Westnewton Bridge – Scour protection measures

A Feasibility study for provision of hardened invert around bridge footings

The flood event of 25th September 2012 caused damage to one the piers of Westnewton Bridge and emergency works have been carried out to temporarily reinstate the foundations.

There remains a substantial risk to the bridge from flood events and, to permanently safeguard the integrity of the bridge foundations, the County Council envisages submitting a detailed scheme for consent with a view to construction in summer 2015.

Furthermore, to minimise scour of the RH bank upstream of the bridge and limit deposition that may block the available waterway through the arches, it is considered that keeping the river on a straight alignment up to and through the bridge would be beneficial. Please see options considered at the bottom of the page.

The permanent options to protect the invert around the bridge from scour are considered as described below:

Option	**Advantages**	**Disadvantages**	**Conclusion**
1. Do not provide invert.	Minimal intervention. No short term cost	Bridge foundations would remain at risk from scour. Potential loss of Highway and large cost to reinstate.	Cannot secure safety of travelling public therefore **disregard**
2. Sheet piled invert with concrete apron around individual abutments and piers.	Will provide permanent protection to bridge foundations. Would leave invert at centre of spans in natural condition. Good for fish passage.	Local scour effects around sheet piling would be significant. Very difficult to install sheet piling in confined head room, probably impossible. Significant works in the river environment.	Probably impossible to carry out therefore **disregard**
3. Underpin abutments and piers with concrete footings.	Will provide permanent protection to bridge foundations. Would leave invert under bridge spans in natural condition. Good for fish passage.	Deep excavations required with severe concerns over provision of safe working area. Probably impossible to keep water out of excavation. Significant works in the river environment.	Cannot be carried out safely therefore **disregard**
4. Installation of inclined steel piles through masonry to	Will provide permanent protection to bridge foundations. Would leave invert under bridge spans in natural	Very difficult to install sheet piling in confined head room, probably impossible. Major intervention into Listed Building	Major intervention into Listed Building but probably impossible to carry out therefore **disregard**

provide support against scour.	condition. Good for fish passage.	because piles would be cored through masonry. Significant works in the river environment.	
5. Manage river by frequent intervention	Used to be carried out on a regular basis by Environment Agency prior to current environmental legislation. Concrete and/or steel installations not required in water course.	Difficult to react in a timely manner to build up of gravels and changes in river alignment. Many consultations/surveys and studies required for every intervention. Significant works in the river environment.	Continual intervention in river corridor needing extensive consultation to achieve consent on each occasion. Not considered realistic therefore **disregard**
6. Concrete Invert provided across whole width of river.	Will provide permanent protection to bridge foundations.	Significant works in the river environment. Risk of step forming in invert that would be a risk to fish passage.	Major scheme – much study and justification required – **possible solution**
7. Soft engineering only	Concrete and/or steel installations not required in water course.	Soft engineering measures around the bridge foundations are not robust enough to resist the extreme turbulence that occurs in this location. Measures have only a short term life spa and would have to be repeated to maintain protection.	Expert geomorphologist considers soft engineering to be inappropriate to resist scour forces through the bridge therefore **disregard**
Conclusion – carry out study of option 6 to include hydrological, geomorphological and ecological issues.			

B Feasibility study for options to maintain river alignment through centre arch of bridge arch

When the river moves laterally it promotes scour on the outside of bends but deposition on the inside. This deposition leads to a reduction of the available waterway through the bridge arches leaving them at greater risk to blockage from debris during flood events. This issue was shown to be a concern after the near catastrophic scour events of September 2012. The deposition used to be removed as it occurred by the Environment Agency and its predecessors but recent environmental legislation prevents this course of action without extensive study and justification. It is proposed to limit the rivers potential for meandering by studying the hydrological and geomorphological characteristics and providing bank protection where needed. The ideal for this aim is to ensure that the river is aligned with the centre arch of the bridge so reducing the propensity for deposition.

Option	Advantages	Disadvantages	Conclusion
A. Do nothing	No intervention into river environment	High potential for deposition and risk of debris blocking available arches for flood water as evidenced on previous occasions	Significant risk of blockage of bridge without intervention to remove deposition. Not a realistic long term solution therefore **disregard**
B. Manage river by frequent intervention	Used to be carried out on a regular basis by Environment Agency prior to current environmental legislation.	Difficult to react in a timely manner to build up of gravels and changes in river alignment. Many consultations/surveys and studies required for every intervention. Significant works in the river environment.	Continual intervention in river corridor needing extensive consultation to achieve consent on each occasion. Not considered realistic therefore **disregard**
C. Protect existing RH bank with hard engineering	RH bank protected against scour and failure	Unlikely to gain approval because of ecological designation	Probably unlikely to gain assent/consent therefore **disregard**
D. Protect existing RH bank with soft engineering	RH bank protected against scour and failure	Soft engineering has a limited lifespan and therefore maintenance likely to be required.	Probably only option that is likely to be acceptable to the consenting bodies. – **Possible solution**
E. Maintain river on straight alignment with hard engineering	River straightened and deposition minimised	Unlikely to gain approval because of ecological designation	Probably unlikely to gain assent/consent therefore **disregard**
F. Maintain river on straight alignment with soft engineering	River straightened and deposition minimised	Soft engineering has a limited lifespan and therefore maintenance likely to be required.	Probably only option that is likely to be acceptable to the consenting bodies. . – **Possible solution**
Conclusion – carry out study of options D and F to include hydrological, geomorphological and ecological issues.			

Addendum to feasibility study to provide soft engineering options to maintain river alignment through centre arch of bridge arch

Option	Advantages	Disadvantages	Conclusion
I. Willow spiling to RH bank	Soft engineering option that promotes ecological values	Existing bank has log soldiers along bulk of length. 30 metre length to be reinstated. Willow spiling would not have the inherent protection below invert level in this high energy location	Not suitable for a high energy scour location therefore **disregard**.
II. Combined solution with willow spiling and armoured rock toe facility	Softer engineering option that can resist some scour at base level.	The use of armoured stones would be unlikely to be accepted by the heritage bodies. Would also be expensive and would require deep excavation to install.	Expensive with large excavations therefore **disregard**
III. Combined solution with willow spiling and toe protection provided by logs spiked to subgrade and laid longitudinally	Softer engineering option that can resist some scour at base level.	Very expensive and time consuming operation. Would require deep excavation to install.	Expensive with large excavations therefore **disregard**
IV. Log soldiers driven in as piles to depth as toe protection.	Quick to install with minimal excavation. Would tie into existing installation.	Existing installation failed due to lack of toe embedment. Proposed installation to have deeper installation.	Potential solution but could require maintenance **– Possible solution**
V. Log soldiers driven in as piled protection against 'cut back' scour	Quick to install with minimal excavation. Would be hidden by vegetation and be mostly below ground.	Limited life span for wood at surface levels therefore adopt hardwood materials to improve resistance against abrasion and rotting	Potential solution but could require maintenance **– Possible solution**
Conclusion – carry out study of options (IV) and (V) to cater for abrasion characteristics of environment and deeper embedment depth			