A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010059

7.28.1 Applicant's Responses to Deadline 7 Submissions - Appendix A - River Coquet Fluvial Geomorphology Assessment – Valley Side–Channel Connectivity

Rule 8(1)(c)

Planning Act 2008

Infrastructure Planning (Examination Procedure) Rules 2010

May 2021

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Examination Procedure) Rules 2010

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Appendix A - River Coquet Fluvial Geomorphology Assessment – Valley Side-Channel Connectivity

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CONTENTS

1 APPENDIX A - RIVER COQUET FLUVIAL GEOMORPHOLOGY ASSESSMENT – VALLEY SIDE–CHANNEL CONNECTIVITY 1

FIGURES

Figure 1 - Large Scale Instability Locations with the River Coquet Gorge 2

Figure 2 - Eroding Toe of Landslide approx. 500m Upstream of Existing Bridge 4

Figure 3 - Geomorphological Map of the Area around the Proposed Site 5

1 APPENDIX A - RIVER COQUET FLUVIAL GEOMORPHOLOGY ASSESSMENT – VALLEY SIDE–CHANNEL CONNECTIVITY

1.1.1. At Item 16 of their Deadline 7 submissions, the EA stated that they welcomed the Applicant's narrative in respect of the role that the slopes of the River Coquet Gorge play in the supply of sediment, channel planform and flow dynamics. However, they also requested that:

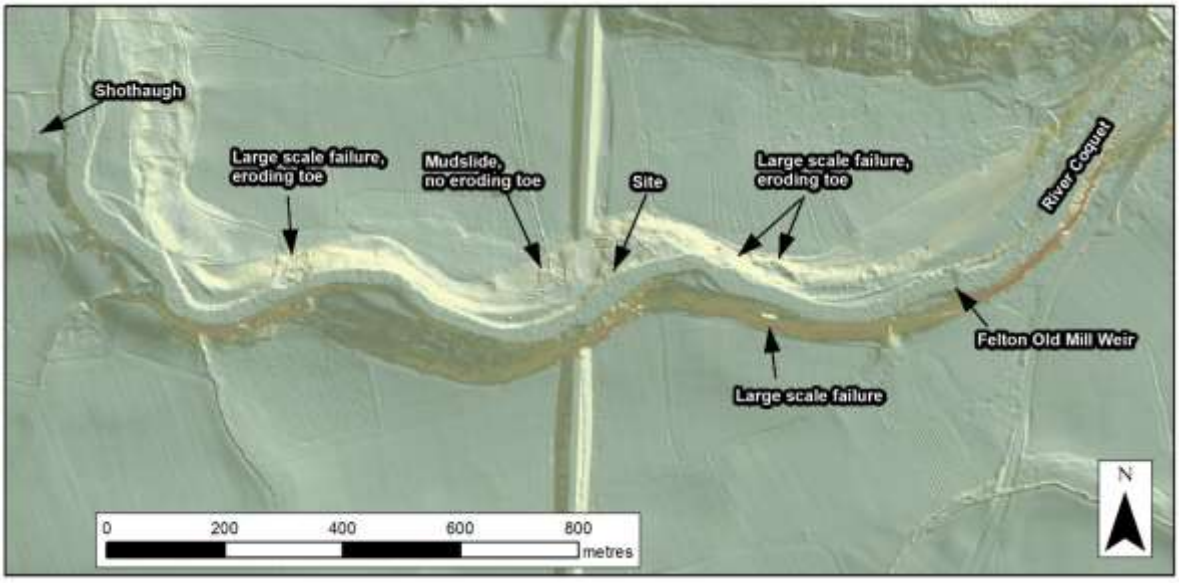
> *The updated geomorphological assessment should include a narrative on the stability of the gorge slopes, the interaction with the river and why the Applicant believes the proposed works to the north and south banks will not result in a deterioration of the river is pulled together to form a section of the updated geomorphological assessment.*

1.1.2. This Appendix consolidates the requested information and, in this context, provides further detail as to why the proposed works to the Stabilisation Works and the Southern Access Works will not result in a deterioration of the river.

1.1.3. The proposed and existing A1 crossings lie within the longitudinal extent of the River Coquet gorge. The riverbed is approximately 30m lower than the relatively low relief plateau surrounding the gorge, which lies at approx. 60m OD. British Geological Society (BGS) mapping indicates instability on the valley sides of the River Coquet gorge, as does geomorphological mapping and interpretation of Environment Agency LiDAR data (dating from 2009), which indicates that the deeply incised gorge slopes have a range of active and relict instability features. The larger of these features are shown in Figure 1.

