

**State of Vermont  
Structures and Hydraulics Section**

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*Agency of Transportation*

**TO:** John Wilkin, District Technician  
James Cota, District 8 Project Manager

**CC:** Chris Brunelle, A.N.R. River Management Engineer

**FROM:** Cassidy Cote, Hydraulics and Structures Engineer

**DATE:** December 11, 2018

**SUBJECT:** Franklin VT-236, State Park Road, MM 3.825 over unnamed tributary to Lake Carmi  
Site location 300 feet south of TH-4, Dewing Road  
GPS coordinates: [N 44.97998°](#), [W 72.84373°](#)  
PID 65818

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

**Hydrology**

The following physical characteristics are descriptive of this drainage basin:

Drainage Area	0.20 square miles
Land Cover	Fields, farmland, forest
Avg. Drainage Basin Slope	7.3 %

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

Annual Exceedance Probability (AEP)	Flow Rate in Cubic Feet per Second (cfs)	
43 %	38	
10 %	57	
4 %	68	
2 %	78	Design Flow – Major Collector
1 %	89	Check Flow

**Channel Morphology**

The channel for this intermittent stream is straight to sinuous with an estimated local channel slope of 7.0%. Drainage from TH-4 is routed southerly along VT-236 and converges with the westerly flowing main channel at the structure entrance. The main channel is grass lined with several large cobbles at the structure inlet. Additional drainage from the north converges at the structure outlet. The channel then runs along VT-236, joins with the intermittent stream at VT-236 MM 3.792, circumvents Lakeview Farm and continues for 0.76 miles to Lake Carmi. This stream spans approximately 4 feet at a depth of 1 to 2 feet.

## **Existing Conditions**

The existing structure is a corrugated metal pipe with a diameter of 3 feet, providing a waterway opening of 7 square feet. A 2-foot vertical drop and scour pool are present at the outlet. A section of pipe has separated, resulting in a 9-foot wide sinkhole forming on the downslope of VT-236, exposing the pipe and allowing sediment to enter the structure from overhead. This separation has also resulted in sediment transport from beneath the structure. These conditions have the potential to lead to structural complications for both the roadway and the pipe. This structure results in a headwater depth of approximately 8.4 feet at 2% AEP and 10.5 feet at 1% AEP.

Our calculations, field observations and measurements indicate the existing structure does not meet current standards of the VTrans Hydraulic Manual. The existing structure also constricts the channel width, resulting in an increased potential for debris blockage.

## **Replacement Recommendations**

In sizing a new structure, we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards regarding span length and opening height, and allow for roadway grade and other site constraints. Based on the above considerations and the information available, we recommend any of the following structures as a replacement at this site:

- A concrete box with an inside opening span of 4 feet and minimum opening height of 4 feet. This configuration provides 16 square feet of waterway area. This structure results in a headwater depth of 3.7 feet at 2% AEP and 4.1 feet at 1% AEP. We recommend the addition of 6-inch baffles as a means of roughening the interior surface. This retrofit will decrease velocities and extent of erosion at the outlet of the structure.
- A corrugated metal pipe arch with a minimum clear span of 60 inches and clear height of 46 inches, providing a waterway area of 16 square feet. This structure results in a headwater depth of 3.6 feet at 2% AEP and 4.0 feet at 1% AEP. If a culvert slope over 6.5% is selected for replacement of this structure, we recommend the addition of 6-inch baffles as a means of roughening the interior surface. This retrofit will decrease velocities and extent of erosion at the outlet of the structure.
- A minimum 4.5 foot diameter corrugated metal pipe, with 16 square feet of waterway area. This structure results in a headwater depth of 4.1 feet at 2% AEP and 4.5 feet at 1% AEP. We recommend the addition of 6-inch baffles as a means of roughening the interior surface. This retrofit will decrease velocities and extent of erosion at the outlet of the structure.

