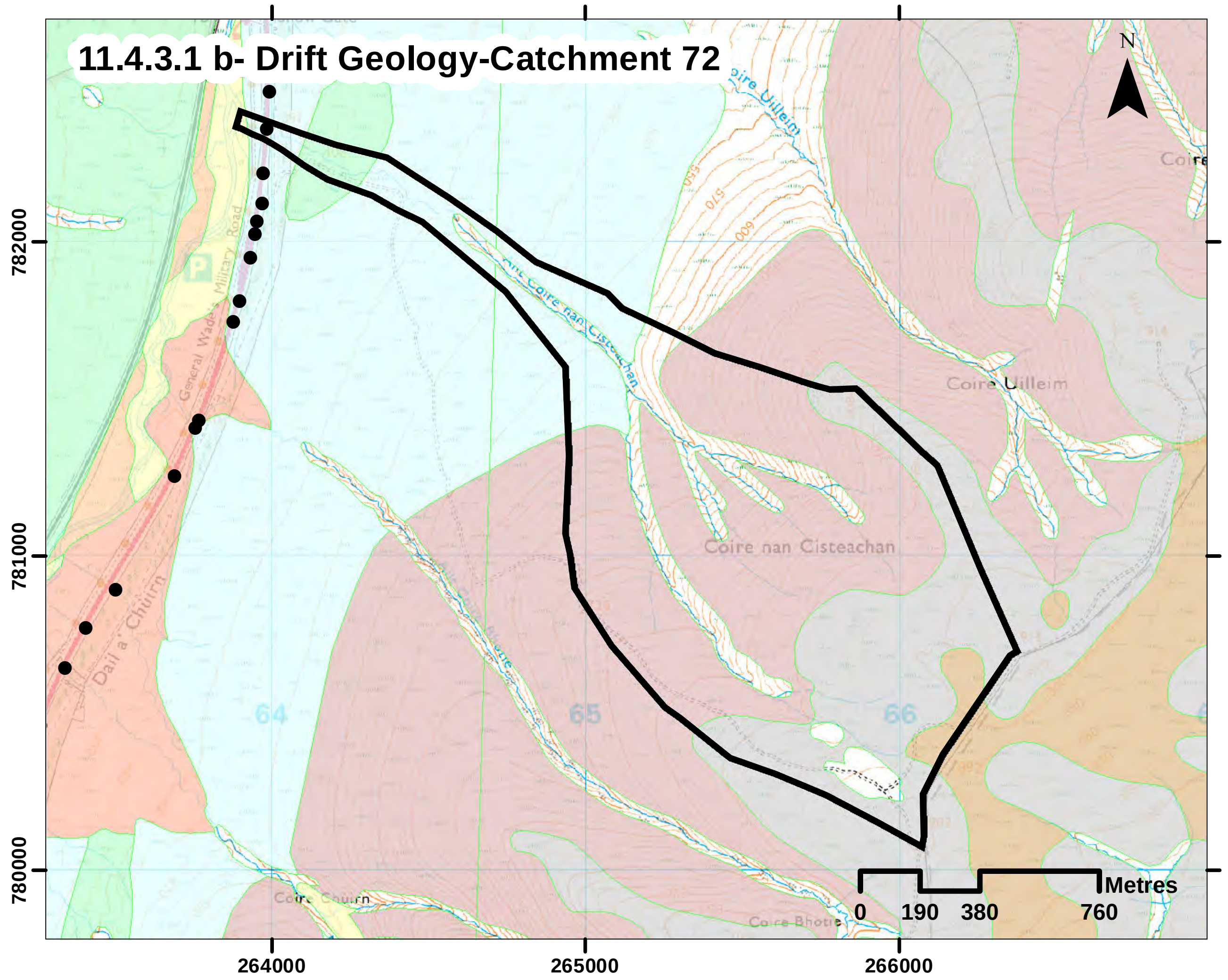
Photograph 11.4.3.34 - Upstream from crossing, confined channel

