TOWN OF WARREN, VERMONT

WARREN COVERED BRIDGE

WARREN BRIDGE CB6
WORLD GUIDE NO. 45-12-15

REHABILITATION PROJECT

VTRANS PROJECT NO. STP EH 12 (4)

ENGINEERING INVESTIGATION AND RECOMMENDATIONS REPORT

NOVEMBER, 2013

DuBois & King inc.

ENGINEERING ● PLANNING ●DEVELOPMENT ● MANAGEMENT

Executive Summary

The Warren Covered Bridge (Warren Bridge CB6) has served the community well for over 130 years, but has experienced deterioration to several components, most notably the West abutment. Recent VTrans inspection reports have stated that the covered bridge roof is in need of replacement, bearing blocks have developed decay, and the West abutment has heavy concrete facing deterioration. The Town has received a Transportation Enhancement Grant to fund replacement of the West abutment and other necessary repairs.

DuBois & King has performed a site inspection, reviewed existing bridge and inspection records, completed a hydrologic and hydraulic study, documented site information and resources, analyzed rehabilitation alternatives, developed construction cost estimates, and identified a series of recommended alternatives.

During our site inspection, DuBois & King confirmed many of the issues identified in the State inspection report, as well as identified specific timber members in need of repair or replacement, and obtained key measurements needed in evaluation and design.

The results of the hydrologic and hydraulic study were that the existing bridge is adequately sized hydraulically to pass the 100-year storm with at least 1 foot of freeboard, even under several scenarios of future streambed movement. The study also considered the feasibility and hydraulic effects for construction of a new West abutment 6-feet behind the existing abutment.

Previously obtained subsurface investigations indicate bedrock approximately 7.5 feet below the channel bottom. These boring locations are in close proximity to the West abutment, but additional borings are recommended for design of a new abutment as ledge is known to slope steeply at the project site. Review of the environmental resources indicated the need for specific permits and clearances, but no impacts to environmental resources other than the historic bridge itself.

Several rehabilitation alternatives were considered for the West abutment and other components of the bridge. Replacement of the West abutment is recommended due to its severely deteriorated condition. It is recommended to replace the abutment at its present location because a longer span is not needed hydraulically, and lengthening the span is not practical due to negative impacts to the superstructure. Opinions of probable construction cost were developed for each alternative or recommendation made.

Following analysis of the information and consideration of alternatives, several recommendations are made for rehabilitation of the bridge. The recommendations are as follows:

- Replace West abutment with new exposed-face, MSE type abutment and wingwalls, on cast-in-place concrete pad bearing on bedrock, located in the position of the existing abutment
- Repair east abutment bearing seat cap by pumping grout under the base
- Fill scour hole at east abutment and repair cracks on the northeast wingwall
- Remove and replace downstream, West bank retaining wall only in immediate disturbance area
- Replace cedar shakes on north side of roof
- Replace bolster beam bearing blocks of main truss (12 total)
- Replace bearing beam bearing blocks (8 total)
- Replace 9-foot length, 4-foot height of siding at each of the four corners of bridge
- Replace two (2) rotted stringers at West end bay
- Evaluate capacities of decayed stringers to ensure load capacity, shave off decayed portions to prevent further moisture penetration
- Replace approach railing and signing

The aforementioned recommendations will provide a durable, long-lasting new West abutment, extend the service life of the timber covered bridge superstructure, and improve safety and functionality of the bridge.

Because the total cost of all of the recommended improvements exceeds the Town's available funding, DuBois & King will work with the Town and VTrans to prioritize the improvements, and select from several strategies to advance the project.

Warren Covered Bridge
Engineering Investigation and Recommendations Report

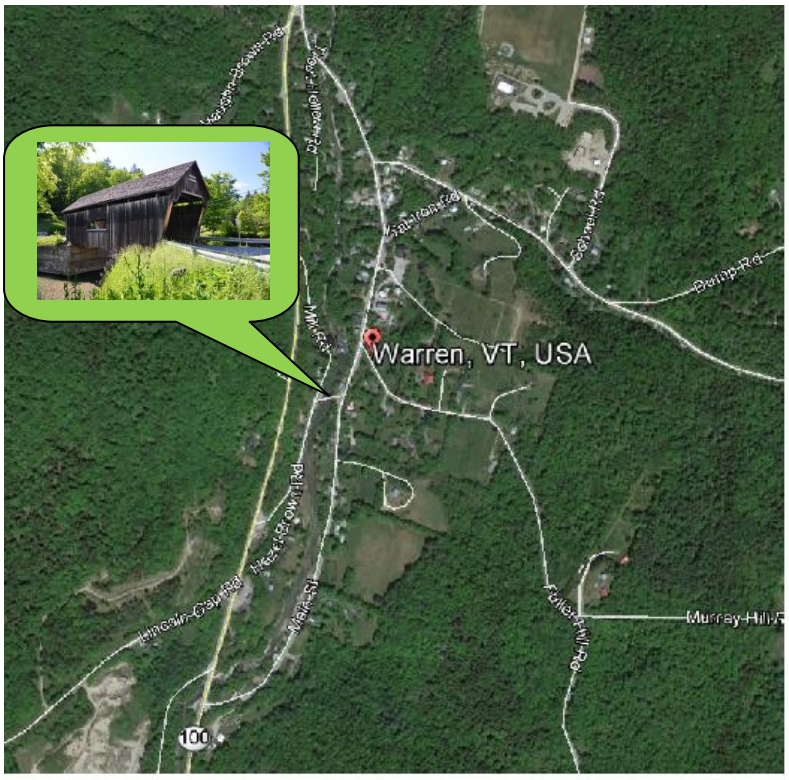
TABLE OF CONTENTS

Introduction

The Warren Covered Bridge (Warren Bridge CB6) has experienced deterioration to several components, most notably the West abutment. Recent VTrans inspection reports have stated that the covered bridge roof is in need of replacement, bearing blocks have developed decay, and the West abutment has heavy concrete facing deterioration. The Town has received a Transportation Enhancement grant to fund the replacement of the deteriorated West abutment and wingwalls, to replace the roof, and raise the road grade. The grant is in the amount of $300,000, plus $75,000 of local matching funds, resulting in total available project funding of $375,000. This Report has been prepared to assess the existing condition of the bridge's components, and make recommendations for repairs.

1. Overview

The Warren Covered Bridge (Warren Bridge CB6) carries Covered Bridge Road (TH 3) over the Mad River. The bridge is an important piece of Town history, and a major tourist attraction in the Town. The bridge is owned and maintained by the Town of Warren. The bridge is listed in the Covered Bridge World Guide as Bridge No. 45-12-15.



Project Location Map

The bridge is a queen post truss timber covered bridge, originally constructed in 1879-1880. The bridge has been rehabilitated several times over its life, most recently in 1980 and again in 2000. The clear span length is approximately 42.5 feet between the abutments, in an East-West orientation. The truss lengths are 54'-8" at the base. The bridge is approximately 13'-4" wide

between rails, serving one-lane of traffic. The timber superstructure is supported on (what is believed to be) the original stone abutments, which have been faced and capped with concrete. The bridge crosses the Mad River at a skew of approximately 70 degrees to the channel. The bridge serves approximately 280 vehicles daily and is posted for 10,000 lbs.

The rehabilitation in 1980 consisted of new concrete abutment caps, backwalls, and short wingwalls, raising the east end of the bridge 6 inches, adding plank guardrail, and cosmetic repairs (see Appendix H). The rehabilitation completed in 2000 consisted of replacement of the bottom chord of the upstream truss, replacement of rotting members in both trusses, replacement of the bed timbers (bolster beams), repair to the end posts, replacement of the bearing blocks, replacement of the floor planks and running boards, and replacement of the siding. The cedar shakes on the roof were replaced on the south half of the bridge in 2013.

2. Site Information

a. Design Criteria

Although the bridge is currently posted for less than design loads prescribed for new bridges, design of the abutment will be based on current design criteria. Designing the abutment for larger loads will not cause the design to be overly conservative. Below are the design criteria that are appropriate for design of a new abutment and retaining wall:

Bridge Design Codes, Specifications, and Guidelines

- AASHTO LRFD Bridge Design Specifications, 6th Edition
- VTrans 2011 Standard Specifications for Construction
- VTrans Structures Design Manual, 5th Edition
- Structural Capacity: HL-93 (Substructures)

Design of the replaced timber superstructure components will be such that they will match the existing dimensions and appearance. Design of timber components will be completed in accordance with the current edition of the National Design Specification for Wood Construction (NDS).

In addition, the VTrans “Historic Covered Bridge Preservation Plan” will be followed. VTrans, in conjunction with the Vermont Historic Preservation Officer and the Federal Highway Administration, prepared and adopted a preservation

plan specific to Vermont and its covered bridges. Key elements of the plan include:

- Minimal change will occur to defining characteristics of the structure
- Distinctive features shall be preserved
- Repair, rather than replace deteriorated elements, if at all possible
- If replacement is warranted, then match original design, and materials, if possible
- New additions or alterations shall be reversible

b. Site Inspection and Inspection Report Summary

A site inspection of the bridge was conducted on September 10, 2013. Engineers from DuBois & King, and the Town's Director of Public Works were in attendance. The interior and accessible parts of the exterior were reviewed to identify the general condition of the bridge's various components. Much of the bridge is in good condition; however, some concerns were noted:

- The cedar shakes on the north side of the roof are cupping, cracked and broken, and the shakes need to be removed and replaced; the shakes on the south half are in good condition as they have been recently replaced.
- The bolster beam bearing blocks of the main trusses (3 at each truss bearing, 12 total) are rotting and need to be replaced.
- The stringer bearing beam bearing blocks (4 at each abutment, 8 total) are rotting and need to be replaced.
- The exterior siding at each of the four corners is rotting and needs to be replaced (limits include the lower 4 foot panel, zero to 9 feet from the ends of bridge).
- Multiple longitudinal stringers have mold on them with 3/16" deep decay at the ends. Holes in one of the stringers indicate insect intrusion. There is a heavy check in one of the stringers near mid-span. These stringers should be evaluated for existing condition capacity and may require replacement.
- The East abutment's concrete bearing seat has experienced subsidence due to erosion of backfill and/or settlement of the abutment, causing ponding around the bearing blocks. Small sink holes have developed around the top of this abutment as a result of water draining off of the seats and/or subsidence of the abutment.
- A scour hole was noted in the river channel in front of the East abutment that should be filled.

- The approach rail at all 4 quadrants is substandard.
- The Northeast wingwall has cracks and discoloration (approx. 1.5 ft. x 10ft.).

DuBois & King engineers also noted the following:

- The trusses are in good condition.
- The deck planking and longitudinal running boards are in fair to good condition.
- The floor beams are in good condition.
- The interior siding is in good condition.
- The exterior siding is in fair to good condition, except as noted above.

See the bridge photos contained in Appendix B for a further understanding of the existing conditions.

Appendix E includes an inspection report by the Vermont Agency of Transportation (VAOT) Structures Section Bridge Management and Inspection Unit dated August 31, 2012. It is summarized as follows:

- The alignment is poor for modern day traffic
- The rail at the Southwest corner is rotten and broken. The steel beam rail at the Northeast corner has been removed
- The transverse planking has some leakage and staining with soft rot, but decay is minimal
- The stringers may have some decay at the abutment ends
- Oak bearing blocks are rotten. Only the front blocks are in bearing at each corner
- The cedar shingle roof has many holes where the shingles are degrading, especially along the south side exposed to sun
- The West abutment has areas of degradation with scaling and delamination
- The Southwest wingwall has heavy scaling and some break up
- General scour exists with some exposed ledge

c. Hydrologic and Hydraulic Evaluation

i. Introduction

The Warren Covered Bridge crosses the Mad River with a clear span between abutment faces of approximately 42.5 feet, on a skew of approximately 70 degrees to the channel. Due to the skew of the bridge, and the fact that the abutments are not parallel, the effective hydraulic opening is 40 feet. The bank-full width has been calculated as 56 feet, so the bridge abutments currently constrict the channel.

Downstream from the bridge is a timber dam that is in a state of severe deterioration. This dam currently impounds a portion of the river that extends upstream past the bridge. Consequently, the hydraulics at the bridge are currently controlled by the dam more than the bridge itself. However, there are no plans to replace this dam, and it is expected that the dam will soon fail completely. After this occurs, the hydraulic condition at the bridge will change and the bridge will be the hydraulic control in the immediate area. Additionally, it is expected that once the dam fails, the sediment in the channel that has accumulated over many years due to the dam will begin to migrate downstream, and eventually the channel at the bridge will retain little if any sediment. This change will result in a larger hydraulic opening at the bridge, and the abutments will be more exposed than they are currently. For the purposes of our hydraulic evaluation, D&K has considered both the existing condition with the dam in place, and the future condition with the dam no longer remaining. Our complete "Hydrologic and Hydraulic Assessment for Proposed Bridge Rehabilitation" is included as Appendix G.

ii. Hydrology

Peak river discharges for the 2-100 year storm events were estimated at the bridge site using the results published in the FEMA Flood Insurance Study (FIS) for Washington County, Vermont dated March 19, 2013. The FIS (from the HEC-2 model obtained from the FEMA Library) provided flows for the reach of the Mad River through the Village of Warren, and these estimates were used without modification. Based on this information, D&K used a 25-year peak discharge rate of 3,990 c.f.s., and a 100-year peak discharge rate of 5,330 c.f.s. for the hydraulic modeling of alternatives.

iii. Hydraulics

Hydraulic analyses for the existing and proposed conditions were performed using the HEC-RAS computer program. Cross section geometry used in the models was based on field survey obtained from a study performed by the U.S. Army Corps of Engineers on the Mad River from the timber crib dam upstream to the VT Route 100 Bridge over the Mad River in March 2004. Additional survey of the Covered Bridge area was obtained in September 2013 and included in the model.

A total of twelve models were run using HEC-RAS to determine hydraulic flow conditions at the bridge. The models included the 25-year and 100-year peak discharges for existing conditions, and for the alternative (which is to reconstruct the West abutment 6 feet west of the existing location). For each of these four iterations, three different scenarios were modeled:

- The existing timber dam remains in place
- The existing timber dam is no longer in place and the upstream channel remains largely unchanged
- The existing timber dam is no longer in place and the sediment upstream of the dam scours to an estimated new streambed elevation

Results of our analyses are included in the following tables:

Table 1 - Results of Hydraulic Analysis - Q25

Description	Existing	Alternative A
With timber crib dam intact		
Water Surface Elevation (ft)	901.7	901.2
Headspace below low chord (ft)	2.8	3.3
Water over Road?	No	No
River Velocity (fps)	10.6	9.1
No timber crib dam and existing streambed		
Water Surface Elevation (ft)	901.5	901.0
Headspace below low chord (ft)	3.0	3.7
Water over Road?	No	No
River Velocity (fps)	10.9	9.4

No timber dam with future streambed		
Water Surface Elevation (ft)	897.8	897.7
Headspace below low chord (ft)	6.7	8.0
Water over Road?	No	No
River Velocity (fps)	15.5	14.9

Table 2 - Results of Hydraulic Analysis - Q100

Description	Existing	Alternative A
With timber crib dam intact		
Water Surface Elevation (ft)	903.3	902.9
Headspace below low chord (ft)	1.2	1.6
Water over Road?	No	No
River Velocity (fps)	12.8	10.9
No timber crib dam with existing streambed		
Water Surface Elevation (ft)	903.5	902.7
Headspace below low chord (ft)	1.0	2.0
Water over Road?	No	No
River Velocity (fps)	13.2	11.3
No timber crib dam with future streambed		
Water Surface Elevation (ft)	900.3	899.7
Headspace below low chord (ft)	4.2	5.9
Water over Road?	No	No
River Velocity (fps)	16.6	16.1

The hydraulic analyses show that the existing bridge span is more than adequate to pass all storm events up to the 100-year storm with greater than 1 foot of headspace between the flood elevation and the low chord of the bridge. This analysis was confirmed anecdotally during Tropical Storm Irene, as the water surface elevation did not reach the low chord of the bridge during that storm event.

