

HYDRAULICS UNIT

TO: Johnathan Kuehne, District 1 Technician
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FROM: David Willey, Hydraulics Project Supervisor

DATE: September 3, 2015

SUBJECT: Manchester TH 6 (Richville Road) Bridge 5 over unnamed stream
 Site about 300' east of TH 34 (Sugar House Lane)
 GPS coordinates: N 43.1322° W 73.0714°

We have completed our hydraulic study for the above referenced site, and offer the following information for your use:

Hydrology

This site has a hilly to mountainous drainage basin. It is a mostly forested. The total contributing drainage area is about 0.9 sq. mi. There is an overall length of 13,400' feet from the divide to the site, with a 2060-foot drop in elevation, giving an average overall channel slope of about 15%. The stream slope at the site was estimated to be about 7% upstream and 2% downstream. Using hydrologic methods in the Agency Hydraulics Manual, we determined the following design flow rates:

<u>Annual Exceedance Probability (AEP)</u>	<u>Flow Rate in Cubic Feet per Second (CFS)</u>
43%	80
10%	160
4%	220
2%	280 - Major Collector Design Flow
1%	340 - Check flow

Channel Morphology

The channel is moderate gradient. There is coarse sediment transport at the site. There is a lot of deposition in the pipe and in the channel near the pipe, likely due to the change from a steep slope upstream to a flatter slope downstream. Field measurements of bankfull width varied from 10' to 12'. The Vermont Hydraulic Geometry Relationships anticipate a bankfull width of 12' for stream channels in equilibrium at this watershed size. Those curves may not be valid for this drainage area. No indications of active horizontal instability were observed.

Existing Conditions

The existing structure is a corrugated metal pipe with a clear width of 6'-9" and a clear height of 4'-11". It provides a waterway opening of 26 sq. ft. The pipe invert is rusting and the pipe shape is distorted on the outlet end. There is coarse sediment in the full length of the pipe.

Our calculations, field observations and measurements indicate the existing structure does not meet the current standards of the VTrans Hydraulic Manual nor does the existing structure meet state stream equilibrium standards for bankfull width (span length). The existing structure constricts the channel width, resulting in an increased potential for debris blockage. Headwater to depth ratios exceed allowable values established in the current VTrans Hydraulics Manual. Water overtops the road below the design 2% AEP.

Replacement Recommendations

In sizing a new structure we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards with regard to span length and opening height, and allow for roadway grade and other site constraints.

The low height from the stream bed to the road limits the replacement options to a wide low structure, such as a box. A pipe arch option is given below and could be considered if adequate cover could be provided over the pipe.

Based on the above considerations and the information available, we recommend any of the following structures as a replacement at this site:

1. A concrete box with a 12' wide by 7' high inside opening. The box invert should be buried 2'. That will result in a 12' wide by 5' high waterway opening above streambed, providing 60-sq. ft. of waterway area. Bed retention sills should be added in the bottom. Sills should be 12" high across the full width of the box. So the top of the sills will be buried 12" and not be visible. Sills should be spaced no more than 8'-0" apart throughout the structure with one sill placed at the inlet and one at the outlet. The box should be filled up to the stream bed level with stone graded to match the natural stream bed material and that keeps water above the surface. This structure will result in a headwater depth at the 2% AEP = 4.5' and at 1% AEP = 5.3', with no roadway overtopping up to the 1% AEP.
2. A 12'-4" wide by 7'-9" high corrugated metal pipe arch, with the invert buried 2' and 12" high bed retention sills and fill added as described for the box above. That will result in a 12'-4" wide by 5'-9" high waterway opening above streambed, providing about 54-sq. ft. of waterway area. This structure will result in a headwater depth at the 2% AEP = 5.0' and at 1% AEP = 5.8', with no roadway overtopping up to the 1% AEP. This structure should only be used if adequate cover can be provided.
3. Any similar structure with a minimum clear span of 12' and at least 54-sq. ft. of waterway area, that fits the site conditions, could be considered. Any structure with a closed bottom should have bed retention sills and a buried invert as described above.

The structures recommended above meet the current standards, based on the listed waterway areas. Due to the large amount of sediment deposition, it may be desirable to oversize the structure and make it taller than recommended above, to allow for future sediment deposition.

Prior to any further action toward implementation of any of the above recommendations, structure size and type must be confirmed, and may be modified, by the VT ANR River Management Engineer to ensure compliance with state environmental standards for stream crossing structures.

Other regulatory authorities including the US Army Corps of Engineers may have additional concerns or requirements regarding replacement of this structure.

General comments

If a new box is installed, we recommend it have full headwalls at the inlet and outlet. The headwalls should extend at least four feet below the channel bottom, or to ledge, to act as cutoff walls and prevent undermining.

If the pipe arch is installed, concrete headwalls should be constructed at the inlet and outlet. The headwalls may be either half height or full height. The headwalls should extend at least four feet below the channel bottom or to ledge, to prevent undermining of the structure. We recommend a minimum cover of 3' over all pipe structures. Pipe manufacturers can provide specific recommendations for minimum and maximum fill heights and required pipe thickness.

It is always desirable for a new structure of this size to have flared wingwalls at the inlet and outlet, to smoothly transition flow through the structure, and to protect the structure and roadway approaches from erosion. The wingwalls should match into the channel banks. Any new structure should be properly aligned with the channel, and constructed on a grade that matches the channel.

Stone Fill, Type III should be used to protect any disturbed channel banks or roadway slopes at the structure's inlet and outlet, up to a height of at least one-foot above the top of the opening. The stone fill should not constrict the channel or structure opening.

Please note that while a site visit was made, these recommendations were made without the benefit of a survey and are based on limited information. The final decision regarding replacement of this structure must comply with state regulatory standards, and should take into consideration matching natural channel conditions, roadway grade, environmental concerns, safety, and other requirements.

Please contact us if you have any questions or if we may be of further assistance.

DCW

cc: Josh Carvajal, A.N.R. River Management Engineer
Hydraulics Project File via NJW