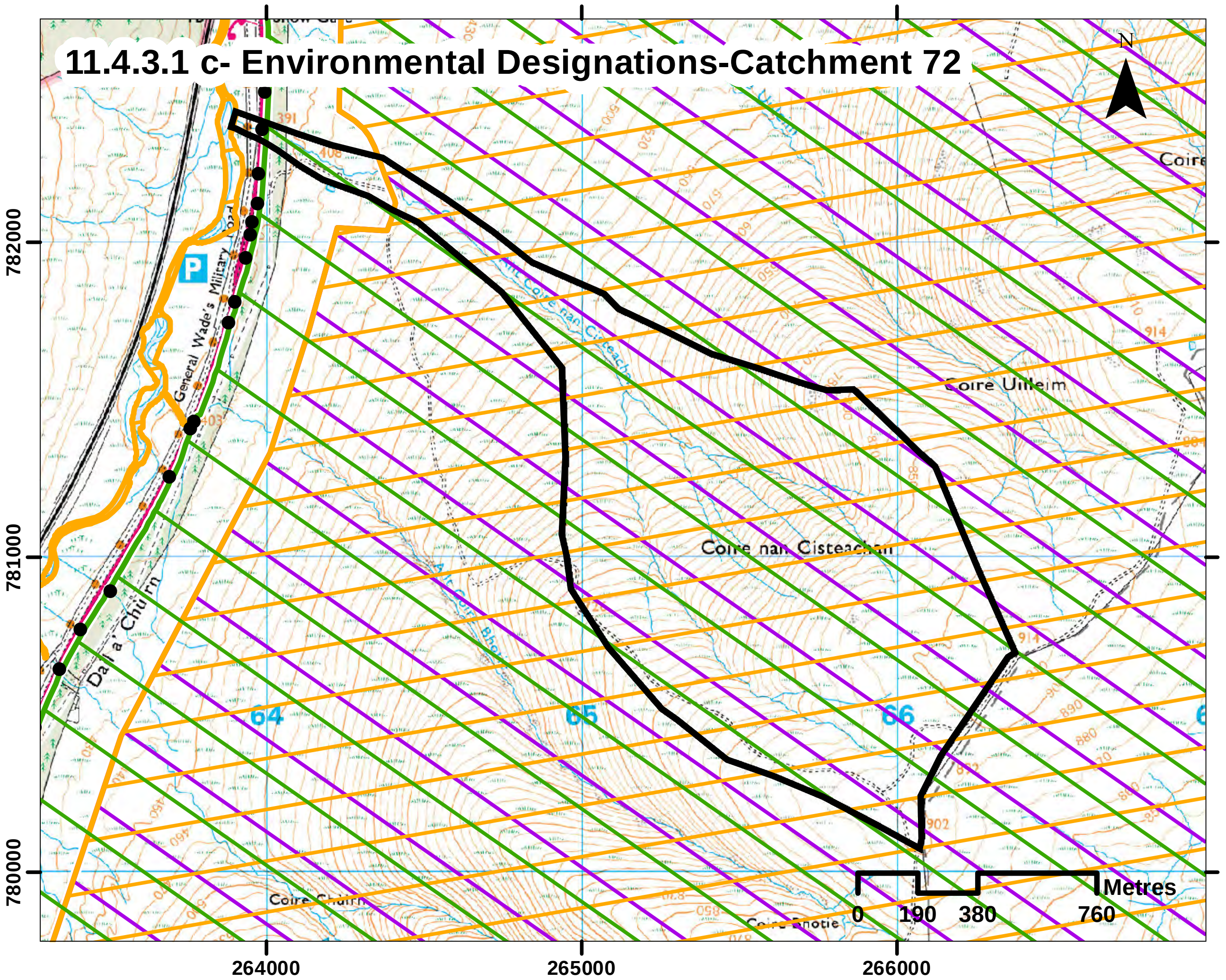
Photograph 11.4.3.35 - Upstream, Cascade morphology