Lengthening the bridge span is not necessary to meet VTrans' hydraulic requirements for a Town highway bridge. However, reconstructing the West abutment 6 feet behind the existing abutment has been considered because the Town and the Vermont Agency of Natural Resources River Engineer

have expressed their desire to enlarge the hydraulic opening if it can be done without affecting the superstructure. Opening the channel 6 feet has been selected because it is thought to be the most the span can be lengthened without significantly altering the timber superstructure. Lengthening the span would have several beneficial effects:

- The longer span length would locate the abutment farther out of the channel, provide a span closer to the bank full width, and increase the ability of the bridge to pass debris
- The longer span would reduce river velocities and thus scour potential

The feasibility of locating the new abutment 6 feet behind the existing abutment is discussed in the Alternatives section of this report.

d. Subsurface Investigations

Geotechnical borings were taken near the bridge in 2004 for the U.S. Army Corps of Engineers project mentioned previously. A plan indicating the location of these borings and the associated boring logs are included in Appendix D. Ledge was encountered approximately 7.5' below the channel bottom; however, exposed ledge near the bridge indicates that the ledge is steeply inclined in the area of the bridge. New borings will be taken at the location of the proposed West abutment once the final location and configuration is determined. It is expected that the new abutment can be founded directly on ledge as ledge will likely be encountered near, or just below, the bottom of channel elevation.

e. Utilities

Existing overhead telecommunications (Waitsfield and Champlain Valley Telecom) lines are present, running along Covered Bridge Road West of the bridge, and crossing the Mad River on the north side of the bridge. There is also an overhead electric line crossing the Mad River on the North side of the bridge. There is a sewer manhole with force main in the pavement of Covered Bridge Road, on the West side of the bridge. There is a dry hydrant located behind the guardrail in the Southeast quadrant of the bridge.

Depending on the contractor's means and methods of construction, the overhead utility along Covered Bridge Road will likely be a conflict during construction. Early coordination with the utility addressing this issue during design will reduce

the risk for delays during construction. Construction of any alternative considered is expected to neither impact the overhead utilities North of the bridge, nor the underground utilities in the area.

f. Right-of-Way

The existing right-of-way along Covered Bridge Road, Main Street, and Mill Road are 3-rods (49.5-feet) and shown on the Existing Conditions Drawing in Appendix C. These widths should provide adequate space to encompass any work/alternative under consideration. Neither permanent nor temporary construction easements should be needed to construct the project.

g. Environmental Resources

i. Historical and Archaeological

The Warren Covered Bridge was originally built by local millwright, Walter Bagley in 1879-1880. As an early remaining covered bridge in the State, it was listed individually on the National Register of Historic Places in 1974 (#74000269) and is listed as a contributing Structure #57 in the Warren Village Historic District. The Warren Village Historic District nomination notes that "the portals do not match, making it asymmetrical". The nomination also notes that it was restored in 1955. Despite the restoration work, it was listed on the Register in both 1974 and again considered contributing in 1992 when the Village Historic District was listed. The bridge was rehabilitated in 1980, replacing abutment seats and backwalls, with other repairs to the timber superstructure. After a severe 1998 flood, the bridge was again heavily restored in 2000 and retains its historic appearance and integrity. The structural elements were replaced in-kind matching the species as well as the size and shape of the members. The 2000 restoration work was consistent with the Secretary of the Interior's Standards for Preservation Projects, preserved the bridge's historic integrity and therefore has not affected the National Register status of the bridge.

The proposed plans for repairs to the bridge will be presented and discussed with the Vermont Historic Covered Bridge Preservation Committee. Any repairs will be in accordance with the recommendations of the Committee, and with the Vermont Historic Covered Bridge Preservation Plan. A Section 106 historical clearance will ultimately be needed before the project can proceed to construction.

The project is presently under review by the VTrans Archaeology Officer to determine if the project will impact any archaeological resources. Due to the limited project impact area and the fact that the project has been disturbed numerous times, no archaeological impacts are expected. An archaeology clearance is expected after the Officer's review is completed.

ii. Natural Resources

A review of the project site and the Vermont Natural Resource Inventory Database resulted in the identification of no known natural resources within the project area. The project is not expected to have any impacts to natural resources.

iii. Other Resources

A review of the project site and the Vermont Natural Resource Inventory Database resulted in the identification of no other environmental resources or concerns within the project area. The project is not expected to have any negative impacts to agricultural resources, hazardous waste sites, floodplains, rivers, wildlife habitats, or any other resource.

iv. Permits

A Stream Alteration Permit from the Vermont Agency of Natural Resources and a U.S. Army Corps of Engineers Section 404 General Permit will be required for the work in the river and construction below the ordinary high water.

Because the project will disturb a small area, and no additional impervious areas will be created, neither a construction stormwater permit nor stormwater operational permit will be required. Also, no wetlands will be impacted, so a wetlands permit will not be needed.

Because the project is funded in part by a Federal Transportation Enhancement grant, the National Environmental Policy Act (NEPA) will apply to the project. Therefore, a Categorical Exclusion will need to be prepared and approved by VTrans. This will include a Section 106 historical review. Plans will also be submitted to the Vermont Historic Covered Bridge Preservation Committee for their review and input.

h. Maintenance of Traffic

There are two options to maintain traffic; use of an on-site detour (temporary bridge), or closing the bridge to traffic and establishing a detour on other roads. Closing the bridge to traffic during construction will save the Town the significant costs associated with maintaining traffic through the bridge site. A detour on other roads consists of using Main Street and VT Route 100 to circumvent the bridge site. If a detour on other roads is used, Covered Bridge Road would be closed only in the vicinity of the bridge, allowing access for residents along this road and Mill Road. The existing traffic volumes using the Covered Bridge are minimal and should not cause a detriment to the detour route. Due to the substantial savings realized, DuBois & King recommends closing Covered Bridge Road to traffic in the vicinity of the bridge during construction, and detouring traffic on other roads.

3. Alternatives

a. West Abutment Alternatives

i. Replace West Abutment 6 Feet Behind Existing Abutment

This alternative involves replacement of the West abutment 6 feet behind the existing abutment, which in turn will increase the span length. The effects of lengthening the span on the truss and floor framing system have been evaluated. A longer span would have several negative effects on the timber superstructure, summarized below:

- The bearing seat for the longitudinal floor stringers is interior to the span of the truss bearing seats, meaning that the floor stringers are not of adequate length to accommodate a longer span. Lengthening the span would require replacing all of these stringers (14 total), with longer and possibly larger stringers.
- Lengthening the span would reduce the bearing area underneath the truss bolster beams, increasing bearing stresses.
- With a longer span, additional stress would be placed on the timber trusses, resulting in reduced load carrying capacity or necessary strengthening to maintain the existing load capacity.
- Additional decking and runner boards would be needed for the increased span length.

Although a longer span length would increase the hydraulic opening and thus have modest beneficial hydraulic effects, the longer span would have several negative impacts on the timber superstructure and would substantially increase project costs. For the aforementioned reasons, replacement of the West abutment 6 feet behind existing abutment is not recommended.

ii. Replace West Abutment with Cast-in-Place Concrete Abutment

This alternative involves removal of the existing West abutment and replacement with a new cast-in-place concrete abutment at its present location. Due to the proximity to bedrock, the new abutment would consist of a cast-in-place concrete stem and spread footings, supported on bedrock. Any kind of pile foundation would not be practical because of the shallow depth to bedrock. The new abutment would have wingwalls extending to retain the approach embankments.

Alternative iiA – Exposed Concrete Facing: This alternative consists of an exposed concrete facing to match the east abutment. This is the least costly facing alternative.

Alternative iiB – Dry Stacked Stone Facing: This alternative consists of a facing providing a dry-stacked stone appearance.

The West Abutment is in poor condition

iii. Replace West Abutment with Precast Concrete Unit Block or MSE Wall Abutment

This alternative involves removal of the existing West abutment and replacement with a new precast concrete unit block or MSE wall type abutment. Due to the proximity to bedrock, the new abutment would be founded on a small cast-in-place concrete pad founded on bedrock. The new abutment would also have precast concrete unit block or MSE wingwalls to retain the approach embankments.

Alternative iiiA – Exposed Concrete Facing: This alternative consists of an exposed concrete facing to match the east abutment. This is the least costly facing alternative.

Alternative iiiB – Dry Stacked Stone Facing: This alternative consists of a facing providing a dry-stacked stone appearance. The stone facing can be cast into the precast concrete forms, reducing construction labor and cost.

iv. Repair West Abutment

This alternative would consist of removing areas of spalled concrete and resurfacing these areas, and filling the additional cracks and holes. This alternative is not recommended for the following reasons:

- The abutment is in very poor condition and would require further repairs much sooner than an entirely new abutment
- The abutment is likely not founded on ledge and would be susceptible to scour if/when the downstream dam no longer exists

The existing abutment has been faced with concrete since its original construction, and therefore is not representative of the original construction. Therefore, it is not likely that repairing rather than replacing the existing abutment would be required due to historical considerations. This will be confirmed as part of the Section 106 historic review.

b. East Abutment Alternatives

The East Abutment bearing seat cap was observed to have experienced subsidence due to scour and/or settlement. This subsidence has caused water to pond around the bearing blocks and led to their rot. The alternatives to address this issue include:

East Abutment Bearing Seat Subsidence

i. Replace the abutment bearing seat cap

This alternative would ensure a better product and would last

longer than repairing the existing cap. Full replacement may be excessive since the existing cap can be salvaged. Replacement would be the most expensive alternative.

ii. Repair the abutment bearing seat cap

Although the cap has issues with ponding, the issue can be remedied by modifying the cap. This can be done by coring the cap and pump-grouting concrete below it to set a stable base. The cap would be ground down several inches, and new concrete would be placed on top of the cap on a slope, ensuring proper drainage. Short of ignoring the issue, this would be the least expensive alternative.

Included with each East abutment alternative is filling the scour hole at the East abutment with stone fill, and repair of the cracks on the Northeast wingwall.

c. Downstream Retaining Wall Alternatives

The downstream retaining wall on the West side of the river is in poor condition and in need of repair. At a minimum, a portion of the stone wall will need to be removed and reset due to the excavation required for the new abutment wingwall. Alternatives considered for the downstream retaining wall include the following:

i. Remove and Reset Existing Dry Stacked Stone Wall – Entire Length

The majority of the wall length has shifted or moved, and is significantly out of plumb. This alternative involves removing the entire length of wall and resetting the wall properly in-place. Although the wall will not be of the construction that a new, engineered concrete wall would be, the wall will be plumb and in a more stable condition than it is currently.

ii. Remove and Reset Existing Dry Stacked Stone Wall – Only Within Limits of Disturbance

This alternative entails removing and resetting the existing stone wall only within the limits necessary to construct the new abutment and wingwalls. This is the least costly alternative, although does not address the remaining portion of wall or the long-term service life of the wall.

iii. Remove and Replace Existing Dry Stacked Stone Wall with Cast-in-Place Concrete Wall

This alternative involves removal of the entire stone wall and replacement with a cast-in-place concrete wall on spread footings. The cast-in-place concrete wall would be designed to bear on bedrock and to current design code criteria, resulting in a wall that is more resistant to scour, instability, and an extended service life. The construction cost of a new cast-in-place concrete wall would be greater than removal and resetting the existing wall, although several benefits would be realized.

Alternative iiiA – Exposed Concrete Facing: This alternative consists of an exposed concrete facing and is the least costly facing alternative. The decision of facing on the abutments will impact the facing on the retaining wall.

Alternative iiiB – Dry Stacked Stone Facing: This alternative consists of a dry stacked stone facing to the retaining wall. This alternative is more costly, although provides an appearance that more closely resembles the existing wall.

iv. Remove and Replace Dry Stacked Stone Wall with Precast Concrete Unit Block or MSE Wall

Involved with this alternative is removal of the entire stone wall and replacement with a precast concrete unit block or mechanically stabilized earth (MSE) wall. This type of wall would be designed and constructed with the similar benefits as a cast-in-place concrete wall. Either an exposed concrete facing or a stone facing form-liner could be used. A stone facing form-liner will produce a look with the general form of a dry stacked stone wall, although lacking the detailed color and texture.

d. Superstructure

There are several recommendations to the superstructure based on D&K's site inspection and State inspection report. Below is a list of recommendations regarding the superstructure and roadway approaches:

- Replace cedar shakes on north side of roof
- Replace bolster beam bearing blocks of main truss (12 total)

- Replace bearing beam bearing blocks (8 total)
- Replace 9-foot length, 4-foot height of siding at each of the four corners of bridge
- Replace two (2) rotted stringers at West end bay
- Evaluate capacities of decayed stringers to ensure load capacity, shave off decayed portions to prevent further moisture penetration
- Replace roadway pavement and subbase within limits of disturbance
- Signing for the bridge should be replaced to meet current MUTCD standards
- Remove and replace approach railing with either timber or steel beam approach railing. At a minimum, the guardrail approaches to the West abutment will need to be removed and reset with the replacement of the abutment.

Raising the superstructure to provide a flatter grade along the bridge has been suggested by the Town, and was included in the TE grant application. However, this is not recommended as the East end of the bridge was raised in 1980 to address drainage problems and such a change now may create drainage problems again. Additionally, it would not be advisable to raise the bridge because the West roadway approach acts as an overflow channel during extreme flood events, and raising the West approach would lessen the overflow area, and may create flooding problems in other areas.

4. Estimates of Cost

Estimates of probable construction cost were developed for each alternative considered. The estimates are based on the quantities involved with each alternative with applied unit prices. The unit prices were obtained from VTrans average price list and from projects of similar scope and size. Construction cost estimates provided include only the construction cost and not for other items such as design, right-of-way acquisition, utility relocation, or construction observations. These conceptual costs are subject to change due to fluctuations in the cost of labor and materials, and with the refinement of the overall design during subsequent phases of the project. Estimates of probable construction cost are summarized in the following section.

5. Alternatives and Cost Matrix

Following is a table summarizing the Alternatives considered and the associated estimates of probable construction cost.

	ALTERNATIVE/REPAIR RECOMMENDATION	ESTIMATED CONSTRUCTION COST
WEST ABUTMENT	ALT iiA - CAST-IN-PLACE EXPOSED CONCRETE FACING	$344,000
	ALT iiB - CAST-IN-PLACE DRY STACKED STONE FACING	$413,000
	ALT iiiA - MSE EXPOSED CONCRETE FACING**	$277,000
	ALT iiiB - MSE DRY STACKED STONE FACING	$319,000
EAST ABUTMENT	ALT i - REPLACE ABUTMENT BEARING SEAT CAP	$21,000
	ALT ii - REPAIR ABUTMENT BEARING SEAT CAP**	$7,000
RETAINING WALL	ALT i - REMOVE AND RESET STONE WALL (ENTIRE LENGTH)	$64,000
	ALT ii - REMOVE AND RESET STONE WALL (PARTIAL LENGTH)**	$22,000
	ALT iiiA - CAST-IN-PLACE CONCRETE WALL (EXPOSED FACE)	$147,000
	ALT iiiB - CAST-IN-PLACE CONCRETE WALL (STONE FACE)	$182,000
	ALT iv - UNIT BLOCK OR MSE WALL	$105,000
SUPERSTRUCTURE / APPROACHES	RECOMMENDED SUPERSTRUCTURE & ROADWAY APPROACH REPAIRS**	$46,000
	REPLACE APPROACH RAIL AND SIGNING**	$13,500

**** Recommended Alternatives**

6. Summary and Recommendation

DuBois & King provides the following recommendations for the Warren Covered Bridge Rehabilitation. The recommendations are based upon the criteria listed previously and below, and as discussed in detail throughout this report.

The recommendations are as follows:

- Replace West abutment with new exposed-face, MSE type abutment and wingwalls, on cast-in-place concrete pad bearing on bedrock, located in the position of the existing abutment
- Repair East abutment bearing seat cap by pumping grout under the base and resurfacing the cap
- Fill scour hole at East abutment and repair cracks on the Northeast wingwall
- Remove and replace downstream, West bank retaining wall only in immediate disturbance area
- Replace cedar shakes on North side of roof
- Replace bolster beam bearing blocks of main trusses (12 total)

- Replace bearing beam bearing blocks (8 total)
- Replace 9-foot length, 4-foot height of siding at each of the four corners of bridge
- Replace two (2) rotted stringers at West end bay
- Evaluate capacities of decayed stringers to ensure load capacity, shave off decayed portions to prevent further moisture penetration
- Replace approach railing and signing

The recommendations are based on the following:

- A new MSE type abutment and wingwalls bearing on bedrock will provide a durable, long-lasting, support for the covered bridge at the lowest construction cost
- An exposed concrete face is significantly less cost than a dry-stacked stone facing
- Replacement of the West abutment 6-feet behind the existing abutment, and repairing the West abutment, have not proved practical
- Repair of the East abutment bearing seat instead of replacement will improve drainage, service life, and is more cost-effective than replacement
- Removing and resetting the existing retaining wall downstream of the West abutment only in the disturbance area is the least costly alternative
- Replacing the cedar shakes on the North side of the roof will better protect timber components and extend the service life of the bridge
- Replacing timber components noted will extend the service life of the superstructure and prevent further deterioration
- Replacing approach railing and signing will improve safety and functionality of the bridge

Cost of Recommended Improvements

The estimated costs for the recommended improvements are as follows:

Replace West abutment with exposed face concrete MSE-type wall	=$ 277,000
Repair East abutment bearing seat cap	= $ 7,000
Remove and reset downstream wingwall	= $ 22,000
Repair superstructure as recommended	= $ 46,000
Replace approach rail and signing	= $ 13,500
Construction Subtotal	= $365,500

In addition to the construction costs, the Town should expect to incur additional costs for construction observation. This cost is estimated at 10% of the construction cost, or approximately $36,000. Minimal additional costs can be expected for right-of-way (attorney's fees) and municipal management.