1.1.4. Rapid post-glacial incision is likely to have initiated valley development and 'priming' of the landscape for the slope failures seen today. Incision was enhanced by higher energy discharges during seasonal thaws at the end of the last glacial period, and higher rainfall at the beginning of the current interglacial period; more rapid erosion of weak glacial sediments, and bedrock strata weakened by periglacial freeze-thaw processes; and the effect of permafrost conditions on the bedrock, meaning infiltration rates were low and pore water pressures were high during seasonal melt.

Figure 1 - Large Scale Instability Locations with the River Coquet Gorge



1.1.5. Within the gorge, which for the purposes of this Appendix is considered to extend approximately from Shothaugh to Felton Old Mill Weir, river incision has exposed a sequence of Carboniferous sandstone, mudstone and limestone beds, with colluvial deposits (i.e. material resulting from past landslides) on the slopes. There is a made ground embankment in the vicinity of the existing A1 crossing. Valley side instability has been identified during site walkovers, ground investigation (see Section 2.2 of 6.38 Environmental Statement Addendum: Stabilisation Works for Change Request) and from available remotely sensed data to take the following forms:

- Individual rockfalls from the sandstone scarps, which are exposed to varying degrees in the upper valley sides in the vicinity of the bridge, most of which will come to rest on lower slopes, some of which may reach the river. This mechanism is caused by the progressive weakening of bedrock that crops out on slopes that have been over-steepened by river incision.
- Large scale failures, some of which are mudslides in colluvium or at limited depth in bedrock affecting the lower portion of the valley side, which are driven elevated pore water pressures caused by sustained antecedent rainfall. Others are potentially deeper seated failures where oversteepening and suitable geological conditions have combined to result in block failure. A shallow mudslide occurs around 50m to the west of the existing bridge on the north bank, and the potentially deeper seated failures occur on the north and south banks around 300m downstream of the existing bridge and around 500m upstream of the existing bridge on the north bank.
- Tension cracking and displacement of embankment features (e.g. footpaths and fences) in the vicinity of the north abutment of the existing bridge. It is unclear if

the basal shear surface of these failures is formed by the base of the made ground embankment, or whether pre-existing landslide debris has been remobilised. This is the form of failure where the north bank stabilisation is taking place. Further information on failure in this area has been presented in Section 2.2 of 6.38 Environmental Statement Addendum: Stabilisation Works for Change Request and Sections 1 and 2 of 6.49 Options Appraisal of River Coquet Bridge Foundation Stabilisation and Scour Protection System [REP7-005]

1.1.6. The connectivity of each failure mechanism with the River Coquet channel is discussed below.

ROCKFALL

1.1.7. The propensity of rockfalls to interact directly with the river is affected by the nature of the pathway from the source location to the river. Where the lower slope between the sandstone source area and the river is relatively steep, rockfalls are more likely to reach the river. Furthermore, where there is an absence of trees and/or a channelised runout zone, rockfalls may be more likely to reach the river.

1.1.8. For instance, at the location of the proposed works on the left (south) bank, there is evidence of historical rockfall runout on the lower slopes, much of which has been arrested by the presence of trees, but some of which reaches the river.

1.1.9. Immediately to the west of the existing bridge, relatively fresh, unweathered rockfall free of moss was noted resting on the lower slopes not far from the river during a site walkover in February 2021. This rockfall appeared to have followed a channelised pathway towards the river. On the north bank, in the vicinity of the bridge, the exposed sandstone scarp is much more limited in height than on the south bank, and the lower valley side slopes are at a lower angle, so the run-out zone for rockfall terminates on these lower angled slopes.