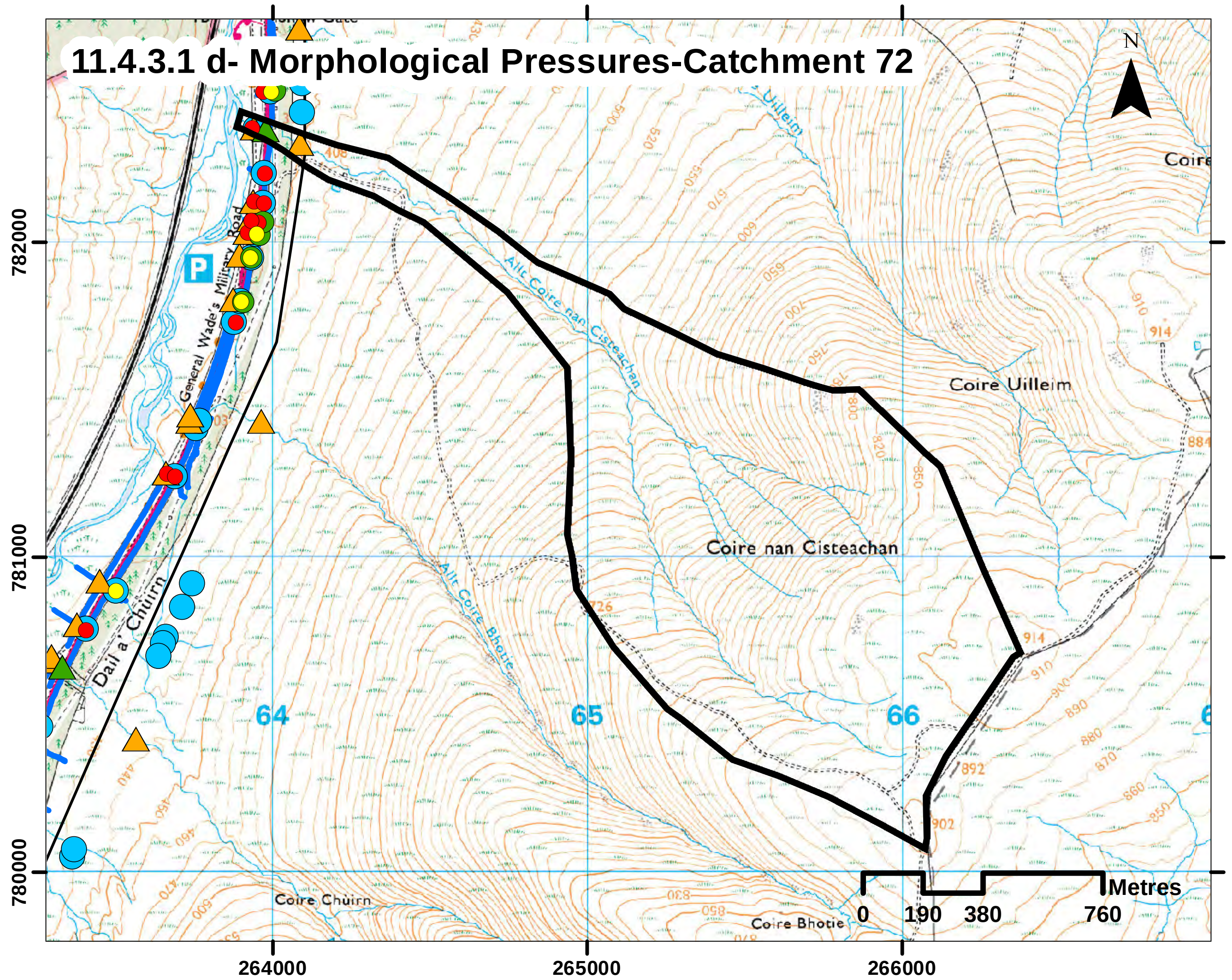
Photograph 11.4.3.36 - Deposition and woody debris upstream of crossing

Photograph 11.4.3.37 -Downstream to crossing









Legend

General
- Crossing Location
- Catchment Area

Solid Geology
- Gaick Psammite Formation - Psammite
- Scottish Highland Ordovician Minor Intrusion Suite - Pegmatite
- Vein-Quartz

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
- Special Protection Area

Morphological Pressures
- Road Bridge
- Track/Footbridge
- Culvert
- Cascade
- Step in Bed
- Catchpit
- Drainage Ditch
- Power Lines