Given that the Town has a total of $375,000 in total funding of the project, $66,700 has been dedicated to design engineering, approximately $5,000 can be expected for right-of-way and municipal management, and $36,000 will be needed for construction observation, approximately $267,000 would be available for construction. Because this is less than the funding needed for construction of all of the recommended improvements, the Town will need to consider options to proceed forward. These should include:

- Seeking additional funding to proceed with all of the recommended improvements
- Only implementing some of the recommended improvements until additional funding can be secured
- Bidding the project so that some items are Bid Alternates, and then proceeding with only those items that fit within the available funding

We will want to discuss these options in detail with the Town, and gain the Town's and VTrans' concurrence on a preferred strategy before proceeding with the design of the project.

APPENDIX A

GLOSSARY OF BRIDGE TERMS

GLOSSARY OF BRIDGE TERMS
(Covered Bridges)

AASHTO – American Association of State Highway and Transportation Officials.

ADT – Average Daily Traffic.

ABUTMENT – A substructure element supporting each end of a single span bridge of superstructure and, in general, retaining or supporting the approach embankment.

BED TIMBERS - Timber beams typically located between the top of an abutment or pier and the underside of the truss bottom chord. Intended to serve as bearing block. Also known as Bolster Beams.

BEAM – A linear structural member designed to span from one support to another.

BOLSTER BEAMS – See Bed Timbers above.

CAST-IN-PLACE – Concrete poured within formwork on site to create a structural element in its final position.

CAMBER – A slight convexity on the road surface.

CHORD – A horizontal member of a truss.

COLUMN – A verticle structural member that transfers dead and live load from the bridge deck and girders to the footings or shafts.

COMPRESSION – The pushing force, which tends to shorten a member; opposite of tension.

CONCRETE – A mixture of water, sand, stone, and a binding element, which hardens to a rock-like consistency.

COUNTER BRACE - A diagonal timber in a truss which slants in the opposite direction from the brace.

CROSS BEAM – Transverse member in the upper framing that connects between each truss top chords.

CROSS BRACE – Transverse brace between two main longitudinal members.

DEAD LOAD – A static load due to the weight of the structure itself.

DECK – The roadway portion of a bridge that directly supports vehicular and pedestrian traffic.

DIAGONAL – A sloping structural member of a truss or bracing system.

EXPANSION JOINT – A joint designed to provide means for expansion and contraction movements produced by temperature changes, load, or other forces.

FATIGUE – Cause of structural deficiencies, usually due to repetitive loading over time.

FLANGE – The flat top and bottom plates of a beam, stringer, or girder.

FLOORBEAM - A transverse beam supporting other beams (stringers) and the bridge deck.

FOOTING – The enlarged, lower portion of a substructure that distributes the structure load either to the earth or to supporting piles; the most common footing is the concrete slab.

GIRDER – A main support member for the structure that usually receives loads from floor beams and stringers; also, any large beam, especially if built up.

GVW – Gross Vehicle Weight.

HANGER ROD – A tension member that suspends the deck framing under the arch.

HINGE – A point in a structure at which a member is free to rotate.

INVENTORY RATING - A live load, which can safely utilize an existing structure for an indefinite period of time.

KNEE BRACE – A diagonal member that braces the framing laterally.

LAMINATED ARCH - A timber arch made of layers of bent planks secured by nails or treenails.

LATTICE - Diagonal web members of a Town lattice type truss.

LIVE LOAD – Vehicular traffic, wind, water, etc.

LOAD RATING – The determination of the live load carrying capacity of an existing bridge.

LOWER CHORD – The bottom horizontal member of a truss.

MEMBER – An individual angle, beam, plate, or built piece intended to become an integral part of an assembled frame or structure.

OPERATING RATING – The maximum permissible live load to which the structure may be subjected.

PIER – A vertical support or substructure unit that supports the spans of a multi-span superstructure at an intermediate location between its abutments.

PILE – A verticle shaft driven into the ground that carries loads through weak layers of soil to those capable of supporting such loads.

PLATE GIRDER – A large, solid web plate with flange plates attached to the web plate by flange angles or fillet welds; fabricated from steel.

PORTAL - General term for the entrance of a covered bridge.

POSTING LOAD – A live load a bridge may safely utilize on a routine basis for a limited period of time.

PRE-CAST GIRDER – Fabricated off site of Portland Cement Concrete, reinforcing steel, and post-tensioning cables. These girders are shipped to the construction site by truck and hoisted into place by cranes.

PURLIN – A longitudinal member in the roof framing.

RAFTER - One of several parallel sloping beams that support a roof.

REINFORCED CONCRETE – Concrete with steel reinforcing bars bonded within it to supply increased tensile strength and durability.

RIVETED CONNECTION – A rigid connection of metal bridge members that is assembled with rivets. Riveted connections increase the strength of the structure.

R.O.W. – Right-of-Way.

SHAKE – A wood shingle made from split logs.

SPALLS – Popouts, shallow holes and deteriorated areas in concrete.

SPAN – The distance between piers or abutments.

SECTION LOSS – Loss of material (thickness or width) in steel members, usually from corrosion.

STAY – Diagonal brace installed to minimize structural movement.

STRINGER – A longitudinal beam supporting the bridge deck.

SUBSTRUCTURE – The parts of a bridge that are below the bottom of the girders. Pilings, shafts, spread footings, piers and abutments are part of the substructure.

SUPERSTRUCTURE – The parts of a bridge that are above the piers and abutments. Girders, trusses, bridge deck, and bridge railing are parts of the superstructure.

TENSION – A force that pulls or stretches.

TREENAIL - A wooden peg that is used to fasten timbers.

TRUNNEL - A wooden peg that is used to fasten timbers.

TRUSS – A rigid, jointed structure made up of individual straight pieces arranged and connected, usually in a triangular pattern, so as to support longer spans.

TRUSS BRIDGE – A bridge having a pair of trusses for the superstructure.

UPPER CHORD – The top longitudinal member of a truss.

VOIDED SLAB – A reinforced concrete slab with a hollow interior, similar to, but normally wider and flatter than, a pre-cast girder.

WEB – The portion of a beam located between and connected to the flanges.

APPENDIX B

PHOTOGRAPHS

Photograph 1 - Elevation, Facing Upstream

Photograph 2 - West Abutment

Photograph 3 - West Abutment

Photograph 4 - East Abutment

Photograph 5 - Ends of Stringers and Stringer Bearing Beam

Photograph 6 - East Abutment Bridge Seat and Bridge End

Photograph 7 - Portal at East End

Photograph 8 - Inside Bridge

Photograph 9 - Retaining Wall (Downstream Side, West Bank)

Photograph 10 - Substandard and Damaged Approach Rail at SW corner

APPENDIX C

EXISTING CONDITION DRAWINGS

N

VT STATE PLANE GRID

MILL RD. (TH NO. 44)

MAD RIVER

MAIN ST. (TH NO. 4)

COVERED BRIDGE RD. (TH NO. 3)

APPROXIMATE EXIST. 3-ROD RIGHT-OF-WAY

4" PVC OUTLET

4" HDPE OUTLET

EXISTING COVERED BRIDGE (CB NO. 6)

COV. BRIDGE / NO TRUCKS OR BUSES

MILL RD. COVERED BRIDGE RD.

BM
TOP OF SW CORNER OF EAST ABUTMENT
EL. 905.68

POB STA 1+00.00

POE STA 2+63.39

1+00

2+00

2+63

12+00

12+2

1+00

AER E&T

GUY

COMB

STEPS

GARDEN

GARAGE

PAVED DRIVE

WALL

MHS

2" APPLE

HVCTRL 14

HVCTRL 15

HVCTRL 16

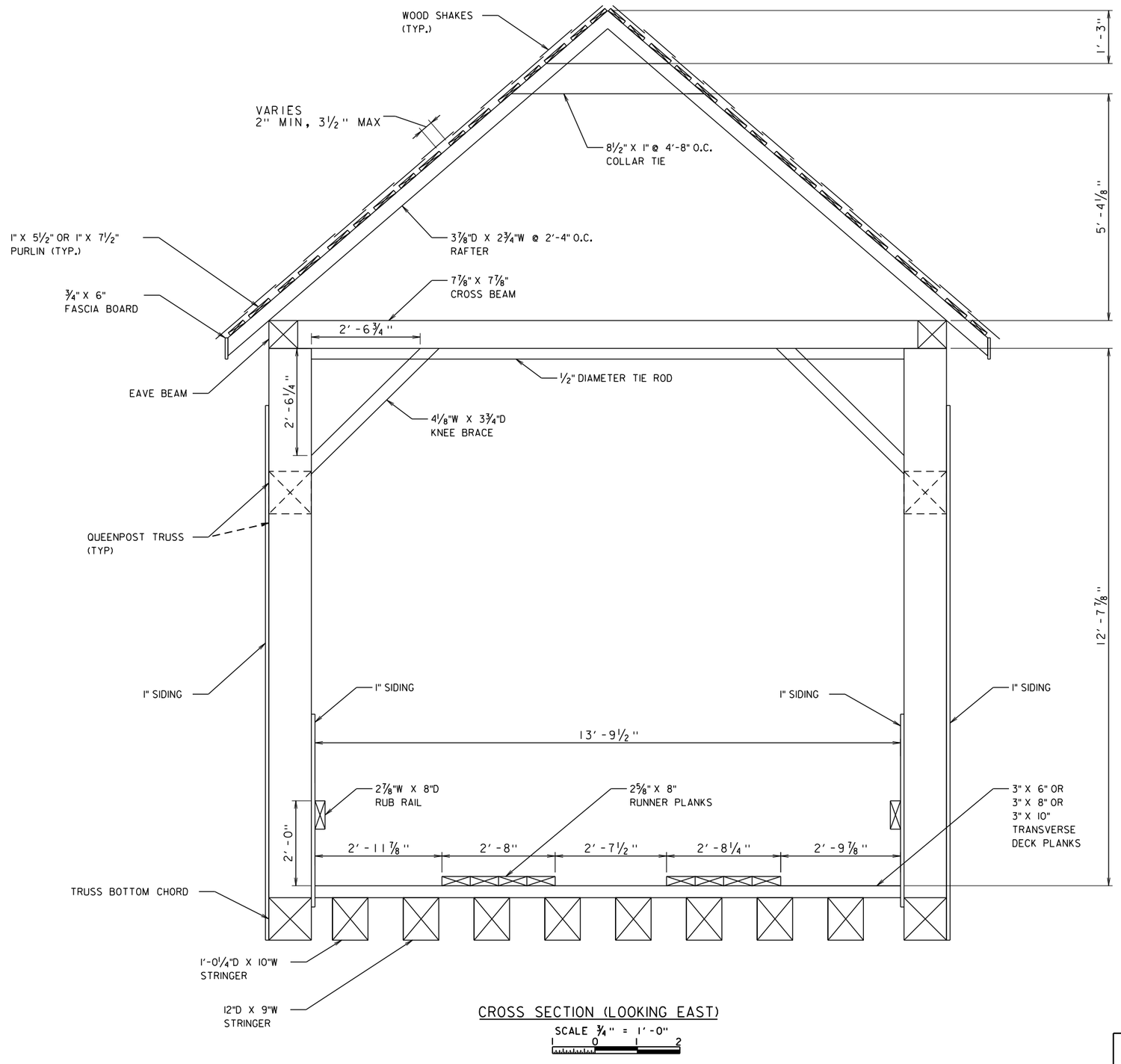
HVCTRL 17

DRY HYD

STOP SIGN

SCALE 1" = 10'-0"
10 0 10

PROJECT NAME:	WARREN
PROJECT NUMBER:	621945
FILE NAME: ...\CADD FILES\621945bdr.dgn	PLOT DATE: 11/8/2013
PROJECT LEADER: EPD	DRAWN BY: RHB
DESIGNED BY: RHB	CHECKED BY: EPD
EXISTING CONDITIONS PLAN	SHEET 1 OF 4

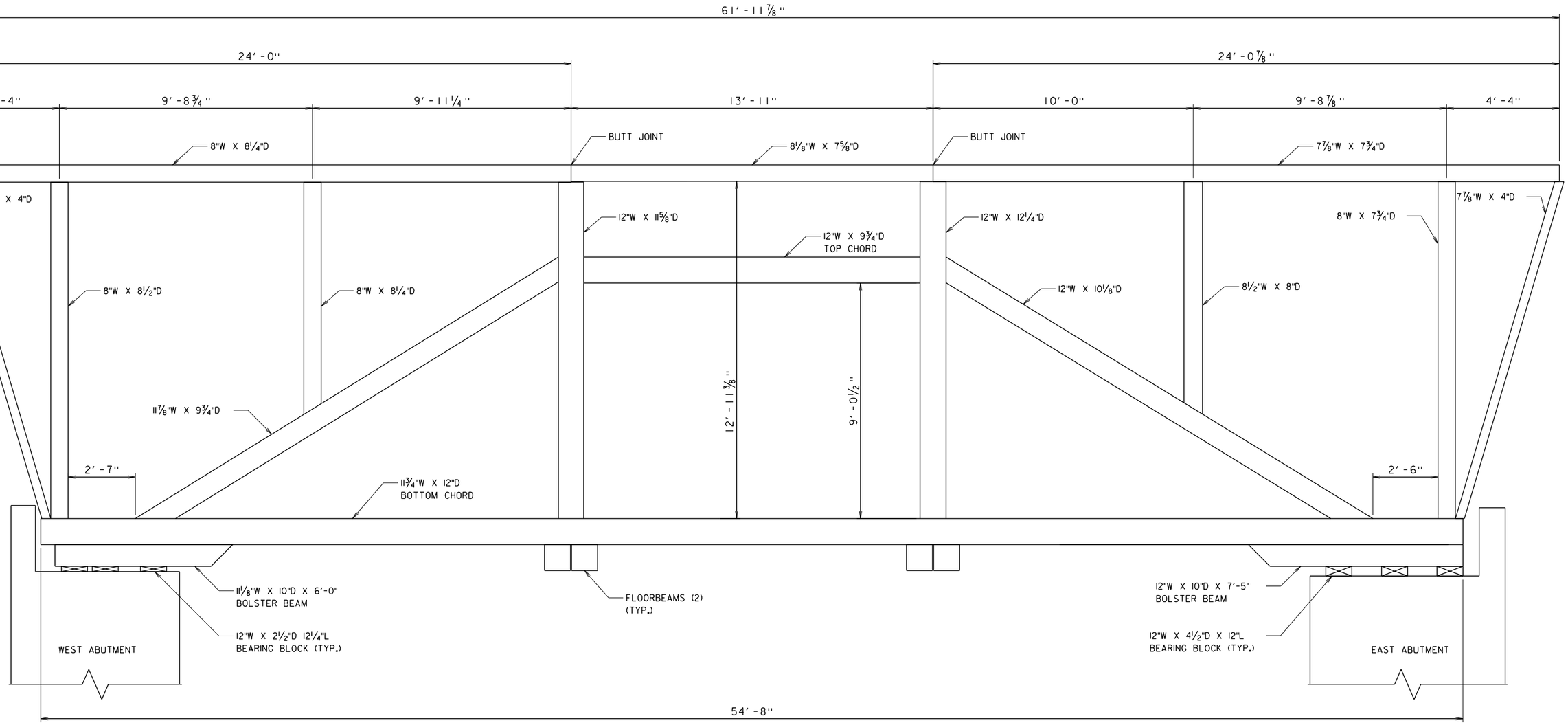


CROSS SECTION (LOOKING EAST)

SCALE ¾" = 1'-0"

0 1 2

PROJECT NAME:	WARREN
PROJECT NUMBER:	621945
FILE NAME: ...\CADD FILES\621945sup.dgn	PLOT DATE: 11/8/2013
PROJECT LEADER: E. DETRICK	DRAWN BY: E. OHANIAN
DESIGNED BY:	CHECKED BY:
EXISTING CROSS SECTION	SHEET 2 OF 4