LARGE VALLEY SIDE FAILURES

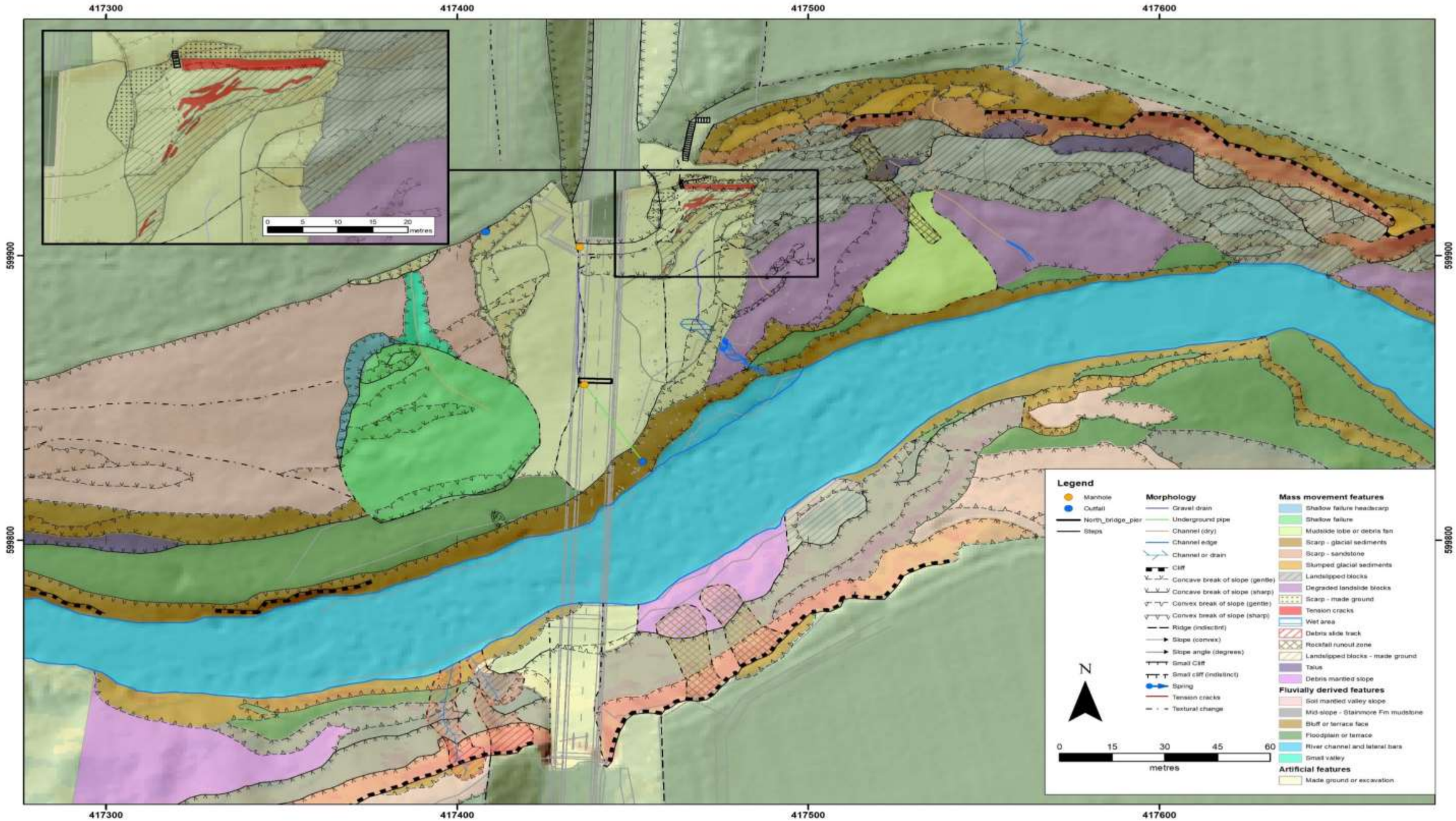
1.1.10. Larger valley side failures may or may not directly interact with the River Coquet. The locations of large valley side failures whose toes have reached and are being eroded by the River Coquet are indicated in Appendix A to 6.47 River Coquet Fluvial Geomorphology Assessment [REP7-003]. These are located on the left (north) bank 500m upstream and 300m downstream of the existing bridge and are unaffected by the Scheme. These failures will have historically supplied material to fluvial system and continue to do so through the erosion of their toes. The change to planform caused by these failures through constriction of the channel is likely to be temporary and localised as fluvial action removes finer failed sediment; however, some large boulders may continue to have an influence on local flow conditions over longer periods. A photograph of such a feature is shown in Figure 2.

Figure 2 - Eroding Toe of Landslide approx. 500m Upstream of Existing Bridge

1.1.11. Other historical valley side failures are present, but do not have a direct interaction with the river under the majority of flows, these include a failure around 300m downstream of the site on the south bank and a shallower failure 50m to the west of the existing bridge on the north bank, which has its toe on the terrace. 6.47 River Coquet Fluvial Geomorphology Assessment [REP7-003] shows the area is only inundated at very high flows (>0.5% AEP, 200-year event); the toe shows no evidence of recent erosion. However, there is a channel leading directly to its headscarp, indicating that this failure may have been driven by a combination of run-off or poor drainage.