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

Drawing 11.4.3.1 Catchment 72 Catchment Overview

DESIGN: EL	DRAWN: EV	CHK: EL	APP: EL

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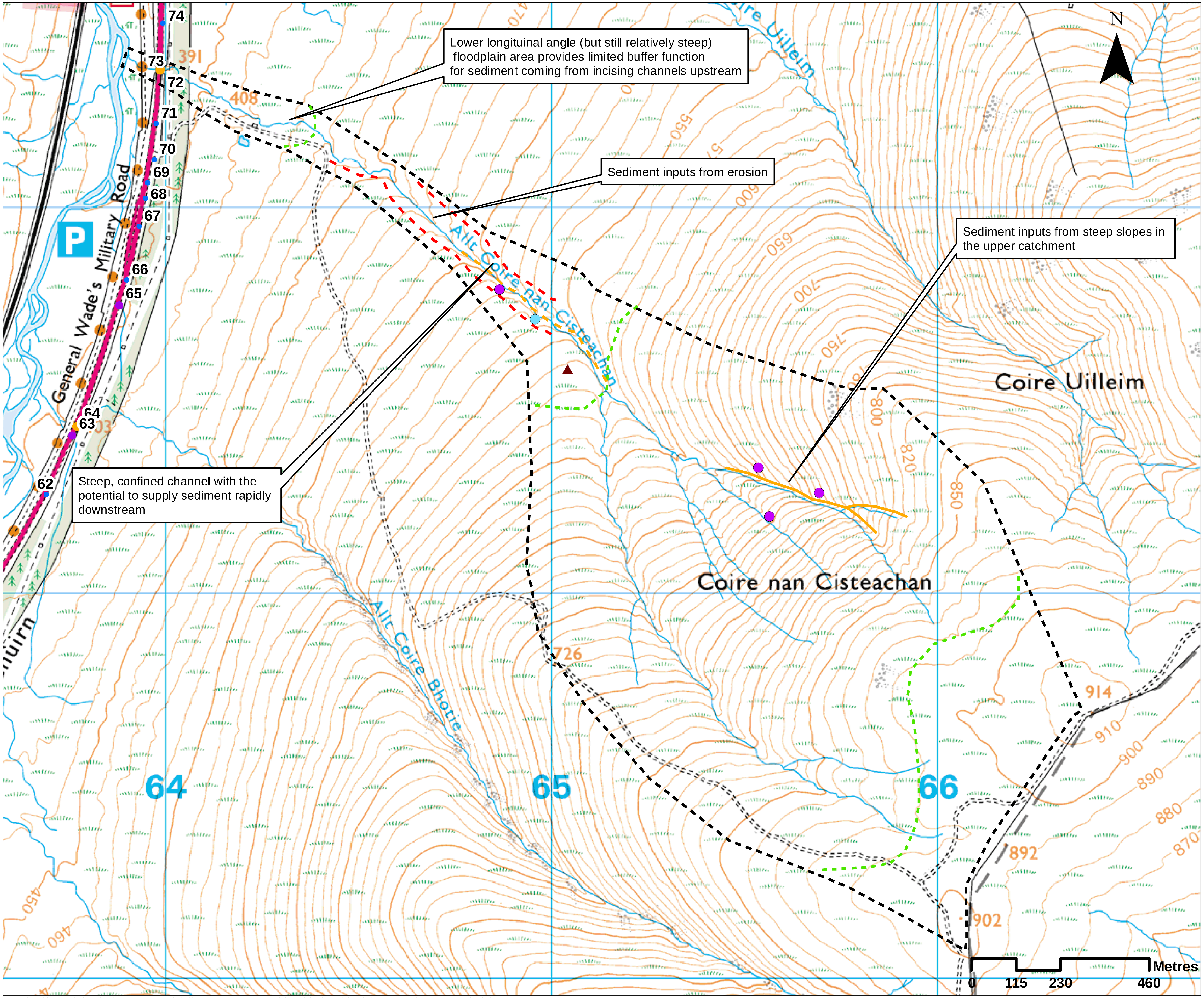

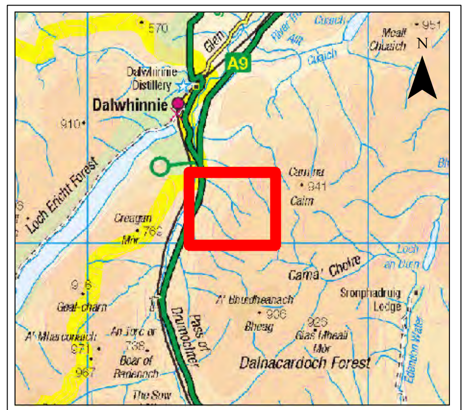

Legend

- Major crossing
- Minor crossing
- Other crossing
- Peat
- Coupled debris flow
- Valley side erosion
- Break in slope
- Terrace
- Potential valley side erosion
- Valley side erosion
- Crossing catchment

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PROJECT 8 DALWHINNIE TO CRUBENMORE EIA

DRAWING 11.4.3.2. Catchment 72 Baseline Assessment

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Annex 11.4.3 - Hydromorphological Catchment Assessment - 74 and 75

Catchment No.	**74 and 75**
Catchment Name	**-**

Channel Nature	Nature of water course	Drain	
	Size of water course	Other	

Quantitative Spatial Elements	Catchment Area (km^2)	No Data	
	Average slope in catchment (°)	No Data	
	% Catchment over 750m (for snow melt risk)	No Data	

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

Geology	Majority Bedrock (see Drawing 11.4.3.1 a and b Catchment 74 and 75)	Gaick Psammite formation-Psammite	resistant to weathering, impermeable
	Is an alluvial fan present at or near the crossing?	No	