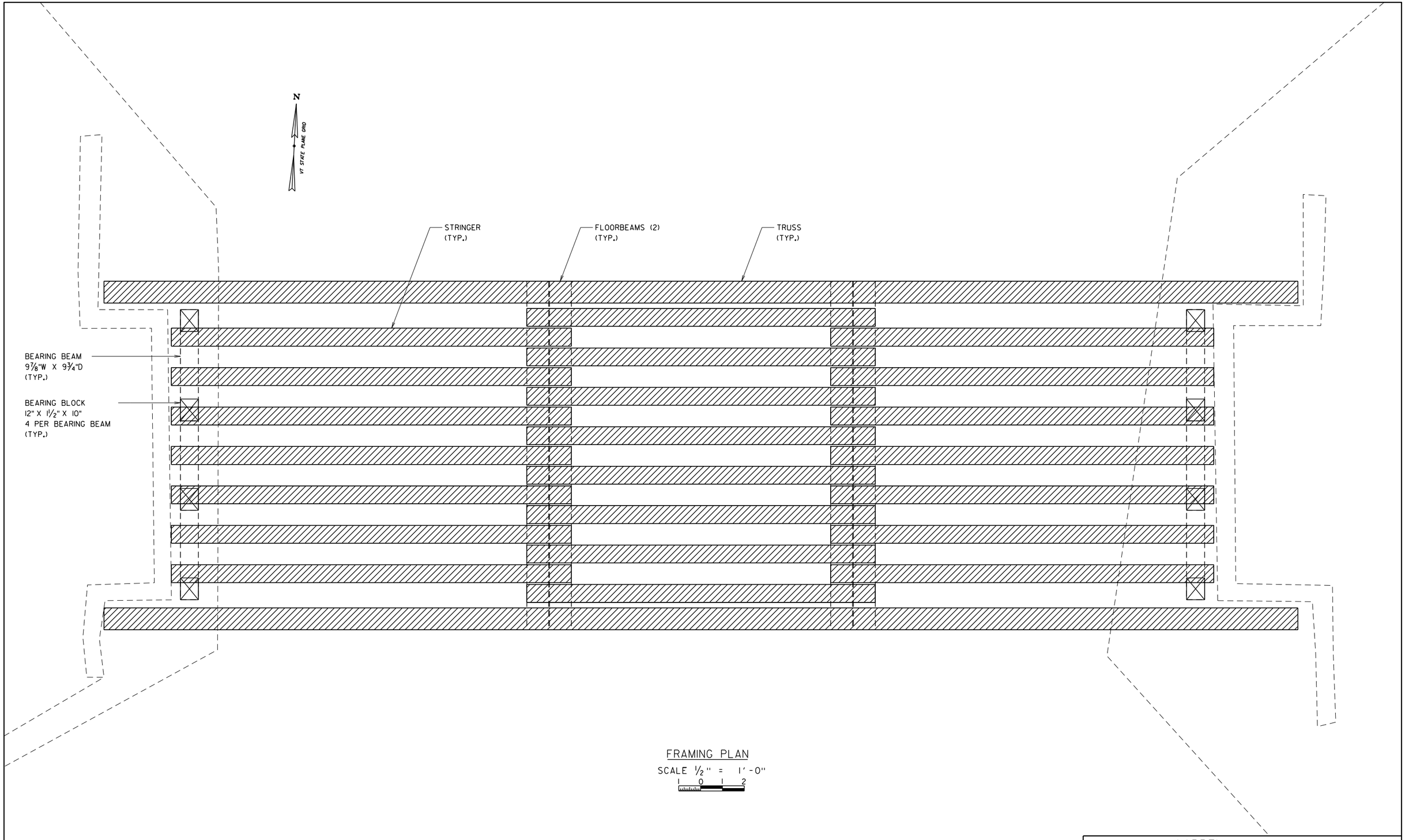


TRUSS ELEVATION

SCALE 1/2″ = 1′-0″

1 0 1 2

PROJECT NAME: WARREN	
PROJECT NUMBER: 621945	
FILE NAME: ...\CADD FILES\621945sup.dgn	PLOT DATE: 11/8/2013
PROJECT LEADER: E. DETRICK	DRAWN BY: E. OHANIAN
DESIGNED BY:	CHECKED BY:
EXISTING TRUSS ELEVATION	SHEET 3 OF 4



FRAMING PLAN

SCALE 1/2" = 1'-0"

PROJECT NAME:	WARREN	
PROJECT NUMBER:	621945	
FILE NAME: ...\CADD FILES\621945sup.dgn		PLOT DATE: 11/8/2013
PROJECT LEADER: E. DETRICK		DRAWN BY: E. OHANIAN
DESIGNED BY:		CHECKED BY:
EXISTING FRAMING PLAN		SHEET 4 OF 4

APPENDIX D

2004 BORING LOGS AND PLAN

VT STATE PLANE GRID

River Curve #1
PI STA 159+74.14
North =7706.6289
East =46759.2191
PC STA 159+31.10
PT STA 160+16.35
R = 250.00'
D = 22°55'06"
L = 85.25'
d = 19°32'15.88" Right
T = 43.04'
E = 3.68'

River Curve #2
PI STA 162+16.09
North =7486.4828
East =46656.8415
PC STA 161+69.98
PT STA 162+61.18
R = 250.00'
D = 22°55'06"
L = 91.20'
d = 20°54'04.07" Left
T = 46.11'
E = 4.22'

River Curve #3
PI STA 163+11.01
North =7390.7830
East =46650.0834
PC STA 162+90.21
PT STA 163+31.22
R = 100.00'
D = 57°17'45"
L = 41.01'
d = 23°29'57.95" Right
T = 20.80'
E = 2.14'

WALL STA 0+00.00 = RIVER STA 160+18.64 OFFSET 42.81 LT

IMPROVEMENTS TO EXISTING TIMBER WALL. SEE SHEET -- FOR DETAILS.

LOT #004-004-200
N/F JAMES & CAROL GROOM
B. 45, P. 701

WALL STA 2+00.13 = RIVER STA 162+26.90 OFFSET 36.48 LT

LOT #004-004-110
N/F TOWN OF WARREN
UNRECORDED

MAIN ST. TOWN HIGHWAY NO. 4

LOT #004-003-800
N/F GERALDINE COTA
B. 42, P. 53

LOT #004-004-300
N/F JOHN LOUIS MOSLEY II
B. 116, P. 250

OLD FOUNDATION

CONCRETE BLOCK

BOTTOM OF EXISTING TIMBER WALL

CURVE #1

CURVE #2

CURVE #3

S5°24'09.95"W

S24°56'25.84"W

S27°32'19.72"W

COVERED BRIDGE

TP6

WARREN TIMBER DAM

MATCHLINE STA. 164+60

MILL ST. TOWN HIGHWAY NO. 44

COVERED BRIDGE RD. TOWN HIGHWAY NO. 44

LOT #003-000-100
N/F PETER & PATRICIA FLOYD
B. 93, P. 474

LOT #003-000-200
N/F JEAN S. SHARRY
B. 137, P. 248

LOT #003-000-300
N/F TOWN OF WARREN
B. 125, P. 466

SCALE 1" = 20'-0
20 0 20

PLOTTED 10/29/2013

Revision	Description	Date	Approved

Dufresne Group — engineering · planning · management · development

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

Designed by
Drawn by
Checked by
Submitted by
ARCHITECT ENGINEER
Reviewed by
SECTION CHIEF
Concurred by
CHIEF, DESIGN BRANCH

U.S. ARMY CORPS OF ENGINEERS

MAD RIVER AT WARREN, VERMONT

AQUATIC ECOSYSTEM RESTORATION
REAL ESTATE PLAN

WARREN VERMONT

Approval Recommended:
CHIEF, ENGINEERING DIVISION
Approved by
COLONEL, C.E. DISTRICT ENGINEER

SHEET REFERENCE NUMBER:
CC-WRR-C106
C106

DATE: MARCH 2004
SCALE: 1" = 20'
SHEET 8 OF 38

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-21
SHEET 1 OF 1
START DATE 22-Jul-2003
FINISH DATE 22-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR Barry Cahoon

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Soft, Grey sand with gravel (typical).
3.0
5.0
Hard. Cobbles and boulders.
4.5
Very tight, Silt.
5.5
7.5
Refusal @ 5.5
10.0
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-22
SHEET 1 OF 1
START DATE 22-Jul-2003
FINISH DATE 22-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR Barry Cahoon

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Gravel.
1.0
Soft, Grey sand with gravel (typical).
5.0
7.5
10.0
Hard.
11.5
Refusal @ 11.5
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-23
SHEET 1 OF 1
START DATE 22-Jul-2003
FINISH DATE 22-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR Barry Cahoon

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Hard cobble and gravel. Current river armor layer.
1.0
Soft.
3.0
5.0
Hard. Cobble and boulders.
6.0
Soft.
7.0
7.5
Refusal @ 7.0
10.0
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-24
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR WTM

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Soft, Grey sand with gravel (typical).
5.0
7.5
10.0
Ledge. Refusal @ 9.5. Auger sliding toward east bridge abutment.
9.5
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-25
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR SRP

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Soft, Grey sand with gravel (typical).
5.0
7.0
7.5
Hard. Cobble.
8.1
Soft. Grey silty sand.
9.5
10.0
Refusal @ 9.5
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-26
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR SRP

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Soft, Grey sand with gravel (typical).
5.0
7.5
8.0
Gravel and cobble.
10.0
10.5
Refusal @ 10.5
12.5
15.0
17.5

NOTES: 1. Sample collected from 1-10'
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-27
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR SRP

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Soft, Sandy gravel with silt.
5.0
7.5
9.0
Gravel and cobble.
10.0
10.5
Refusal @ 10.5
12.5
15.0
17.5

NOTES: 1. Sample collected from 1-10'
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-28
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR SRP

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Sandy gravel.
5.0
7.0
7.5
Coarse gravel
10.0
Ledge. Auger sliding upstream.
11.0
Refusal @ 11.0
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-29
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR SRP

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Sandy gravel.
5.0
5.5
7.5
Ledge. Refusal @ 5.5. Auger sliding east toward timber wall.
10.0
12.5
15.0
17.5

NOTES: 1.
2.

BORING LOG

PROJECT: MAD RIVER ECOSYSTEM RESTORATION
LOCATION: BARRENS, VT

JOB NO. R17672L5
HOLE NO. SB-30
SHEET 1 OF 1
START DATE 23-Jul-2003
FINISH DATE 23-Jul-2003
DRILLER Manlea Thompson
HELPER Don Palmer
INSPECTOR SRP

	CASING	SAMPLE	CORE
TYPE			
SIZE ID			
HAMMER WT.			
HAMMER FALL			

GROUNDWATER			DEPTH TO	
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE

DEPTH IN FEET | CASING BLOWS PER FOOT | SAMP NO. | SAMPLE DEPTH | SAMPLE BLOWS PER 6 INCHES | RECOV.

SOIL DESCRIPTION

2.5
Sandy gravel.
1.5
Ledge. Auger sliding east away from timber wall.
3.5
5.0
Refusal @ 3.5
7.5
10.0
12.5
15.0
17.5

NOTES: 1.
2.

PLOTTED 10/29/2013

Revision	Description	Date	Approved

Dufresne Henry — engineering planning management development

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NEW YORK, NEW YORK

Designed by:
Drawn by:
Checked by:
Submitted by:
ARCHITECT ENGINEER
Reviewed by:
SECTION CHIEF
Concurred by:
CHIEF, DESIGN BRANCH

MAD RIVER AT WARREN, VERMONT
U.S. ARMY CORPS OF ENGINEERS

AQUATIC ECOSYSTEM RESTORATION
BORING LOGS

WARREN VERMONT

Approval Recommended:
CHIEF, ENGINEERING DIVISION
Approved by
COLONEL, C.E. DISTRICT ENGINEER

SHEET REFERENCE NUMBER: CC-WRR-C133
C133

DATE: MARCH 2004
SCALE: NOT TO SCALE
SHEET 35 OF 38

APPENDIX E

2012 VTRANS BRIDGE INSPECTION REPORT

STRUCTURE INSPECTION, INVENTORY and APPRAISAL SHEET

Vermont Agency of Transportation ~ Structures Section ~ Bridge Management and Inspection Unit

Inspection Report for WARREN | *bridge no.: 00006* | *District: 6*

Located on: TR 03 FAS 188 ove MAD RIVER | *approximately 0.5 MI E JCT. VT.100 S* | *Owner: 03 TOWN-OWNED*

CONDITION

Deck Rating: 7 GOOD

Superstructure Rating: 6 SATISFACTORY

Substructure Rating: 5 FAIR

Channel Rating: 6 SATISFACTORY

Culvert Rating: N NOT APPLICABLE

Federal Str. Number: 200188000612172

Federal Sufficiency Rating: 021.5

Deficiency Status of Structure: FD

AGE and SERVICE

Year Built: 1879 Year Reconstructed: 2000

Service On: 1 HIGHWAY

Service Under: 5 WATERWAY

Lanes On the Structure: 01

Lanes Under the Structure: 00

Bypass, Detour Length (miles): 01

ADT: 000280 % Truck ADT: 06

Year of ADT: 1995

GEOMETRIC DATA

Length of Maximum Span (ft): 0047

Structure Length (ft): 000058

Lt Curb/Sidewalk Width (ft): 0

Rt Curb/Sidewalk Width (ft): 0

Bridge Rdwy Width Curb-to-Curb (ft): 13.4

Deck Width Out-to-Out (ft): 13.8

Appr. Roadway Width (ft): 021

Skew: 00

Bridge Median: 0 NO MEDIAN

Min Vertical Clr Over (ft): 10 FT 00 IN

Feature Under: FEATURE NOT A HIGHWAY OR RAILROAD

Min Vertical Underclr (ft): 00 FT 00 IN

STRUCTURE TYPE and MATERIALS

Bridge Type: QUEEN POST COV. BR.

Number of Approach Spans 0000 *Number of Main Spans: 001*

Kind of Material and/or Design: 7 TIMBER

Deck Structure Type: 8 TIMBER

Type of Wearing Surface: 7 WOOD OR TIMBER

Type of Membrane 0 NONE

Deck Protection: 0 NONE

APPRAISAL *AS COMPARED TO FEDERAL STANDARDS

Bridge Railings: 0 DOES NOT MEET CURRENT STANDARD

Transitions: 0 DOES NOT MEET CURRENT STANDARD

Approach Guardrail 0 DOES NOT MEET CURRENT STANDARD

Approach Guardrail Ends: 0 DOES NOT MEET CURRENT STANDARD

Structural Evaluation: 2 INTOLERABLE, REPLACEMENT NEEDED

Deck Geometry: 2 INTOLERABLE, REPLACEMENT NEEDED

Underclearances Vertical and Horizontal: N NOT APPLICABLE

Waterway Adequacy: 6 OCCASIONAL OVERTOPPING OF ROADWAY WITH INSIGNIFICANT TRAFFIC DELAYS

Approach Roadway Alignment: 4 MEETS MINIMUM TOLERABLE CRITERIA

Scour Critical Bridges: U UNKNOWN FOUNDATION

DESIGN VEHICLE, RATING, and POSTING

Load Rating Method (Inv): 5 NO RATING ANALYSIS PERFORMED

Posting Status: R POSTED FOR OTHER LOAD-CAPACITY RESTRICTION

Bridge Posting: 5 NO POSTING REQUIRED

Load Posting: 01 NO LOAD POSTING SIGNS EXIST NEAR BRIDGE

Posted Vehicle: POSTING NOT REQUIRED

Posted Weight (tons):

Design Load: 0 OTHER OR UNKNOWN

INSPECTION and CROSS REFERENCE

X-Ref. Route:

Insp. Date: 082012 *Insp. Freq. (months) 24* *X-Ref. BrNum:*

INSPECTION SUMMARY and NEEDS

08/31/2012 - The dilapidated approach rail system is quite poor and needs upgrading. Cedar shingle roof needs replacement. Bearing blocks have developed some decay. Most rotten blocks are not in bearing, with the exception of the front seat edge blocks. Abutment #2 (west) has some heavy facing deterioration and could use cleaning and patching. Consider installing low vertical clearance signs and load limit signs at each end of the bridge which conform to the MUTCD. ~ MJ/DK

11/02/2011 Irene repairs, Abutment 2 on the downstream end has a new stone wall in place and has been back filled. MJK JM

09/08/11 Irene inspection, Abutment 2 wing wall on the downstream side has washed out. Recommendation to the town road superintendent (Barry Simpson) was to backfill wing wall and then the structure would be ok for traffic with monitoring. MJK JM

This structure is in good condition for the most part. The timber bearing blocks that are rotten should be replaced. The scour hole along the abutments should be filled in. The timber roof shingles should be replaced to stop any leakage onto the truss members and deck. 7/710 DCP

Route: FAS 188 Bridge #: 6 District: 6 Date: 8/31/12
Town: Warren Crossing: Mad river Inspection Type: Routine
Bridge Type: Queen post cov. br. Inspectors: MJ/DK

Item 72 Approach Alignment * Problem Area ** Critical Area

Alignment: * Poor - for modern day traffic.
Rail: * Rotted and broken timber plank at the southwest corner. Misc. steel beam elsewehere - removed at the the northeast corner to falicitate channel and retainment work.
Post: Galv. and wooden.
Settlement:
Erosion:

Item 58 Deck

Wearing Surface: Oak runners - minor wear.
Curb:
Sidewalks:
Rail: Single wood plank - ok.
Rail Posts: Truss components.
Joint Type*: < > and < > *Finger Sliding Vertical Modular VT Cork Strip Compression Plug Other None Joint Condition:
Joint Leakage:
Drains:
Fascia:
Soffit: Transverse planking has some leakage and staining with soft rot. Minimal decay though.

