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Structures and Hydraulics Section
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TO: Alysha Kane, District 5 Project Manager
CC: Jaron Borg, ANR River Management Engineer
FROM: Keith Friedland, Hydraulics Technician
DATE: May 18, 2023

SUBJECT: Monkton, TH-6, Tyler Bridge Road, over Pond Brook tributary to Lewis Creek
Site location: 0.3 miles north of TH-4, States Prison Hollow Road
Coordinates: [44.261694, -73.098806](#)

We have completed our hydraulic study for the above referenced site and offer the following for your use. The drainage area and structure size recommended are both large enough that when a survey of the site becomes available, a more detailed model and site design should be developed for this structure.

Hydrology

The following physical characteristics are descriptive of this drainage basin:

Drainage Area	16.0 square miles
Land Cover	Forest, fields wetlands and residential areas
Water Bodies and Wetlands (NLCD 2006)	17.9 %

Using the USGS hydrologic method, the following design flow rates were selected:

Annual Exceedance Probability (AEP)	Flow Rate in Cubic Feet per Second (cfs)	
50 % (Q2)	260	
10 % (Q10)	510	
4 % (Q25)	660	Design Flow – Local Road
2 % (Q50)	780	
1 % (Q100)	910	Check Flow

Channel Morphology

The channel for this perennial stream is sinuous to meandering with an estimated local channel slope of 0.3%. Field measurements of bankfull width varied from 18 to 22 feet at a bankfull depth of 2 to 4 feet upstream and downstream of the structure.

Existing Conditions

The existing structure is a corrugated metal pipe arch with an approximate clear span of 12 feet and a clear height of 8 feet, providing an approximate waterway opening of 75 square feet. Our calculations, field observations and measurements indicate the existing structure does not meet the requirements 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. This complication is known to cause ponding at the inlet, increase stream velocity and scour at the outlet, and may lead to erosion and failure of channel banks.

This structure results in a headwater depth of approximately 9.3 feet at 4% AEP with water overtopping the roadway before the 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 consider roadway grade and other site constraints.

The low height from the streambed to the road might limit the replacement options to the bridge or concrete box structure, as the roadway may have to be raised for the open bottom arch. Pipe manufacturers can provide specific recommendations regarding minimum and maximum fill heights and required pipe thickness.

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

- A concrete slab bridge with a clear span of 20 feet and clear height of 8 feet, providing 160 square feet of waterway area. The bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. This structure results in a headwater depth of 5.6 feet at the 4% AEP and 7.0 feet at the 1% AEP. *This structure provides 2.4 feet of freeboard at the design AEP.*
- An open bottom arch with a minimum clear span of 23 feet and clear height of 8 feet, providing a waterway area of 134 square feet. The bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. This structure results in a headwater depth of 6.0 feet at 4% AEP and 7.5 feet at 1% AEP. *This structure provides 2.0 feet of freeboard at the design AEP.*
- A concrete box with an inside opening span of 20 feet and minimum height of 8.5 feet. The box invert should be buried 1.5 feet. This will result in a clear height of 7 feet above streambed, providing 140 square feet of waterway area. Bed retention sills should be added in the bottom of the structure. Sills should be 12 inches high at the edges of the box and 6 inches high in the center, creating a V-shape across the full width of the box. Sills should be spaced no more than 8 feet apart throughout the structure with one sill placed at both the inlet and the outlet. The structure should be filled level to the streambed with E-Stone, Type I, allowing flow to be kept above the surface, providing the conditions necessary for aquatic organism passage. This structure results in a headwater depth of 5.7 feet at the 4% AEP and 7.0 feet at the 1% AEP.

Note: *Any similar structure 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. If an open bottom structure is installed, the VTrans Hydraulics Manual requires a minimum of 1-foot of freeboard at the design AEP.*

To match the approximate local stream slope, the structures recommended above have been modeled with a culvert slope of 0.3%. **The local stream slope should be verified prior to installation of the new structure.**

Stone Fill, Type II 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.

Prior to any action toward the implementation of any recommendations received from VTrans, stream type and structure size 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. This structure is within the mapped FEMA flood insurance study floodplain.

General Comments

It is always desirable for a new structure to have flared wingwalls, matched into the channel banks at the inlet and outlet, to smoothly transition flow and protect the structure and roadway approaches from erosion. It is also recommended that full height concrete headwalls be constructed at the inlet and outlet. Any closed bottom structure should also be equipped with cutoff walls, extending to a depth equal to the culvert rise, up to 4 feet, or to ledge, to serve as undermining prevention. E-Stone thickness plus the bottom of structure thickness should be included when determining the total cutoff wall depth.

If a new bridge is installed, the bottom of abutment footings should be at least 6 feet below the channel bottom, or to ledge, to prevent undermining. Abutments on piles should be designed to be free standing for a scour depth at least 6 feet below channel bottom.

Any new structure should be properly aligned with the channel, span the natural channel width, and be constructed on a grade that matches the channel.

The structures recommended above have been sized with respect to hydraulic and environmental standards and do not consider debris blockage complications. To minimize maintenance and ensure constructability, it is recommended that the structure height be adequate for installation of E-Stone and passage of debris.

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. **We can always check other options if the town settles on something not noted above.**