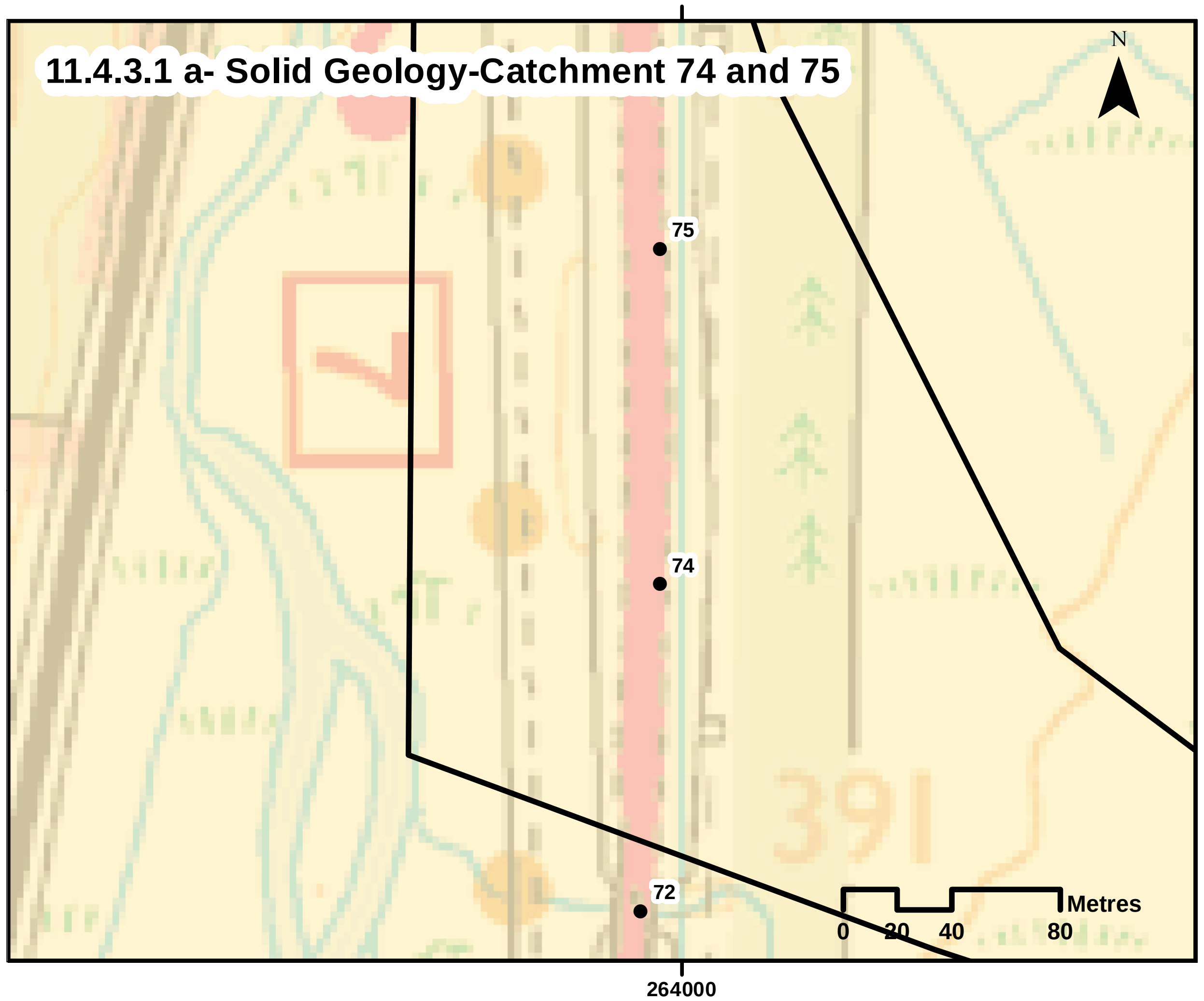
Environmental designations (see Drawing 11.4.3.1 c, Catchment 74 and 75)	Ramsar	No	
	SAC	Yes	**Drumochter Hills -** Acidic scree, alpine and subalpine heaths, blanket bog, dry heaths, montane acid grasslands , mountain willow scrub, plants in crevices on acid rocks, species-rich grassland with mat-grass in upland areas, tall herb communities, wet heathland with cross-leaved heath. **River Spey** - Atlantic salmon, freshwater pearl mussel, otter, sea lamprey
	SPA	Yes	**Drumochter Hills -** Dotterel breeding, merlin breeding
	SSSI	Yes	**Drumochter Hills -** Breeding bird assemblage, fluvial geomorphology of Scotland, montane assemblage, vascular plant assemblage