1.1.12. The area to the east of the existing bridge on the north bank, where the new bridge is proposed, is interpreted to be situated at the western extent of a historical (post-glacial) landslide complex developed in bedded competent over less competent strata. The landslide mechanism comprises the detachment of blocks of competent sandstone from the top of the slope, followed by downslope movement and degradation. It is also interpreted as an area which was formerly a focus of instability, but away from which the focus of erosion, which has migrated downstream. This has left comparatively low slope angles on the lower slopes and degraded instability features. A geomorphological map of this area is shown in Figure 3.

Figure 3 - Geomorphological Map of the Area around the Proposed Site



SCARPS AND TENSION CRACKS IN MADE GROUND AROUND THE BRIDGE

1.1.13. The scarps and tension cracks in the made ground embankment around the bridge are likely to be indicative of failure in the made ground but the possibility of the reactivation of post-glacial instability at depth cannot be ruled out. These relatively recent features are interpreted to be driven by geological and drainage factors, rather than fluvial erosion. However, the risk that such erosion may occur over the lifetime of the scheme and contribute to instability of the slope must be taken into consideration in the design of the scheme.

IMPLICATIONS OF SLOPE STABILISATION AND BANK PROTECTION FOR THE ONGOING BEHAVIOUR OF THE RIVER COQUET

1.1.14. The change to planform caused by the failures that have runout debris eroded by the River Coquet are likely to be temporary and localised as fluvial action removes finer grained sediment. Large boulders may continue to have an influence on local flow conditions over longer periods. However, these failures are outwith the extent of the Stabilisation Works and the Southern Bank Access Works. While these events are an important characteristic of the gorge as a whole and episodically supply sediment to the river, they do not individually and fundamentally affect the nature and form of the gorge. Furthermore, events of this nature will continue to occur outwith the extent of the stabilisation and will therefore be unaffected.

1.1.15. Specifically, at the location of the north bank stabilisation and bank protection works, a wide, relatively gently sloping area adds significant lag to input of sediment from failures of the upper valley side (such as rockfall or movement of existing degraded landslide blocks) to channel. Debris will tend to rest in this gently sloping area until removed by flooding, rather than directly entering the river. The bank stabilisation proposed here covers a short extent of the gorge where the current sediment supply to the channel is negligible. Landsliding has occurred at this location in the geological past under different climatic conditions. Movement of relict landslide debris, of sufficient magnitude to deliver large volumes of sediment to the river or temporarily alter its planform, at the location of the north bank Stabilisation Works is unlikely under contemporary climate conditions. Nonetheless slope movement is possible, particularly following sustained high levels of antecedent rainfall and if future erosion at the slope toe is significant. Therefore, such movement and the potential for fluvial erosion needs to be considered when designing the new bridge, leading to the requirement for the Stabilisation Works. Other areas of the gorge where instability has occurred, such as those valley side failures whose toes are eroding to a much larger degree, will have a much greater influence on sediment supply to the channel over the lifetime of the Scheme than the stabilisation location.

1.1.16. At the location of the south bank works, the primary mechanism for delivery of material from the valley side to the river is rockfall. Some rockfall will be arrested by the presence of trees and some will make it to the river. In the long term, the presence of rock armour on the south bank is unlikely to affect rockfall pathways to the river, if such rockfalls would have been sufficiently energetic to reach the river in any event.

1.1.17. Whilst 6.38 Environmental Statement Addendum: Stabilisation Works [REP4-063] and 6.40 Environmental Statement Addendum - Southern Access Works [REP4-064] has indicated a requirement to stabilise the north bank at the location of the proposed crossing, and prevent future erosion of the toe of the slopes on the north and south banks to safeguard the stability of the bridge, the Applicant's position is that this will not result in a deterioration of the river because:

- The majority of instability which has occurred at the location of the Stabilisation Works on the north bank has done so under differing climatic conditions, while contributions of sediment to the system at that exact location are currently relatively low.
- There are other parts of the gorge which currently contribute a substantially greater amount of sediment to the system. These areas are expected to continue to supply sediment over the lifetime of the Scheme.
- Notwithstanding the Stabilisation Works, the gorge valley sides in other locations (including more active areas) will still be able to behave naturally, including failure and the contribution of sediment to the system.
- Any failure of the upper slopes on the north and south bank in the vicinity of the works are likely to have substantial lag times before they contribute sediment to the river, due to one or more of:
  - Slow rates of movement;
  - Wide shallow-angled areas across which failed material will be slow to travel or will rest upon until a sufficiently large flood event occurs; or
  - Interception of less energetic rockfall by trees.
- The transfer to the river of sediment by more energetic rockfalls on the south bank is unlikely to be interrupted by the proposed bank protection works due to the steepness of the slope and lack of obstruction presented by the proposed bank protection.

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