Vertical: Good condition. Lower portions are hidden from view due to low boarding.
Diagonals: No problems seen.
Chords: Good condition.
Lateral Bracing: Ok . All intact at present. Some minor damage.
Stringers: Good. 7, 8 and 7Likely some decay at the abutment ends but no outward signs as of yet.
Floorbeams: Good condition. Two large doubled up floorbeams hung from gal. rod.
Girders/Beams:
Cover Plates:
Paint:
Bearing Type*: Wood and < > ***Sliding Bronze Fabric Elastomeric Pot Rockers Nested Rockers Nested Rollers Wood Other None** **Bearing Condition: Random oak bearing blocks are rotten but bolsters are good. Only the front blocks are in bearing at each corner.**
Arches:
Roof/Portal/Siding: * Cedar shingle roof has many holes where the shingles are degrading; especially along the south side exposed to the sun. Top plate at the northwwest end does have a 2x4 x6' long. split along the top inner edge. Present for years. Non issue.
Member Alignment: Trusses are tipped downstream no more than 1/2" in 4'. Measured at each queen post.
Impact Damage: Minor gouges along kneebraces and tension rods have minor bends.
FCM No Comments: * Timber not FC according to FHWA.

Town: Warren Route: FAS 188 Br #: 6 Date: 8/31/12

Item 60 Substructure Abutments * Problem Areas ** Critical Areas

Backwalls: Good. Minor wear along tops with some small popouts at abut. 1.
Bridge Seats: Ok. Signif. support. Concrete sound below bearing.
Stems: Abutment #1 along the older concrete facing has areas of degradation with scaling and delamination; especially along the upstream end. The facing is still secure overall and structurally not a significant concern at present. The upstream wing does have some heavy scaling and cracking some of which is quite deep exposing laid up stone original wing material.
Wingwalls: * Heavy scaling and some break up along the southwest wing end. Facing was tapered increasing in width along the stem and downstream wing.
Footings: Nont in view.
Undermining: None.
Settlement: None. Ledge support assumed at least partially.

Piers < >

Bridge Seats:
Cap:
Shaft:
Columns:
Footings:
Undermining:
Settlement:

Alignment: Farly straight though bridge is skewed and abutments due jut out ward causing a restriction with channel contraction.
Scour: General scour with some ledge exposure.
Erosion: Heavy from Irene and has chronic highwater affects. Work currently underway downstream stabilizing bank protection.
Debris/Bars: Gravel bar below bridge but streambed at bridge is dynamic.
Protection: Stone added along the bridge corners to correct extensive erosion from TS Irene.
Waterway Opening: Open but certainly undersized hydraulicly due to short span length and abutment augmentation since const.

Posting: Yes No * Posted Loading @ Abut. 1: Abut. 2:

Posted Vert. Clr @ Abut. 1: Abut. 2:

Vert. Clr: Lt. Shoulder 10' - 0" Center 12' - 0" Rt. Shoulder Median 10' - 0"
Lt. Shoulder Center Rt. Shoulder

Measurements taken Heading: < >

Additional Signing Restriction: Covered bridge no tucks or buses - only sign at bridge. 10,000lbs. and No trucks at VT 100 intersection. * But no signs at bridge for weight restriction.

Summary: 08/31/2012 - The dilapidated approach rail system is quite poor and needs upgrading. Cedar shingle roof needs replacement. Bearing blocks have developed some decay. Most rotten blocks are not in bearing, with the exception of the front seat edge blocks. Abutment #2 (west) has some heavy facing deterioration and could use cleaning and patching. Consider installing low vertical clearance signs and load limit signs at each end of the bridge which conform to the MUTCD. ~ MJ/DK	**Deck:**	**7**
	Superstructure:	**6**
	Substructure:	**5**
	Channel:	**6**
	Approach:	**4**
	Paint:	**N**

Last Modified on: April 8, 2011

APPENDIX F

HYDROLOGIC AND HYDRAULIC ASSESSMENT FOR PROPOSED BRIDGE REHABILITATION

Hydrologic and Hydraulic Assessment for Proposed Bridge Rehabilitation

WARREN COVERED BRIDGE over the Mad River

Warren, Vermont

Prepared for:
Town of Warren, Vermont

Prepared by:

DuBois & King Inc.

October 21, 2013

D&K#: 621945

Hydrologic and Hydraulic Assessment for
Proposed Bridge Rehabilitation

WARREN COVERED BRIDGE
Over the Mad River

Warren, Vermont

TABLE OF CONTENTS

ATTACHMENTS

1.0 BACKGROUND

This report summarizes DuBois & King's hydrologic and hydraulic (H&H) study for the proposed rehabilitation of the Warren Covered Bridge on Covered Bridge Road over the Mad River in Warren, Vermont. A topographic survey was conducted in September 2013, and this information was used in the hydraulic modeling described in this report. Photographs and a site survey are included in Attachment A.

The existing bridge suffered damaged during Tropical Storm Irene on August 28-29, 2011. The bridge span measured between abutments is 41 feet at the upstream side and 44 feet at the downstream side (the abutments are not parallel), for an average span of approximately 42.5 feet. The bridge is skewed relative to the river, which reduces the average effective span for hydraulic purposes to approximately 40 feet. The vertical opening from the streambed to the low chord of the bridge is approximately 16 feet. The bridge is approximately 17 feet long from upstream to downstream. During Irene, river flows eroded the west roadway approach (left side, looking downstream) leaving the back-side of the left abutment exposed and a portion of the roadway destroyed.

The purpose of the project is to address several problems with the bridge. These problems include a heavily deteriorated west abutment, rotting bearing blocks, a leaking roof, and lack of appropriate approach rails. The purpose of this H&H study is to determine hydraulic conditions at the bridge, and to determine an appropriate location for the west abutment if replacement of the abutment is chosen over rehabilitation.

2.0 DESIGN CONSIDERATIONS

2.1 Hydraulic Capacity

Based on Vermont Agency of Transportation (VAOT) guidelines for Class 3 Town Highways, highway bridges over rivers and other bodies of water will, where practical, be designed to pass the 25-year peak discharge with 1.0 feet of headspace between the water surface and the bridge's low chord (lowest point on the bridges superstructure). In addition, overtopping of the road should not be permitted during the 25-year flood discharge. The guidelines also suggest that consideration be given to the potential effects of the 100-year peak discharge on upstream property, the environment, hazards to human life, and floodplain management criteria. These hydraulic design guidelines apply to open-water conditions. There are no guidelines for hydraulic capacity for ice-affected conditions.

2.2 Ice Jam Potential

There are no factors causing an elevated risk of ice jams at this bridge that would warrant additional design considerations beyond those applicable to open-water conditions.

2.3 Fluvial Geomorphology

Federal and State regulatory agencies require that bridge and culvert designs account for the fluvial geomorphic characteristics of rivers. The intent is to install crossings that maintain the hydraulic continuity through the bridge or culvert opening during bankfull or channel-forming

flow conditions. By doing so, sediment and ice transport processes as well as aquatic organism passage are more likely to be maintained. In general, this objective can be addressed by making bridge openings at least as wide as the natural bankfull channel width.

The U.S. Corps of Engineers Programmatic General Permit for Vermont (an umbrella permit that allows most wetland and river projects to avoid a separate Federal permit) requires that stream crossings be based on geomorphic and ecologic principles. The State Stream Alterations General Permit has similar requirements; a bridge span of no less than the bankfull width is required for coverage under the general permit. Shorter spans may be permissible under an individual permit if it can be shown that the fluvial geomorphic characteristics of the stream are accommodated.

The Vermont Agency of Natural Resources (VANR) developed Hydraulic Geometry Curves in 2006, which estimate stream geometric properties based on drainage area for bankfull or channel-forming flow conditions. These curves estimate a bankfull width of 56 feet for this site (Attachment B). However, the curves apply to alluvial channels with entirely mobile bed and bank materials. Presently there is an old timber crib dam located 300 feet downstream of the bridge, and the dam is located at the entrance to the ledge-lined Warren Gorge. Because of the dam and ledge, the channel is not fully alluvial, and the bankfull width predicted by the curves may not be appropriate.

2.4 Scour Potential

The primary bridge design factors that influence scour potential are the width of the bridge opening, the skew of the opening relative to direction of streamflow, and streambed material. Narrower openings and larger skews increase scour potential. Generally, designing to accommodate fluvial geomorphic considerations (i.e., accommodating bankfull width) also mitigates against excessive scour potential.

Abutment scour at the Warren Covered Bridge has not been evaluated. Based on a visual inspection and the new survey data, there appears to be scour along each abutment footing. To account for scour it is common practice in the State of Vermont to place the bottom of the abutment six feet below the streambed. With the expectation that the downstream timber crib dam will eventually fail and not be replaced, structurally tying the bridge abutment to ledge should be considered to avoid any future scour potential.

2.5 Impacts to Adjacent Structures

Stream crossings typically impact adjacent properties on the upstream side by creating backwater during high flows. They can also impact properties on the downstream side by directing overtopping flows toward structures.

At the Warren Covered Bridge site, there are several properties located upstream of the bridge. The alternatives being considered as part of this project will not increase the upstream flood levels. The alternative to replace the west bridge abutment a few feet west of its present location will actually decrease the upstream flood levels.

2.6 Flood Plain Regulations

Local municipalities regulate development within floodplains, following the requirements of the National Flood Insurance Program (NFIP). The effective flood insurance rate map (FIRM) for the Town of Warren is dated March 19, 2013. The bridge site is mapped as a flood hazard area Zone A1 (detailed study). The FIRM map is included in Attachment B.

The Town of Warren, as a participant in the NFIP, must follow the NFIP regulations, which require a local permit for proposed construction within the flood hazard area. As long as the replacement structure or repair would not cause an increase in flood levels during the 100-year base flood event, no additional permitting or FEMA clearance is required. Documentation (such as a copy of this report) that the replacement crossing would not cause an increase in the 100-year base flood elevation is typically included in the Town's records so it is available in the event of a FEMA audit, and can be available to inform permitting decisions regarding future proposed development near the crossing.

In addition, because the crossing is in an area mapped based on a detailed study, NFIP regulations require the Town to submit to FEMA within six months of construction, information (e.g., plans and hydraulic results) about the new crossing. In practice, on small and mid-size crossings, this submittal rarely occurs. The Town also has the option of applying for a Letter of Map Revision (LOMR) if there's a desire to formally document the new lower flood elevations. A LOMR is not required, and the reduction in flood elevation is rarely large enough for most communities to justify the cost of applying.

3.0 HYDROLOGY

The watershed at the Warren Covered Bridge is a steeply sloped basin that is primarily forested, with some areas of open space, residential development, and commercial development. The total contributing drainage area is about 27.6 square miles. The watershed area was measured using the USGS StreamStats on-line.

Peak river discharges for the storm events were estimated at the bridge site using the results published in the FEMA Flood Insurance Study (FIS) for Washington County, Vermont dated March 19, 2013. The FIS (from the HEC-2 model obtained from the FEMA Library) provided flows for the 10-, 50- 100- and 500-year events, and these estimates were used without modification. The 25-year flow was interpolated. The flows are summarized in Table 1, and documentation is included in Attachment B.

Table 1. Summary of Peak Discharges

Location	Drainage Area (sq mi)	Peak Discharges (cfs)				
		10-year	25-year	50-yr	100-year	500-year
Mad River at the Warren Covered Bridge	27.6	3090	3990	4590	5330	7210

4.0 HYDRAULICS

Hydraulic analysis for the proposed condition was performed using the HEC-RAS computer program. HEC-RAS calculates water surface profiles for steady gradually varied flow in natural or man-made channels. HEC-RAS has the capacity to model various obstructions such as bridges, culverts, weirs and other structures. The program computes a wide range of hydraulic variables for each peak discharge simulated including water surface elevation, velocity, and shear stress.

For this analysis, the starting water surface elevation at the downstream limit of the model was based on the assumption that critical depth occurs downstream of the dam in the steep ledge sections of the Warren gorge. The slope of Mad River downstream of the dam is approximately 0.016 ft/ft or 89 ft/mile. A USGS topographic map was used to measure the downstream slope.

Cross section geometry used in the model was based on field survey obtained from a study performed by the U.S. Army Corps of Engineers in March 2004 on the Mad River from the timber crib dam upstream to the VT Route 100 bridge. Additional survey of the Covered Bridge area was obtained in September 2013 and included in the model. Manning's "n" values (hydraulic roughness of the river channel and its overbanks) were assigned to the channel and overbanks on the basis of field observations, standard reference material. The "n" values of the streambed and overbanks were 0.045 and 0.060, respectively.

The existing bridge configuration and one proposed configuration were modeled. For each configuration, the following three river conditions were evaluated reflecting future changes to the downstream dam and movement of sediment stored upstream of it:

1. Current river conditions with the existing timber crib dam intact three hundred feet downstream of the bridge.
2. Timber crib dam no longer in place.
3. Timber crib dam no longer in place and accumulated sediment upstream of the dam scoured to an estimated new streambed elevation. The estimated bed elevation was based on evaluation of borings in the river that documented ledge elevation and, in some locations, an apparent layer of cobbles that may represent the original channel bed.

4.1 Existing Conditions

The existing structure was included in the existing conditions HEC-RAS model. The measured spans between abutments at the inlet and outlet sides (41 and 44 feet, respectively) were reduced in the model to account for the bridge's skew relative to the river to 39 and 41 feet, respectively. The vertical rise from the streambed to low chord varies significantly from 13 to 20 feet, and this variation was included in the model. Cross sections upstream and downstream of the structure were based the survey obtained in September 2013. It should also be noted that the west (left, looking downstream) roadway approach elevation (+/- 904.0 ft) is significantly lower than the east roadway approach elevation (+/- 908.0 ft). This left approach acts as a relief spillway for extreme flood events. The low chord of the structure is approximately 2.0 feet below the bridge deck elevation. The configuration is summarized in Table 2.

4.2 Proposed Conditions

One proposed bridge configuration, Alternative A, was modeled. Alternative A would entail reconstructing the west (left, looking downstream) abutment at a location 6 feet further west of the present location. Only one proposed bridge configuration is being considered because the existing bridge superstructure was not damaged during Tropical Storm Irene, and the existing abutment configuration allows the passage of all design storms (2-year through 100-year events) with more than adequate headspace between the low chord of the bridge and the flood elevation. Although the existing abutment configurations provide adequate hydraulic capacity, it is desirable to provide a greater channel opening if possible to better match the bankfull width. Widening the opening between the abutments by 6 feet is the only considered replacement alternative because this is the maximum amount the opening can be enlarged without altering the historic superstructure. The configuration of Alternative A is summarized in Table 2.

Table 2. Summary of Proposed Bridge Configurations

	Existing	**Alternative A**
Structure Type	Covered Bridge	Covered Bridge
Span Downstream/Upstream (ft)	44/41	50/47
Skew (degrees)	20	20
Hydraulic Width Downstream/Upstream(ft) [1]	41/39	47/45
Average Vertical Opening (ft)	16	16
Waterway Opening (sq. ft.)	609	693
Elevation of Low Chord [2], Left/Right	904.5/905.7	904.5/905.7
Elevation of roadway approach, Left/Right	904.0/908.0+/-	904.0/908.0+/-

[1] Accounting for skew of bridge relative to river.

[2] The values represent the lowest elevation at the left and right abutments. The low chord elevations are actually one foot higher than the values in the Table for a large portion of the bridge opening.

4.3 Results

The results of the hydraulic analysis are presented in Table 3 for the 25-year flood and Table 4 for the 100-year flood. Flood profiles and copy of the HEC-RAS summary output are included in Attachment C.

Table 3. Results of Hydraulic Analysis – 25-year Flood

Description	Existing	Alternative A
Current River Conditions with Timber Crib Dam Intact		
Water Surface Elevation (ft)	901.7	901.2
Headspace below low chord (ft) [1]	2.8	3.3
Water over Road?	No	No
River Velocity (fps)	10.6	9.1
No timber crib dam and current streambed		
Water Surface Elevation (ft)	901.2	900.6
Headspace below low chord (ft)	3.3	3.9
Water over Road?	No	No
River Velocity (fps)	11.5	10.0
No timber dam with future streambed		
Water Surface Elevation (ft)	897.8	897.7
Headspace below low chord (ft)	6.7	8.0
Water over Road?	No	No
River Velocity (fps)	15.5	14.9

[1]Headspace measured from lowest low chord elevation of 904.5 ft.