***Note:** Any similar structure that fits the site conditions could be considered. Please contact the VTrans Hydraulics Section with alternatives that have significantly different inlet geometry so headwater depths may be calculated.*

High velocities are anticipated at the outlet of these structures during storm events. Stone Fill, Type E3 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. Stone may be particularly necessary at the outlet to resist erosion and prevent a scour hole if this structure is not retrofit with baffles. 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. If they determine that a buried invert is required at this site, the structure size will need to be larger. Regulatory authorities including the US Army Corps of Engineers may have additional concerns or requirements regarding this structure.

## **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. 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, it is recommended that the structure size be adequate for 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.

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**TO:** John Wilkin, District 8 Technician  
James Cota, District 8 Project Manager

**CC:** Chris Brunelle, A.N.R. River Management Engineer

**FROM:** Cassidy Cote, Hydraulics Engineer  
Alex Flinn, Rotation Engineer

**DATE:** August 12, 2019

**SUBJECT:** Franklin VT-236, State Park Road, MM 3.79 over unnamed tributary of Lake Carmi  
Site location 490 feet south of TH-18, Dewing Road  
GPS coordinates: [N 44.979505°](#), [W 72.843974°](#)  
PID 65819

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

**Hydrology**

The following physical characteristics are descriptive of this drainage basin:

Drainage Area	0.03 square miles
Land Cover	Forest and cultivated fields
Avg. Drainage Basin Slope	5.6 %
Water Bodies and Wetlands (NLCD 2006)	0.0 %

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

Annual Exceedance Probability (AEP)	Flow Rate in Cubic Feet per Second (cfs)	
43 %	8	
10 %	13	
4 %	15	
2 %	18	Design Flow – Major Collector
1 %	20	Check Flow

**Channel Morphology**

The channel for this intermittent stream is straight upstream and sinuous downstream, with an estimated local channel slope of 4.9%. The upstream reach is laterally confined by VT-236 and takes a sharp turn to enter the structure. There is a confluence 65 feet downstream of the outlet with another intermittent stream. This crossing is approximately 1 mile upstream of Lake Carmi. Field measurements of channel width varied from 3 to 5 feet at a depth of 2 to 2.5 feet upstream and downstream of the structure.

## **Existing Conditions**

The existing structure is a corrugated metal pipe with a diameter of 3 feet, providing a waterway opening of 7.1 square feet. The inlet has observed scour, resulting in a streambed that is 0.5 feet lower than the structure invert. The inlet is equipped with a concrete cradle wall, which has separated from the pipe. A 2.5-foot vertical drop and scour pool are present at the outlet. Our calculations, field observations and measurements indicate the existing structure does meet current standards of the VTrans Hydraulic Manual. This structure results in a headwater depth of approximately 2.0 feet at 2% AEP and 2.1 feet at 1% AEP.

## **Replacement Recommendations**

In sizing a new structure, we attempt to select structures that meet both the current VTrans hydraulic standards, state environmental standards regarding span length and opening height, and allow for roadway grade and other site constraints. Based on the above considerations and the information available, we recommend any of the following structures as a replacement at this site:

- A minimum 3-foot diameter corrugated metal pipe, with 7.1 square feet of waterway area. This structure results in a headwater depth of 2.0 feet at 2% AEP and 2.1 feet at 1% AEP.
- A corrugated metal pipe arch with a minimum clear span of 42 inches and clear height of 29 inches, providing a waterway area of 6.5 square feet. This structure results in a headwater depth of 1.7 feet at 2% AEP and 1.8 feet at 1% AEP.

*Note: Any similar structure that fits the site conditions could be considered. Please contact the VTrans Hydraulics Section with alternatives that have significantly different inlet geometry so headwater depths may be calculated.*

Stone Fill, Type II may 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. Stone Fill, Type III will be necessary at the outlet to resist erosion and prevent a scour hole. 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. Regulatory authorities including the US Army Corps of Engineers may have additional concerns or requirements regarding this structure.

## **General Comments**

The new structure should be properly aligned with the channel, span the natural channel width, and be constructed on a grade that matches the channel. It is always desirable for a 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 be equipped with cutoff walls, extending a depth equal to the culvert rise, up to 4 feet below the streambed, or to ledge, to serve as undermining prevention.

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.