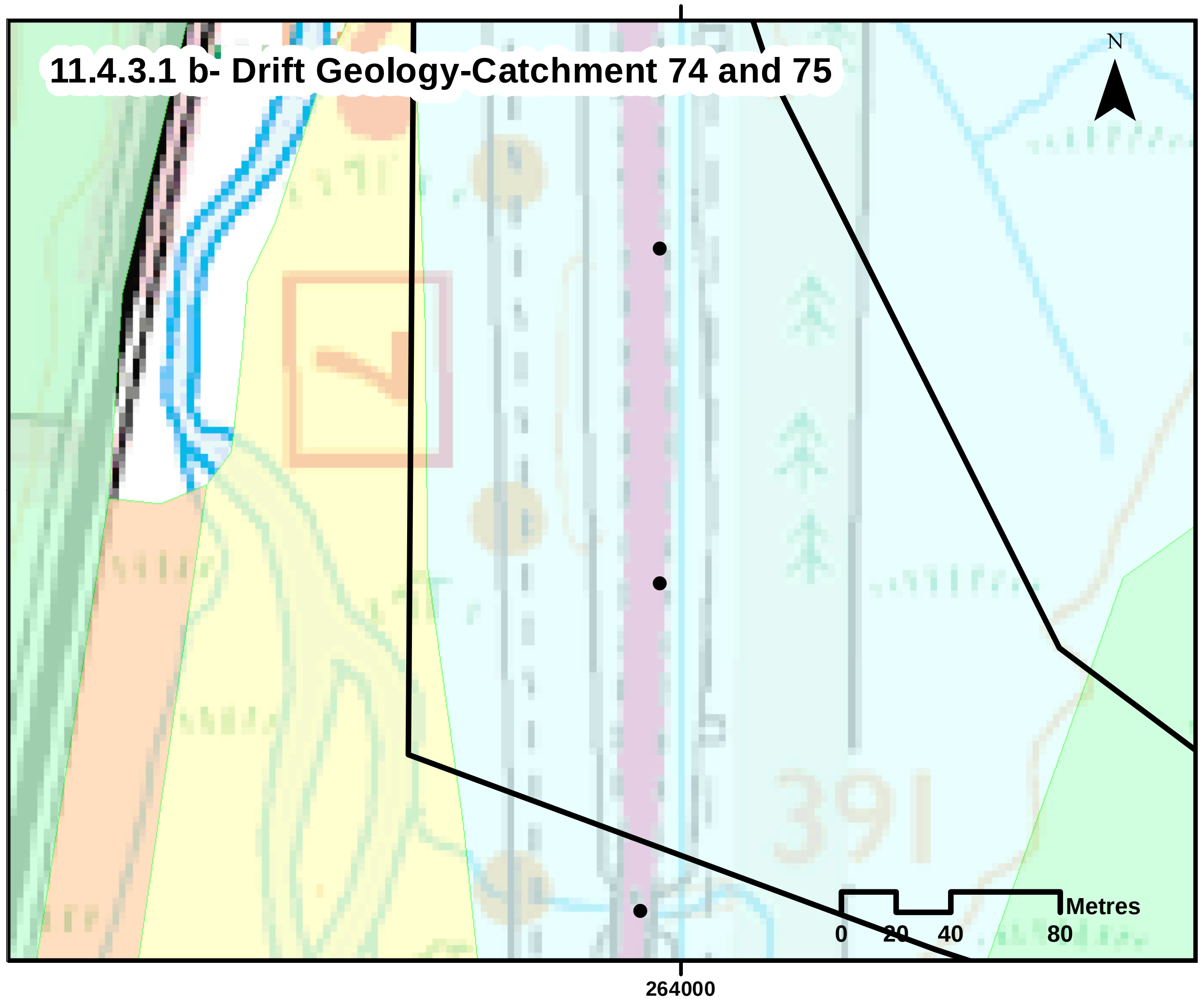
Sediment source and supply - Catchment Scale	Changes in slope and channel confinement	See Drawing 11.4.3.2, Catchment 74 and 75	
	Is peat present in the catchment	Yes	Possible thin deposits
	Is there a bog burst risk	No	
	Current valley side or terrace erosion	No	
	Potential valley side or terrace erosion	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 plantation forestry u/s of crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 74 and 75)	Yes	Temporary access track for ETL in headwaters. Also ETL tower (pylon)
	Comment on sediment source potential in catchment	Limited, although construction of ETL may have generated some	
	Comment on sediment supply potential to crossing	Limited, flow is likely ephemeral	