Table 4. Results of Hydraulic Analysis – 100-year Flood

Description	Existing	Alternative A
Current River Conditions with Timber Crib Dam Intact		
Water Surface Elevation (ft)	903.3	902.9
Headspace below low chord (ft) [1]	1.2	1.6
Water over Road?	No	No
River Velocity (fps)	12.8	10.9
No timber crib dam and current streambed		
Water Surface Elevation (ft)	903.2	902.3
Headspace below low chord (ft)	1.3	2.2
Water over Road?	No	No
River Velocity (fps)	13.7	11.8
No timber crib dam with future streambed		
Water Surface Elevation (ft)	900.3	899.7
Headspace below low chord (ft)	4.2	5.9
Water over Road?	No	No
River Velocity (fps)	16.6	16.1

[1]Headspace measured from lowest low chord elevation of 904.5 ft.

The existing condition and Alternative A models exceed the VAOT hydraulic capacity guidelines for Class #3 Town Highways for existing river conditions as well as the two dam scenarios that assume the timber crib dam is no longer present.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis presented in this report, we offer the following conclusions and recommendations:

1. The existing structure is adequately sized from a hydraulic perspective because it exceeds the VAOT guideline that the 25-year flood should pass with one foot of headspace between the low chord of the bridge and the estimated flood elevation.

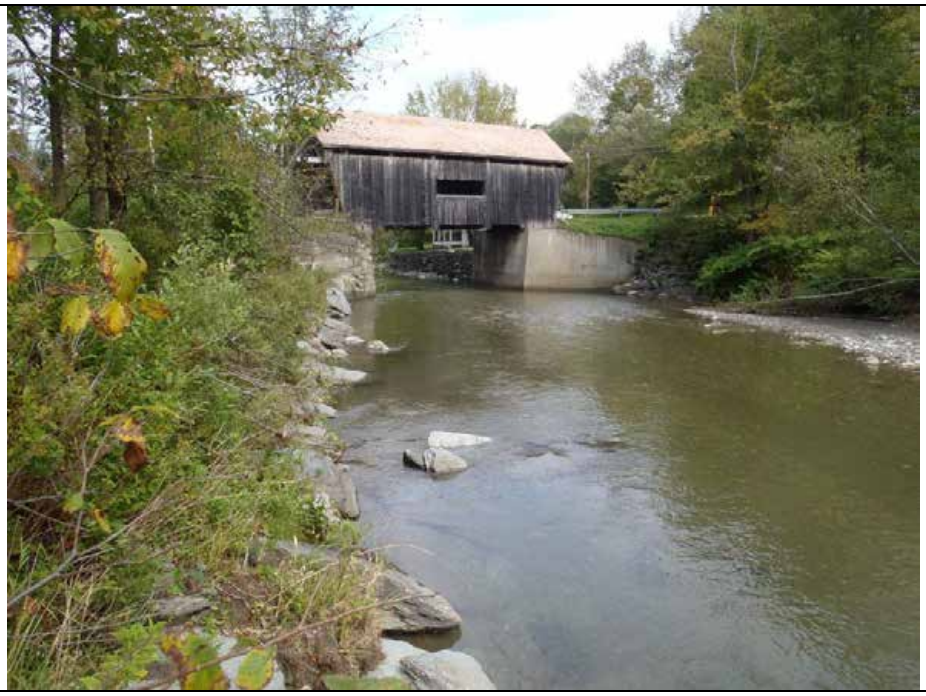
2. The existing structure is undersized from a fluvial geomorphic perspective. The span of the existing bridge is approximately 15 feet less than the 56-foot natural bankfull channel width. The proposed rehabilitation of the bridge structure would increase the span by six feet, but would still be less than the bankfull channel width. As noted in Section 2.3, this reach of the Mad River is transitioning from an alluvial stream setting to a ledge-lined gorge, and the predicted channel bankfull width may not be appropriate.

3. The future flow condition that assumes no timber crib dam with scour of the existing streambed shows a significant increase in the stream velocity. While the precise increase is difficult to estimate due to uncertainty in the profile and cross sectional dimensions of the future channel, the increase in velocity and scour potential is likely to be significant. We recommend that the abutments be structurally connected to underlying ledge to prevent damage due to scour.

4. The west (left, looking downstream) bridge approach is approximately four feet lower than the east approach. During extreme flood events, this area would overtop and potentially prevent flood flows from contacting the bridge structure. Repairs to the bridge should maintain the low left approach.

ATTACHMENT A

Mad River - Covered Bridge
Warren Vermont
Washington County



Mad River - Covered Bridge looking downstream. (Looking north).

Mad River - Covered Bridge looking east.

Mad River - Covered Bridge east abutment.

Mad River - Covered Bridge looking upstream

Mad River - Covered Bridge looking upstream

Mad River - Covered Bridge looking upstream at laid-up stone wall, east side of the stream.

Mad River - Covered Bridge looking down toward the dam.

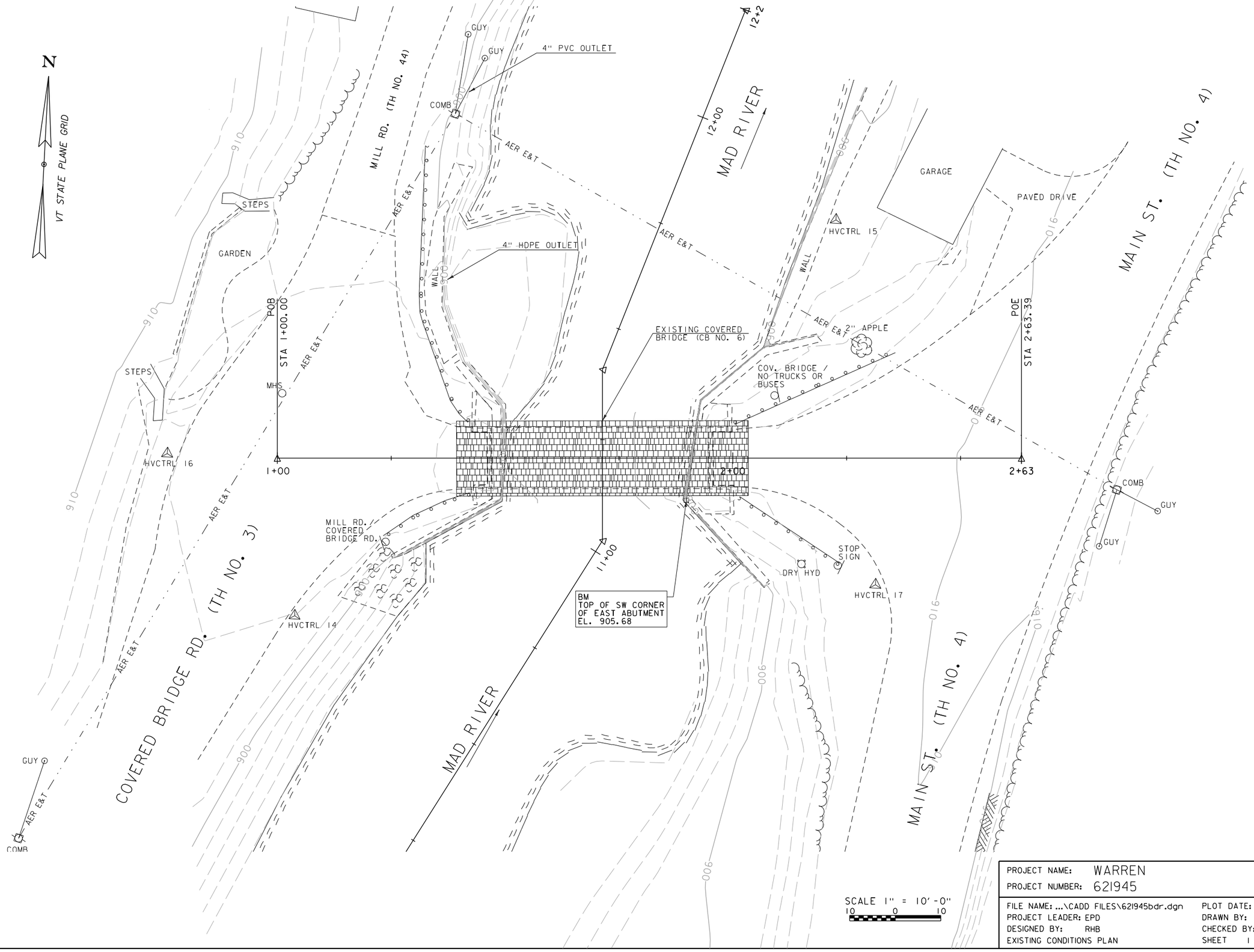
Mad River - Covered Bridge looking upstream (south).

Mad River - Covered Bridge looking downstream (north).

Mad River - Covered Bridge looking downstream (north).

Mad River - Covered Bridge looking downstream (north) at west abutment.

Mad River - Covered Bridge looking upstream at bridge.



PROJECT NAME:	WARREN
PROJECT NUMBER:	621945
FILE NAME: ...\CADD FILES\621945bdr.dgn	PLOT DATE: 10/21/2013
PROJECT LEADER: EPD	DRAWN BY: RHB
DESIGNED BY: RHB	CHECKED BY: EPD
EXISTING CONDITIONS PLAN	SHEET 1 OF 1

ATTACHMENT B

onal Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

METER

48 87 00

Town of Warren 500121

VAUGHN BROWN RD

TROUT HOLLOW RD

MAIN ST

Footbridge

PG0312

LUCE PIERCE RD

SCHOOL RD

DUMP RD

WESTON RD

ZONE AE

ZONE X

CEMETERY RD

PROFILE BASELINE

LIMIT OF DETAILED STUDY

Freeman Brook

BROOK RD

PG0313

ZONE A

COVERED BRIDGE RD

Dam

Timber Crib Dam

Covered Bridge

FULLER HILL RD

MAIN ST

Mad River

MURRAY HILL RD

LINCOLN GAP RD

PG0311

SNOW RD

BOBBIN MILL RD

JOINS PANEL 0527

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0526E

FIRM

FLOOD INSURANCE RATE MAP

WASHINGTON COUNTY, VERMONT
(ALL JURISDICTIONS)

PANEL 526 OF 580
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY	NUMBER	PANEL	SUFFIX
WARREN, TOWN OF	500121	0526	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
50023C0526E

EFFECTIVE DATE
MARCH 19, 2013

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Mad River Data File (HEC-2) from FEMA Engineering Library

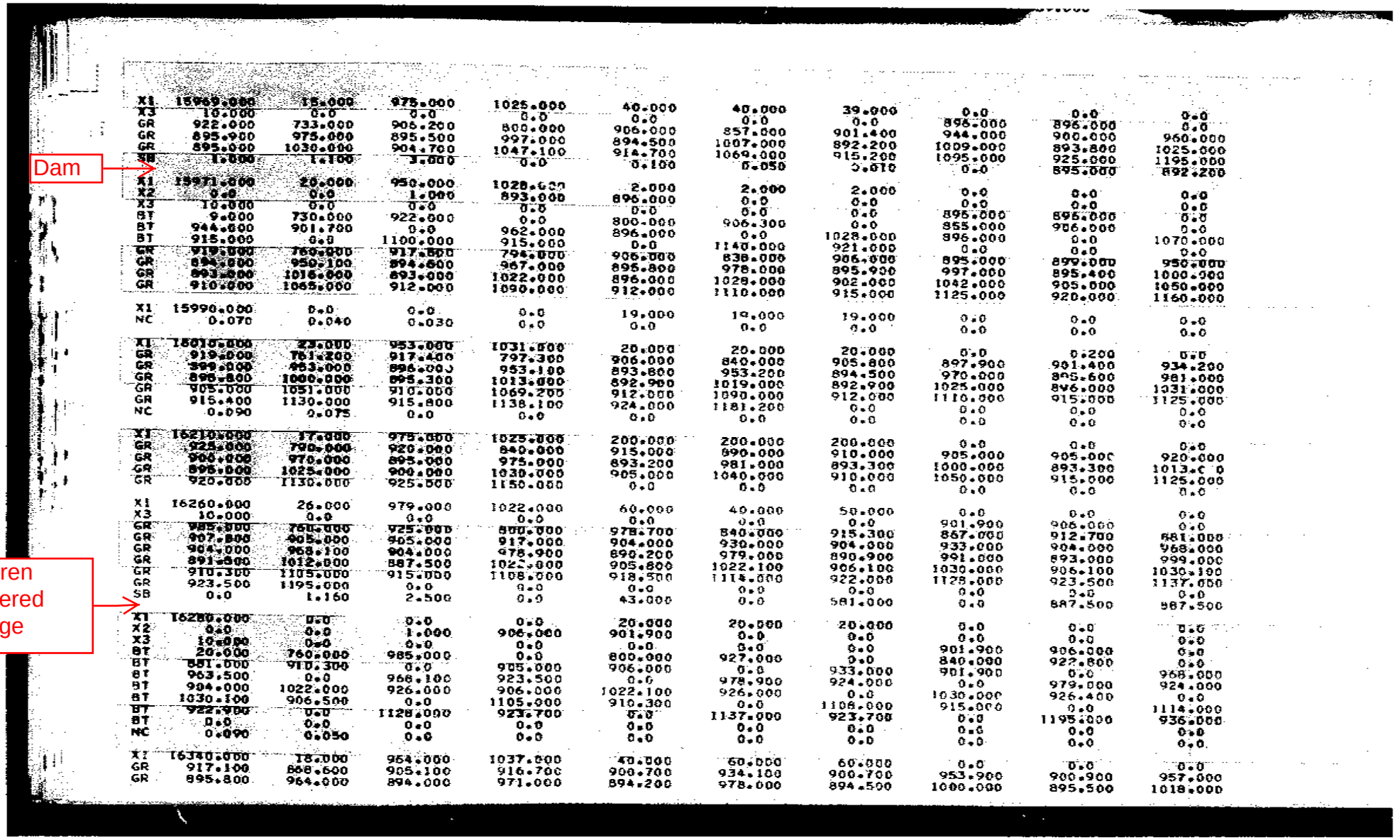
FINAL RUN
MAD RIVER
Multiple FLOOD

```
**********************************************
HEC2 VERSION UPDATED JAN 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09
MODIFICATIONS 52,53,54,55,56,57,58
**********************************************

T1 WARREN VT FLOOD INSURANCE STUDY                    2789-06
T2       TOWN  BOUNDARY D/S TO TOWN BOUNDARY U/S
T3              MAD RIVER      10-YR FLOOD

J1   ICHECK      INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
        0.        2.        0.        0.  0.004300       0.0       0.0       0.    765.000       0.0
J2   NPROF      IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE
     1.000       0.0      -1.000      0.0       0.0       0.0       0.0       0.0       0.0       0.0

J3       1.000     2.000     3.000     4.000     8.000    10.000    26.000     0.0       0.0       0.0
NC       0.070     0.035     0.050       0.0       0.0       0.0       0.0       0.0       0.0       0.0
OT       7.000  4556.000  6758.000  7857.000 10628.000  7857.000  7857.000  7857.000       0.0       0.0

X1         0.0      24.000   970.000  1030.000       0.0       0.0       0.0       0.0       0.0       0.0
GR     795.000   580.000   790.000   595.000   785.000   605.000   780.000   615.000   775.000   630.000
GR     770.000   640.000   765.000   755.000   765.000   915.000   760.000   965.000   760.000   970.000
GR     758.500   973.000   758.500  1027.000   760.000  1030.000   765.000  1035.000   770.000  1040.000
GR     775.000  1070.000   775.000  1145.000   770.000  1395.000   770.000  1420.000   775.000  1935.000
GR     780.000  2100.000   785.000  2170.000   790.000  2220.000   795.000  2280.000       0.0       0.0
NH       5.000     0.070   854.000     0.050   872.000     0.100  1013.000     0.050  1063.000     0.635
NH    1415.000       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0

X1       130.000    30.000   854.000  1064.000  1130.000  1130.000  1130.000       0.0       0.0       0.0
GR     800.500   173.300   772.500   237.900   770.300   328.600   774.100   633.600   771.200   686.200
GR     774.700   741.000   772.500   850.000   768.400   854.000   764.900   861.300   764.900   868.300
GR     767.800   873.000   775.000   905.000   774.200   936.000   774.000   948.000   773.800   961.000
GR     773.400   974.000   773.100   987.000   772.900  1000.000   768.200  1015.000   767.400  1033.000
GR     767.300  1046.000   767.200  1057.000   768.500  1064.000   773.000  1079.000   770.900  1125.200
GR     772.200  1170.600   779.400  1203.000   779.400  1228.200   781.600  1320.800   791.700  1414.700
NC       0.070     0.045     0.050     0.300     0.500       0.0       0.0       0.0       0.0       0.0

X1    2420.000    27.000   966.000  1030.000  2250.000  2050.000  2290.000       0.0       0.0       0.0
GR     816.600   435.000   803.400   485.400   789.500   528.900   789.500   568.300   789.500   682.100
GR     789.500   741.500   789.300   754.400   789.000   767.000   788.800   777.100   785.700   829.400
GR     782.000   880.800   784.500   935.800   784.500   939.000   778.300   958.000   778.300   986.000
GR     777.200   984.000   776.500  1000.000   777.300  1020.000   778.600  1030.000   782.800  1044.000
GR     791.700  1060.000   792.700  1086.300   792.700  1114.700   792.700  1136.100   792.700  1144.600
GR     792.700  1165.800   820.100  1217.200       0.0       0.0       0.0       0.0       0.0       0.0

X1    2479.000    25.000   967.000  1032.000    55.000    40.000    59.000       0.0       0.0       0.0
X3      10.000       0.0       0.0       0.0       0.0       0.0       0.0   792.000   791.900       0.0
GR     500.000   500.000   795.200   507.000   792.200   530.800   795.200   547.000   790.200   595.000
GR     790.200   650.000   790.200   752.000   790.000   937.000   788.700   958.000   787.800   966.900
GR     778.000   967.000   778.000   971.000   777.000   974.000   777.400  1000.000   778.500  1008.000
GR     779.000  1029.000   779.000  1032.000   788.000  1032.100   789.000  1048.000   790.000  1065.000
GR     790.000  1144.000   795.000  1150.000   800.000  1170.000   802.400  1195.000   818.000  1250.000
SB       0.0       1.190     2.500       0.0      65.000       0.0     617.500       0.0     777.000   777.000
```

