

TO: Pete Hardy, Strafford Highway Road Foreman
Lisa Bragg, Strafford Town Clerk/Treasurer

FROM: Patrick Ross, P.E. (cell # 802-272-9935)

DATE: October 26, 2025

SUBJECT: Strafford TH-3, Miller Pond Road, Culvert ID# 27
Site latitude and longitude: (43.8716, -72.3138)

A hydrology and hydraulics evaluation has been completed for the referenced site. The findings and recommendations are provided below. This study is based solely on field measurements; therefore, any proposed replacement should be reevaluated upon completion of a topographic survey.

Hydrology

The watershed consists of a mix of forested and open land, with interspersed storage. The total contributing drainage area is 0.59 square miles, and it includes a storage cap of approximately 3%. An additional 15 acre-feet (approximately) of storage at the inlet further mitigates peak flow rates. According to Pete Hardy, the roadway has not been overtopped by floodwaters, to his recollection. Based on this information - and using the VT USGS hydrologic method regression equations and VTrans transition flow rate modifications - the calculated peak flow rates are likely conservative.

<u>Recurrence Interval in Years</u>	<u>Flow Rate in Cubic Feet per Second (CFS)</u>
2-year	30
10-year	65
25-year	90 – Design Flow
50-year	115
100-year	140 – Check Flow

Existing Condition

The existing culvert, a 36ft long, 3ft diameter corrugated metal pipe (CMP) is situated on an unnamed perennial stream with a field-measured bankfull channel width of 6ft. The culvert's slope is nearly flat, and both the inlet and at the outlet alignments are poor. The outlet discharges directly into a tributary of Abbott Brook at a right angle.

Hydraulic evaluations conducted using the Federal Highway HY-8 Culvert Hydraulics Analysis Program indicate that the existing structure is *hydraulically inadequate* according to VTrans hydraulics standards. Based on the peak flow rates above; the culvert fails to meet the headwater-to-depth requirements of ≤ 0.8 for a 25-year design flood event and ≤ 1.0 for a 100-year check flood event, which are standard for perennial streams. Flood waters also overtop the road well below the 100-year event. In a more extensive hydrology and hydraulic evaluation the flood hydrographs would be routed through the available storage area just upstream of the culvert; it is anticipated that the flow rates would be attenuated such that floodwaters elevations would be significantly reduced when the tailwater conditions (water levels in the outlet brook) are low. It should also be noted that the 3ft CMP does not meet the VTANR Stream Alteration General Permit standard minimum 6ft bankfull width.

Recommendations

For sizing a new structure at this site, several options meet the VTrans hydraulic requirements, the VTANR bankfull width requirement, and fit within the proposed roadway prism. The following structures are prioritized as best-fit solutions for consideration as replacements.

Option #1:

A 78in (6.5ft) corrugated steel pipe, to meet the VTrans hydraulics standards and VTANR stream crossing requirements and fit in the roadway prism, the structure shall be embedded in the streambed to a minimum depth of 18in. The stream slope is so gradual that the culvert will fill naturally and no infill is necessary. After the embedment, this structure will have 5ft of vertical clear rise and the structure will provide approximately 27.4ft² of waterway area. The headwater to depth ratio at the 25-year flood event is ≤ 0.8 with a headwater depth of 3.3ft, and at the 100-year event the headwater to depth ratio is ≤ 1.0 with a headwater depth of 4.4ft. This design also ensures the roadway will not be overtopped during a 100-year flood.

Option #2:

A 95in by 67in steel pipe arch, to meet the VTrans hydraulics standards and VTANR stream crossing requirements and fit in the roadway prism, the structure shall be embedded in the streambed to a minimum depth of 18in. The stream slope is so gradual that the culvert will fill naturally and no infill is necessary. After the embedment, this structure will have 4ft-1in of vertical clear rise and the structure will provide approximately 27.4ft² of waterway area. The headwater to depth ratio at the 25-year flood event is ≤ 0.8 with a headwater depth of 2.8ft, and at the 100-year event the headwater to depth ratio is ≤ 1.0 with a headwater depth of 3.9ft. This design ensures the roadway will not be overtopped during a 100-year flood.

Notes: A.) with either option the inlet should have a full concrete or laid-up stone headwall and mortar (Type S) all exposed joints. The headwall will protect the structure. B.) with any replacement option the structure shall be realigned such the outlet is located approximately 10ft further downstream than the existing pipe outlet. C.) Other similar sized structures could be considered.

General comments:

Stone fill Type II at the inlet and stone fill Type III at the outlet will be needed to protect any disturbed slopes. The stone fill should not constrict the channel or structure opening.

A topographic site survey and an engineering design are always recommended for culvert replacement projects. These steps help ensure design compliance, mitigating construction risks, and achieving efficient and cost-effective outcomes.

The VTANR River Management Engineer (RME) should be contacted to ensure these recommendations meet the Stream Alteration General Permit stream crossing guidelines.

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

Copies: Chris Bump, VTrans District 4;
Jaron Borg, VTANR RME Northeast