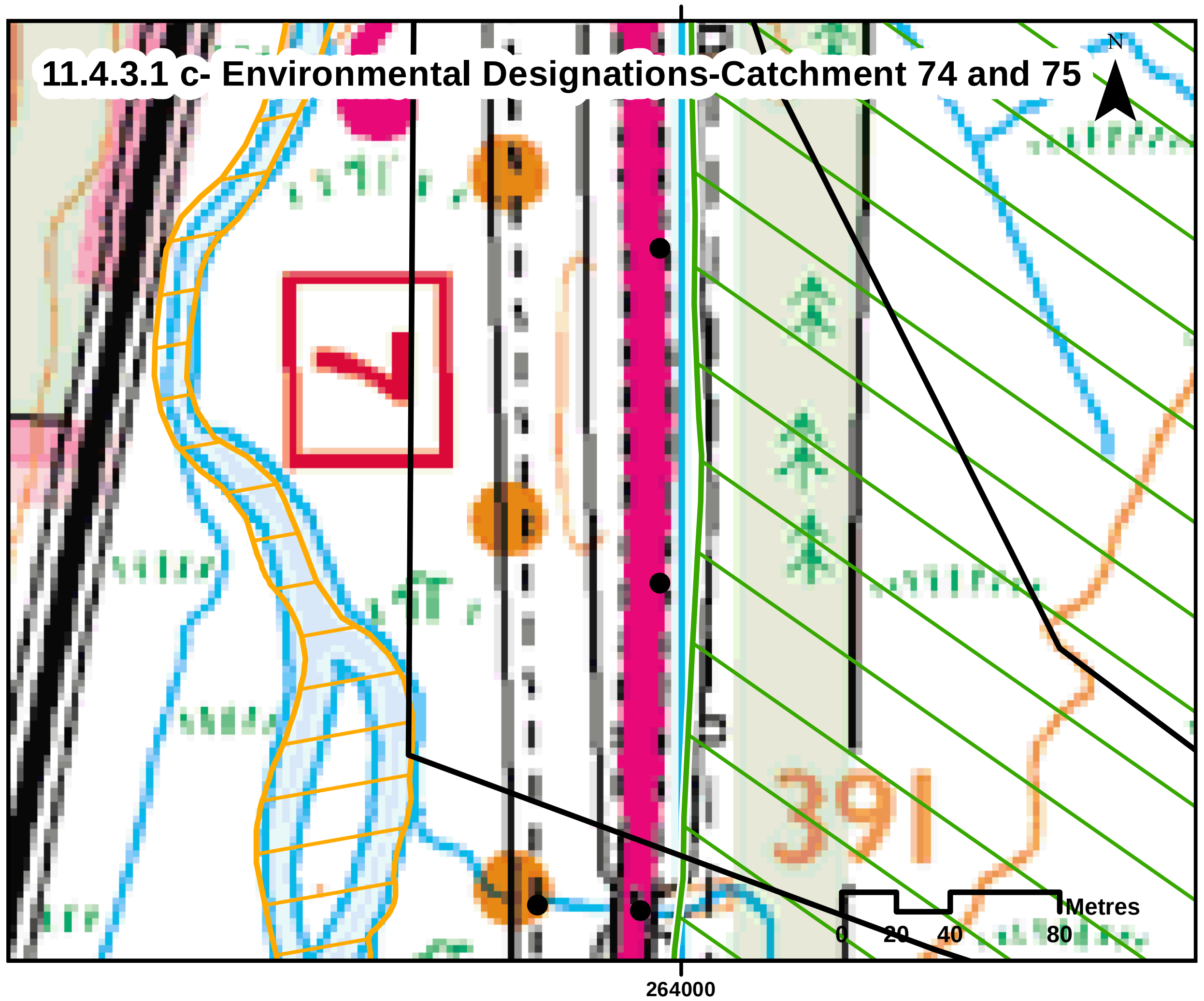
Morphology and Process- Reach upstream of crossing	Channel morphology	Engineered	
	Predominant sediment size	Large gravel-cobble, angular	
	Unvegetated bars	No	
	Vertical incision	None	
	Deposition	None	
	Lateral migration/bank erosion	None	
	Presence and nature of infrastructure (Map 1d)	No	
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 74 and 75)	No	
	Channel realignment	Yes	Vertical realignment - cascade