X1	2801.000	0.0	0.0	0.0	22.000	22.000	22.000	0.0	0.0	0.0
X2	0.0	0.0	1.000	787.800	791.900	0.0	0.0	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	792.000	791.900	0.0
BT	15.000	500.000	804.000	0.0	530.000	792.000	0.0	595.000	792.000	0.0
BT	650.000	792.000	0.0	958.000	792.800	0.0	966.900	792.500	0.0	967.000
BT	792.500	787.500	971.000	792.300	787.500	1029.000	792.300	787.500	1032.000	792.200
DT	787.500	1032.100	792.200	0.0	1048.000	791.900	0.0	1144.000	792.000	0.0
BT	1170.000	799.000	0.0	1195.000	802.500	0.0	1250.000	818.000	0.0	0.0
NC	0.080	0.100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	2550.000	17.000	965.000	1028.000	40.000	50.000	49.000	0.0	0.0	0.0
GR	800.000	665.000	795.000	760.000	795.000	760.100	790.000	945.000	785.000	950.000
GR	780.000	955.000	778.500	965.000	777.500	984.000	777.200	1000.000	777.800	1012.000
GR	779.000	1028.000	780.000	1030.000	785.000	1110.000	790.000	1140.000	795.000	1150.000
GR	800.000	1175.000	805.000	1195.000	0.0	0.0	0.0	0.0	0.0	0.0
X1	3000.000	28.000	975.000	1020.000	450.000	450.000	450.000	0.0	0.0	0.0
GR	825.000	645.000	820.000	550.000	815.000	660.000	810.000	675.000	815.000	685.000
GR	815.000	780.000	810.000	765.000	805.000	788.000	800.000	800.000	795.000	828.000
GR	790.000	882.000	785.000	945.000	780.000	965.000	779.500	975.000	779.000	985.000
GR	779.000	1000.000	779.000	1005.000	779.500	1020.000	780.000	1035.000	785.000	1050.000
GR	790.000	1070.000	795.000	1115.000	800.000	1130.000	805.000	1135.000	810.000	1140.000
GR	815.000	1150.000	820.000	1160.000	825.000	1200.000	0.0	0.0	0.0	0.0
X1	3300.000	24.000	980.000	1020.000	300.000	300.000	300.000	0.0	0.0	0.0
GR	825.000	790.000	820.000	805.000	815.000	820.000	810.000	821.000	805.000	850.000
GR	800.000	880.000	795.000	890.000	790.000	895.000	785.000	910.000	785.000	940.000
GR	785.000	960.000	781.500	980.000	780.000	995.000	780.000	1005.000	782.000	1020.000
GR	785.000	1035.000	790.000	1080.000	795.000	1081.000	800.000	1090.000	805.000	1115.000
GR	810.000	1130.000	815.000	1140.000	820.000	1150.000	825.000	1170.000	0.0	0.0
NC	0.080	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	3800.000	11.000	952.000	1035.000	250.000	250.000	260.000	0.0	0.0	0.0
GR	810.200	665.300	789.800	916.200	789.700	944.000	784.700	952.000	783.300	979.000
GR	782.900	1000.000	783.000	1011.000	784.400	1035.000	788.400	1049.000	793.300	1075.200
GR	811.200	1121.800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NC	0.040	0.0	0.060	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DT	7.000	3982.000	5915.000	6857.000	9289.000	6857.000	6857.000	6857.000	0.0	0.0
X1	7240.000	30.000	932.000	1038.000	3000.000	3500.000	3680.000	0.0	0.0	0.0
GR	829.200	683.600	819.800	690.900	819.200	795.900	821.400	803.300	821.400	809.400
GR	822.000	830.600	822.900	838.000	816.300	851.400	815.700	874.000	807.200	892.500
GR	805.600	901.500	805.600	906.800	805.000	915.500	804.500	920.000	804.000	932.500
GR	802.400	940.000	803.600	948.000	805.600	949.000	806.000	961.000	804.400	980.000
GR	803.000	989.000	802.500	1000.000	802.800	1019.000	803.600	1038.000	808.400	1042.000
GR	809.000	1075.300	809.400	1099.400	815.400	1186.700	815.100	1248.000	873.300	1421.700
NC	0.045	0.090	0.050	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	9800.000	20.000	959.000	1028.000	2200.000	1900.000	2560.000	0.0	0.0	0.0
GR	841.800	715.400	841.600	715.400	833.300	747.600	835.200	822.600	833.800	893.900
GR	833.300	916.700	833.300	938.000	832.000	941.000	815.700	959.000	813.800	965.000
GR	814.000	973.000	814.000	1000.000	814.400	1010.000	814.600	1016.000	815.800	1028.000
GR	819.900	1045.000	823.200	1134.700	836.200	1246.700	834.900	1296.900	849.400	1410.900
NC	0.040	0.100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	12220.000	15.000	975.000	1035.000	1850.000	2340.000	2420.000	0.0	0.0	0.0
GR	865.000	938.000	860.000	945.000	865.000	950.000	830.800	975.000	829.800	983.000
GR	831.500	989.000	831.700	1000.000	830.100	1013.000	830.100	1028.000	830.600	1035.000
GR	835.000	1076.000	840.000	1095.000	845.000	1140.000	850.000	1170.000	860.000	1190.000
NC	0.070	0.0	0.070	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DT	7.000	3664.000	5443.000	6319.000	8548.000	6319.000	6319.000	6319.000	0.0	0.0

X1	13980.000	17.000	974.000	1029.000	1800.000	1420.000	1760.000	0.0	0.0	0.0
GR	874.300	906.000	870.000	930.000	865.000	935.000	850.000	965.000	844.100	970.000
GR	844.100	974.000	843.000	986.000	842.600	993.000	843.600	1000.000	842.300	1014.000
GR	842.200	1016.000	842.400	1029.000	850.000	1029.100	855.000	1032.000	860.000	1045.000
GR	870.000	1075.000	875.000	1105.000	0.0	0.0	0.0	0.0	0.0	0.0
X1	14026.000	29.000	976.000	1008.000	45.000	55.000	46.000	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	868.500	870.000	0.0
GR	925.000	600.000	889.000	833.000	875.000	855.000	874.000	861.000	867.000	905.000
GR	863.500	927.000	857.500	964.000	857.000	965.000	853.000	975.900	852.800	976.000
GR	852.000	978.000	845.000	985.000	836.700	990.000	835.600	1006.000	848.200	1005.100
GR	848.000	1008.000	848.000	1008.100	847.000	1013.000	852.000	1014.000	855.000	1014.100
GR	860.000	1017.000	865.000	1022.000	870.000	1037.000	875.000	1085.000	875.400	1087.000
GR	878.000	1106.000	880.000	1120.000	885.000	1180.000	915.000	1250.000	0.0	0.0
SB	0.0	1.140	2.500	0.0	16.000	0.0	992.000	0.0	835.600	835.600
X1	14054.000	0.0	0.0	0.0	28.000	28.000	28.000	0.0	0.0	0.0
X2	0.0	0.0	1.000	867.500	868.500	0.0	0.0	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	868.500	870.000	0.0
BT	15.000	600.000	925.000	0.0	833.000	889.000	0.0	855.000	875.000	0.0
BT	861.000	872.500	0.0	905.000	869.000	0.0	927.000	868.500	0.0	964.000
BT	859.500	0.0	976.900	870.300	0.0	976.000	873.700	867.500	1008.000	873.700
BT	867.500	1008.100	870.300	0.0	1087.000	870.000	0.0	1115.000	870.000	0.0
BT	1180.000	885.000	0.0	1250.000	915.000	0.0	0.0	0.0	0.0	0.0
NC	0.100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	14104.000	24.000	970.000	1023.000	50.000	40.000	50.000	0.0	0.0	0.0
GR	900.000	705.000	890.000	830.000	885.000	850.000	880.000	860.000	875.000	870.000
GR	870.000	910.000	865.000	945.000	860.000	970.000	855.000	973.000	844.500	980.000
GR	843.800	1000.000	844.200	1009.000	843.000	1023.000	850.000	1035.000	860.000	1035.100
GR	860.000	1050.000	865.000	1065.000	870.000	1070.000	875.000	1105.000	880.000	1125.000
GR	885.000	1200.000	890.000	1215.000	895.000	1220.000	900.000	1230.000	0.0	0.0
X1	14300.000	23.000	970.000	1025.000	210.000	160.000	196.000	0.0	0.0	0.0
GR	900.000	760.000	895.000	780.000	890.000	795.000	885.000	810.000	880.000	830.000
GR	875.000	865.000	870.000	890.000	865.000	930.000	860.000	960.000	850.000	970.000
GR	846.700	995.000	846.700	1015.000	850.000	1025.000	855.000	1030.000	860.000	1035.000
GR	865.000	1050.000	870.000	1065.000	875.000	1110.000	880.000	1150.000	885.000	1180.000
GR	890.000	1195.000	895.000	1225.000	900.000	1245.000	0.0	0.0	0.0	0.0
X1	14550.000	23.000	980.000	1015.000	250.000	250.000	250.000	0.0	0.0	0.0
GR	900.000	755.000	895.000	795.000	890.000	825.000	885.000	840.000	880.000	845.000
GR	875.000	900.000	870.000	935.000	865.000	950.000	860.000	965.000	853.000	980.000
GR	851.200	990.000	852.000	1000.000	853.000	1015.000	855.000	1030.000	860.000	1040.000
GR	865.000	1065.000	870.000	1130.000	875.000	1145.000	880.000	1160.000	885.000	1170.000
GR	890.000	1215.000	895.000	1250.000	900.000	1270.000	0.0	0.0	0.0	0.0
NC	0.090	0.080	0.060	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	14809.000	17.000	986.000	1016.000	240.000	250.000	250.000	0.0	0.0	0.0
GR	899.200	862.700	885.000	890.000	880.000	900.000	875.000	920.000	870.000	930.000
GR	865.000	955.000	861.100	984.000	857.900	988.000	856.700	995.000	855.700	1000.000
GR	856.200	1013.000	857.900	1016.000	860.000	1016.100	865.000	1026.000	870.000	1030.000
GR	875.000	1040.000	880.000	1045.000	0.0	0.0	0.0	0.0	0.0	0.0
NC	0.100	0.090	0.070	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QT	7.000	3089.000	4589.000	5327.000	7206.000	5327.000	5327.000	5327.000	0.0	0.0
X1	15930.000	9.000	961.700	1010.100	1050.000	1050.000	1130.000	0.0	0.0	0.0
GR	905.100	788.000	899.800	863.700	897.600	899.100	890.300	946.700	878.700	960.700
GR	875.500	961.700	879.900	1010.100	878.100	1030.400	903.900	1044.200	0.0	0.0
NC	0.0	0.0	0.0	0.400	0.600	0.0	0.0	0.0	0.0	0.0

FEMA FIS Flood Flows



X1	15969.000	15.000	975.000	1025.000	40.000	40.000	39.000	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	896.000	896.000	0.0
GR	922.000	733.000	906.200	800.000	906.000	857.000	901.400	944.000	900.000	960.000
GR	895.900	975.000	895.500	997.000	894.500	1007.000	892.200	1009.000	893.800	1025.000
GR	895.000	1030.000	904.700	1047.100	914.700	1069.000	915.200	1095.000	925.000	1195.000
SB	1.000	1.100	3.000	0.0	0.100	0.050	0.010	0.0	895.000	892.200
X1	15971.000	20.000	950.000	1028.600	2.000	2.000	2.000	0.0	0.0	0.0
X2	0.0	0.0	1.000	893.000	896.000	0.0	0.0	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	895.000	895.000	0.0
BT	9.000	730.000	922.000	0.0	800.000	906.300	0.0	855.000	906.000	0.0
BT	944.800	901.700	0.0	962.000	896.000	0.0	1028.000	896.000	0.0	1070.000
BT	915.000	0.0	1100.000	915.000	0.0	1140.000	921.000	0.0	0.0	0.0
GR	919.000	760.000	917.800	794.000	906.000	838.000	906.000	895.000	899.000	950.000
GR	894.000	950.100	894.600	967.000	895.800	978.000	895.900	997.000	895.400	1000.000
GR	893.000	1016.000	893.000	1022.000	896.000	1028.000	902.000	1042.000	905.000	1050.000
GR	910.000	1065.000	912.000	1090.000	912.000	1110.000	915.000	1125.000	920.000	1160.000
X1	15990.000	0.0	0.0	0.0	19.000	19.000	19.000	0.0	0.0	0.0
NC	0.070	0.040	0.030	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	16010.000	23.000	953.000	1031.600	20.000	20.000	20.000	0.0	0.200	0.0
GR	919.000	761.200	917.400	797.300	906.000	840.000	905.800	897.900	901.400	934.200
GR	899.000	963.000	896.000	953.100	893.800	953.200	894.500	970.000	895.600	981.000
GR	896.800	1000.000	895.300	1013.000	892.900	1019.000	892.900	1025.000	896.000	1031.000
GR	905.000	1051.000	910.000	1069.200	912.000	1090.000	912.000	1110.000	915.000	1125.000
GR	915.400	1130.000	915.800	1138.100	924.000	1181.200	0.0	0.0	0.0	0.0
NC	0.090	0.075	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	16210.000	17.000	975.800	1025.000	200.000	200.000	200.000	0.0	0.0	0.0
GR	925.000	790.000	920.000	840.000	915.000	890.000	910.000	905.000	905.000	920.000
GR	900.000	970.000	895.000	975.000	893.200	981.000	893.300	1000.000	893.300	1013.000
GR	895.000	1025.000	900.000	1030.000	905.000	1040.000	910.000	1050.000	915.000	1125.000
GR	920.000	1130.000	925.500	1150.000	0.0	0.0	0.0	0.0	0.0	0.0
X1	16260.000	26.000	979.000	1022.000	60.000	40.000	50.000	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	901.900	906.000	0.0
GR	985.000	760.000	925.000	800.000	978.700	840.000	915.300	867.000	912.700	881.000
GR	907.800	905.000	905.000	917.000	904.000	930.000	904.000	933.000	904.000	968.000
GR	904.000	968.100	904.000	978.900	898.200	979.000	898.900	991.000	893.000	999.000
GR	891.000	1012.000	887.500	1022.800	905.800	1022.100	906.100	1030.000	906.100	1030.100
GR	910.300	1105.000	915.000	1108.000	918.500	1114.000	922.000	1128.000	923.500	1137.000
GR	923.500	1195.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB	0.0	1.160	2.500	0.0	43.000	0.0	581.000	0.0	887.500	987.500
X1	16280.000	0.0	0.0	0.0	20.000	20.000	20.000	0.0	0.0	0.0
X2	0.0	0.0	1.000	906.000	901.900	0.0	0.0	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	901.900	906.000	0.0
BT	20.000	760.000	985.000	0.0	800.000	927.000	0.0	840.000	922.800	0.0
BT	881.000	910.300	0.0	905.000	906.000	0.0	933.000	901.900	0.0	968.000
BT	963.500	0.0	968.100	923.500	0.0	978.900	924.000	0.0	979.000	924.000
BT	904.000	1022.000	926.000	906.000	1022.100	926.000	0.0	1030.000	926.400	0.0
BT	1030.100	906.500	0.0	1105.000	910.300	0.0	1106.000	915.000	0.0	1114.000
BT	922.900	0.0	1128.000	923.700	0.0	1137.000	923.708	0.0	1195.000	936.000
BT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NC	0.090	0.050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	16340.000	18.000	954.000	1037.600	40.000	60.000	60.000	0.0	0.0	0.0
GR	917.100	868.600	905.100	916.700	900.700	934.100	900.700	953.900	900.900	957.000
GR	895.800	964.000	894.000	971.000	894.200	978.000	894.500	1000.000	895.500	1018.000