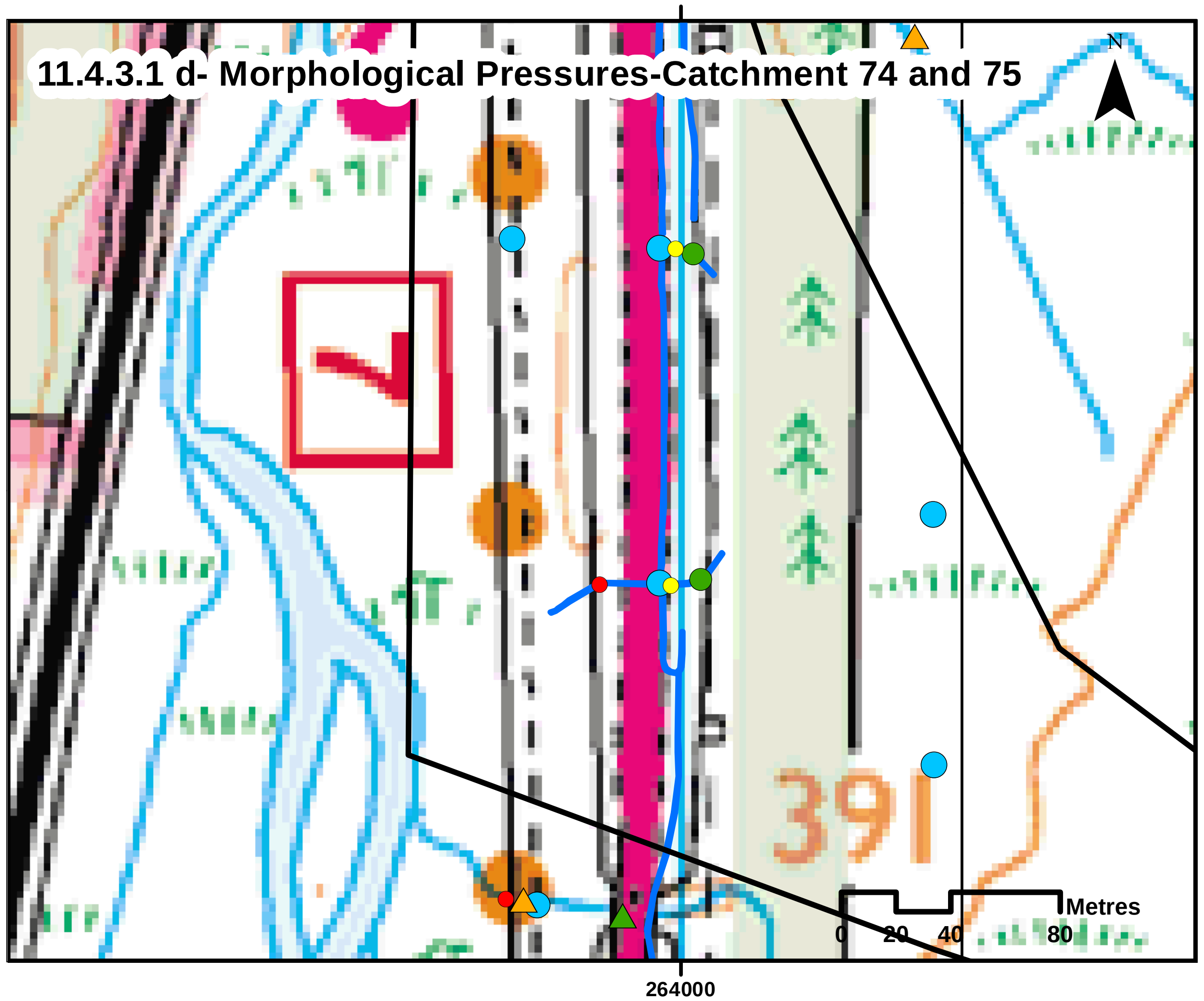
Morphology and Process- At crossing	Channel morphology	Engineered	
	Predominant sediment size	Large-gravel cobble	
	Estimated discharge at 1:200 event (m^3/s)	0.3	
	Unvegetated bars	No	
	Vertical incision	None	
	Deposition	Low	
	Lateral migration/bank erosion	None	
	Damaged/unstable drains or armouring	Yes	Damage to cascade u/s is generating coarse angular sediment deposited in culvert

Morphology and Process- Reach downstream of crossing	Channel morphology	Plane bed	
	Predominant sediment size	Fine	
	Unvegetated bars	No	
	Vertical incision	None	
	Deposition	Low	
	Lateral migration/bank erosion	Low	
	Presence and nature of infrastructure (Map 1d)	Yes	NMU crossing
	Infrastructure type (see Drawing 11.4.3.1 d, Catchment 74 and 75)	Yes	Likely restricting flow and reducing gradient
	Channel realignment	Yes	Vertical
Summary behaviour	Both crossings 74 and 75 are natural streams of short channel length. Both are interrupted in their headwaters by the presence of the ETL construction track and a pylon site which may be generating (have generated) coarse and fine sediment. Both channels drop to the below road level via engineered cascades. Both of these contain coarse angular blocks which appear to be damage to the armouring from which the cascades are constructed, although this is worse at 74 than 75. Some of the coarse angular sediment has been deposited in the culvert at 74 where, as in 75, the gradient reduces suddenly. D/s of the crossings gradients steepen (possibly on the downstream side of the NMU crossing). Previously incised channels appear to have revegetated due to limited flows.		









Legend

General

- Crossing Location

Solid Geology

- Gaick Psammite Formation - Psammite
- Scottish Highland Ordovician Minor Intrusion Suite - Pegmatite
- Vein-Quartz

Drift Geology

- Peat
- Glaciofluvial Ice Contact Deposits
- Gaick Plateau Moraine Formation
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Environmental Designations

- Special Site of Scientific Interest
- Special Area of Conservation

Morphological Pressures

- Road Bridge
- Track/Footbridge
- Culvert
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Drawing 11.4.3.1
Catchment 74 and 75 Catchment Overview

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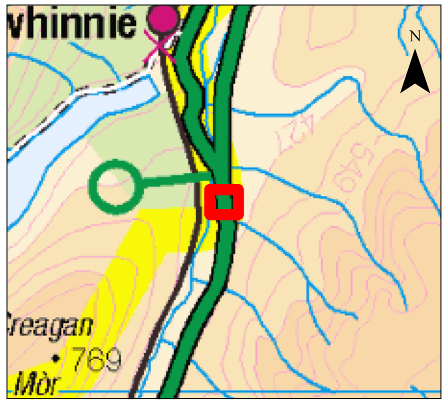

Legend

- Other crossing
- Crossing catchment

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Catchment 74 and 75 Baseline Assessment

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