Dam

Warren Covered Bridge

GR	895.800	1037.000	897.100	1047.000	899.000	1065.000	899.800	1070.000	909.200	1088.400
GR	908.600	1093.100	908.600	1113.600	925.600	1140.800	0.0	0.0	0.0	0.0
NC	0.060	0.0	0.050	0.300	0.500	0.0	0.0	0.0	0.0	0.0
X1	16600.000	19.000	970.000	1030.000	270.000	250.000	260.000	0.0	0.0	0.0
GR	925.000	905.000	920.000	910.000	915.000	912.000	910.000	930.000	905.000	935.000
GR	900.000	965.000	897.600	970.000	894.000	998.000	893.500	1000.000	893.500	1020.000
GR	894.000	1025.000	894.500	1030.000	895.000	1035.000	900.000	1045.000	905.000	1135.000
GR	910.000	1160.000	915.000	1295.000	920.000	1345.000	925.000	1400.000	0.0	0.0
X1	17180.000	23.000	971.000	1041.000	550.000	570.000	580.000	0.0	0.0	0.0
GR	924.400	741.000	908.900	770.700	908.600	800.000	908.600	816.100	906.100	854.800
GR	906.100	903.800	904.200	956.300	901.000	968.700	901.200	971.000	898.000	971.100
GR	896.400	980.000	896.600	992.000	897.000	1000.000	897.300	1018.000	895.800	1033.000
GR	898.000	1041.000	900.400	1041.100	905.500	1061.200	908.900	1072.100	908.900	1091.400
GR	916.200	1108.100	916.200	1134.500	922.100	1196.700	0.0	0.0	0.0	0.0
NC	0.080	0.090	0.080	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	17990.000	18.000	988.000	1010.000	700.000	900.000	810.000	0.0	0.0	0.0
GR	925.000	850.000	920.000	910.000	915.000	935.000	910.000	950.000	905.000	960.000
GR	902.500	984.000	902.100	988.000	899.300	988.100	901.500	996.000	900.300	1000.000
GR	900.900	1003.000	901.500	1010.000	902.900	1040.000	911.300	1056.000	914.300	1066.700
GR	918.700	1101.000	919.000	1130.200	931.000	1165.400	0.0	0.0	0.0	0.0
NC	0.070	0.100	0.070	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	18291.000	19.000	975.000	1015.000	300.000	300.000	301.000	0.0	-2.000	0.0
GR	935.000	830.000	930.000	930.000	925.000	940.000	920.000	950.000	915.000	960.000
GR	910.000	970.000	905.000	975.000	903.300	982.000	902.000	996.000	905.000	1002.000
GR	905.000	1010.000	905.000	1015.000	910.000	1040.000	915.000	1050.000	920.000	1050.000
GR	925.000	1100.000	930.000	1125.000	935.000	1165.000	940.000	1175.000	0.0	0.0
X1	18341.000	26.000	955.000	1067.000	50.000	50.000	50.000	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	930.400	928.000	0.0
GR	940.000	810.000	935.000	838.000	934.000	854.000	953.800	860.000	930.000	935.000
GR	925.000	945.000	924.500	954.900	924.500	955.000	915.700	988.000	909.800	988.100
GR	909.800	994.000	901.100	994.100	902.100	1000.000	902.600	1004.000	904.100	1012.000
GR	906.100	1012.100	907.800	1033.000	907.800	1040.000	922.500	1067.000	922.500	1067.100
GR	922.600	1085.000	925.000	1104.000	930.000	1129.000	935.000	1168.000	939.000	1178.000
GR	940.000	1180.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB	0.900	1.220	2.500	0.0	16.000	9.000	1389.000	1.900	901.100	901.100
X1	18379.000	0.0	0.0	0.0	38.000	38.000	38.000	0.0	0.0	0.0
X2	0.0	0.0	1.000	925.900	928.000	0.0	0.0	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	930.400	928.000	0.0
ST	10.000	700.000	958.500	0.0	854.000	932.400	0.0	860.000	931.000	0.0
BT	954.900	931.000	0.0	955.000	931.000	925.900	1067.000	928.000	923.800	1067.100
BT	928.000	0.0	1178.000	928.000	0.0	1194.000	941.200	0.0	1233.000	950.000
BT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NC	0.090	0.080	0.050	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	18460.000	12.000	978.000	1013.000	40.000	60.000	61.000	0.0	0.0	0.0
GR	933.200	940.400	932.700	948.900	932.200	972.000	910.100	975.000	906.800	978.000
GR	905.200	985.000	903.600	1000.000	905.300	1004.000	906.600	1013.000	910.800	1025.000
GR	927.900	1060.000	951.400	1207.800	0.0	0.0	0.0	0.0	0.0	0.0
X1	18500.000	0.0	0.0	0.0	60.000	60.000	60.000	0.0	0.200	0.0
X1	18650.000	19.000	980.000	1020.000	220.000	70.000	150.000	0.0	0.0	0.0
GR	940.000	810.000	935.000	830.000	930.000	840.000	925.000	850.000	925.000	865.000
GR	925.000	895.000	920.000	908.000	915.000	910.000	910.000	975.000	908.000	980.000
GR	906.000	990.000	904.800	1000.000	906.000	1010.000	908.000	1020.000	915.000	1025.000

GR	[illegible]	[illegible]	925.000	1050.000	930.000	1110.000	950.000	1120.000	0.0	0.0
MC	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X1	19770.000	15.000	985.000	1023.000	1020.000	1070.000	1120.000	0.0	0.0	0.0
GR	945.000	840.000	940.000	870.000	930.000	920.000	925.300	938.000	925.000	950.000
GR	921.300	983.000	919.300	985.000	917.800	998.000	918.000	1000.000	918.700	1009.000
GR	[illegible]	[illegible]	917.900	1021.000	918.900	1023.000	919.600	1037.800	960.900	1109.200
EJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
**********
HEC-2 VERSION UPDATED JAN 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09
MODIFICATIONS 52,53,54,55,56,57,58
**********

T1 WARREN VT FLOOD INSURANCE STUDY                    2789-06
T2        PLOT  BOUNDARY D/S TO TOWN BOUNDARY U/S
T3             MAD RIVER      50-YR FLOOD

J1   ICHECK      INQ        NINV       IDIR       STRT      METRIC     HVINS      Q          WSEL       FQ
          0.         3.         0.         0.  0.004300        0.0        0.0        0.     768.000      0.0
J2   NPROF      IPLOT      PRFVS      XSECV      XSECH         FN      ALLOC        IBW      CHNTM      ITRACE
     2.000        0.0     -1.000        0.0        0.0        0.0        0.0        0.0        0.0        0.0
```

```
**********
HEC2 VERSION UPDATED JAN 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,09,09
MODIFICATIONS 52,53,54,55,56,57,58
**********
T1 WARREN VT FLOOD INSURANCE STUDY                    2789-06
T2      PLOT  BOUNDARY D/S TO TOWN BOUNDARY U/S
T3            MAD RIVER    100-YR FLOOD
J1   ICHECK     INQ      NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ
        0.        4.        0.        0.  0.004300      0.0       0.0         0.    770.000     0.0
J2   NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLOC     IBW       CHNIM     ITRACE
     3.000       0.0    -1.000       0.0       0.0       0.0       0.0       0.0       0.0       0.0
```

```
**********************************************
HEC2 VERSION UPDATED JAN 1976
ERROR CORRECTIONS 01,02,03,04,05,06,07,08,09
MODIFICATIONS 52,53,54,55,56,57,58
**********************************************

T1 WARREN VT FLOOD INSURANCE STUDY          7YR50-06
T2       PLOT  BOUNDARY D/S TO TOWN BOUNDARY U/S
T3             MAD RIVER    500-YR FLOOD

J1   ICHECK    INQ        NINV       IDIR       STRT      METRIC     HVINS      O          WSEL       FQ
          0.         5.         0.         0.  0.004300      0.0        0.0        0.     773.000     0.0
J2   NPROF      IPLOT      PRFVS      XSECV      XSECH      FN        ALLOC      IBW        CHNIM      ITRACE
       15.000     0.0       -1.000      0.0        0.0       0.0        0.0        0.0        0.0        0.0
```

SUMMARY PRINTOUT FOR MULTIPLE PROFILES

MAD RIVER 500-

SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE %CFS<	CWSEL	CRIWS	EG	TOPWID	DEPTH	HV	VCH
0.0	0.0	0.0	0.0	758.50	4556.00	766.15	0.0	766.84	307.71	7.65	0.69	7.50
0.0	0.0	0.0	0.0	758.50	6768.00	767.41	0.0	768.15	337.86	8.91	0.74	8.23
0.0	0.0	0.0	0.0	758.50	7857.00	767.92	0.0	768.69	350.06	9.42	0.77	8.54
0.0	0.0	0.0	0.0	758.50	10628.00	769.04	0.0	769.88	375.94	10.54	0.86	9.23
1130.00	1130.00	0.0	0.0	764.90	4556.00	772.64	0.0	773.26	541.71	7.74	0.62	7.18
1130.00	1130.00	0.0	0.0	764.90	6768.00	773.50	0.0	774.04	732.48	8.60	0.54	7.01
1130.00	1130.00	0.0	0.0	764.90	7857.00	773.86	0.0	774.37	809.77	8.96	0.50	6.84
1130.00	1130.00	0.0	0.0	764.90	10628.00	774.66	0.0	775.10	932.13	9.76	0.44	6.31
2420.00	2290.00	0.0	0.0	776.80	4556.00	784.92	0.0	786.60	207.59	8.12	0.67	7.25
2420.00	2290.00	0.0	0.0	776.80	6768.00	785.98	0.0	786.92	225.42	9.18	0.93	8.75
2420.00	2290.00	0.0	0.0	776.80	7857.00	786.38	0.0	787.44	233.31	9.58	1.07	9.43
2420.00	2290.00	0.0	0.0	776.80	10628.00	787.14	0.0	788.59	248.50	10.35	1.45	11.16
2479.00	59.00	0.0	0.0	777.00	4556.00	784.79	0.0	786.42	65.00	7.79	1.63	10.25
2479.00	59.00	0.0	0.0	777.00	6768.00	785.41	0.0	788.44	65.00	8.41	3.03	13.97
2479.00	59.00	0.0	0.0	777.00	7857.00	785.61	785.61	789.48	65.00	8.61	3.88	15.80
2479.00	59.00	0.0	0.0	777.00	10628.00	787.32	787.32	792.06	65.00	10.32	4.74	17.47
2501.00	22.00	791.90	787.50	777.00	4556.00	785.24	0.0	786.68	65.00	8.24	1.44	9.63
2501.00	22.00	791.90	787.50	777.00	6768.00	786.85	0.0	788.98	65.00	9.85	2.13	11.72
2501.00	22.00	791.90	787.50	777.00	7857.00	787.91	0.0	790.39	65.00	10.91	2.49	12.65
2501.00	22.00	791.90	787.50	777.00	10628.00	789.13	0.0	792.45	65.00	12.13	3.33	14.64
2550.00	49.00	0.0	0.0	777.20	4556.00	786.67	0.0	787.16	171.67	9.47	0.49	6.16
2550.00	49.00	0.0	0.0	777.20	6768.00	789.10	0.0	789.64	188.72	11.90	0.54	6.63
2550.00	49.00	0.0	0.0	777.20	7857.00	790.69	0.0	791.18	222.04	13.49	0.49	6.46
2550.00	49.00	0.0	0.0	777.20	10628.00	792.93	0.0	793.45	309.09	15.74	0.52	6.93
3000.00	450.00	0.0	0.0	779.00	4556.00	787.84	0.0	788.42	152.15	8.84	0.58	7.04
3000.00	450.00	0.0	0.0	779.00	6768.00	790.08	0.0	790.71	189.69	11.08	0.62	7.54
3000.00	450.00	0.0	0.0	779.00	7857.00	791.47	0.0	792.03	217.06	12.47	0.56	7.24
3000.00	450.00	0.0	0.0	779.00	10628.00	793.63	0.0	794.21	259.95	14.63	0.58	7.51
3300.00	300.00	0.0	0.0	780.00	4556.00	788.87	0.0	789.55	171.44	8.87	0.68	7.80
3300.00	300.00	0.0	0.0	780.00	6768.00	790.92	0.0	791.62	186.11	10.93	0.70	7.98
3300.00	300.00	0.0	0.0	780.00	7857.00	792.12	0.0	792.78	187.55	12.12	0.65	7.75
3300.00	300.00	0.0	0.0	780.00	10628.00	794.17	0.0	794.90	190.01	14.17	0.72	8.12
3560.00	260.00	0.0	0.0	782.90	4556.00	790.02	0.0	790.99	141.85	7.12	0.98	8.10
3560.00	260.00	0.0	0.0	782.90	6768.00	791.76	0.0	792.95	154.27	8.86	1.19	9.12
3560.00	260.00	0.0	0.0	782.90	7857.00	792.76	0.0	793.96	161.41	9.86	1.20	9.22
3560.00	260.00	0.0	0.0	782.90	10628.00	794.67	0.0	796.01	171.29	11.78	1.33	9.89
7240.00	3680.00	0.0	0.0	802.40	3982.00	809.25	0.0	809.69	202.72	6.85	0.44	5.02
7240.00	3680.00	0.0	0.0	802.40	5915.00	810.48	0.0	811.07	229.78	8.08	0.59	5.80
7240.00	3680.00	0.0	0.0	802.40	6857.00	810.86	0.0	811.55	236.06	8.46	0.69	6.28
7240.00	3680.00	0.0	0.0	802.40	9289.00	811.96	0.0	812.84	254.58	9.57	0.87	7.06

SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE %CFSC	CWSEL	CRIWS	EG	TOPWID	DEPTH	MV	VCH
9800.00	2560.00	0.0	0.0	813.80	3982.00	821.16	0.0	822.09	126.36	7.36	0.93	7.95
9800.00	2560.00	0.0	0.0	813.80	5915.00	822.66	0.0	823.89	163.55	8.86	1.23	9.30
9800.00	2560.00	0.0	0.0	813.80	6857.00	823.38	0.0	824.67	185.70	9.58	1.30	9.67
9800.00	2560.00	0.0	0.0	813.80	9289.00	824.75	0.0	826.27	199.04	10.95	1.52	10.74
12220.00	2420.00	0.0	0.0	829.80	3982.00	836.92	835.50	838.01	110.96	7.12	1.09	8.97
12220.00	2420.00	0.0	0.0	829.80	5915.00	838.53	0.0	839.91	120.61	8.73	1.38	10.23
12220.00	2420.00	0.0	0.0	829.80	6857.00	839.12	0.0	840.67	124.17	9.32	1.56	10.90
12220.00	2420.00	0.0	0.0	829.80	9289.00	840.62	0.0	842.52	135.63	10.82	1.90	12.18
13980.00	1760.00	0.0	0.0	842.20	3664.00	851.02	0.0	851.89	66.74	8.82	0.87	7.62
13980.00	1760.00	0.0	0.0	842.20	5443.00	852.83	0.0	854.07	71.41	10.63	1.24	9.13
13980.00	1760.00	0.0	0.0	842.20	6319.00	853.71	0.0	855.09	73.67	11.51	1.38	9.68
13980.00	1760.00	0.0	0.0	842.20	8548.00	855.53	0.0	857.31	79.45	13.33	1.78	11.03
14026.00	46.00	0.0	0.0	835.60	3664.00	850.99	0.0	853.13	28.99	15.39	2.13	13.72
14026.00	46.00	0.0	0.0	835.60	5443.00	852.35	0.0	856.04	30.88	16.75	3.69	15.42
14026.00	46.00	0.0	0.0	835.60	6319.00	852.94	0.0	857.43	32.00	17.34	4.49	17.00
14026.00	46.00	0.0	0.0	835.60	8548.00	854.32	854.32	860.88	32.00	18.72	6.57	20.57
14054.00	28.00	868.50	867.50	835.60	3664.00	852.11	0.0	853.86	30.28	16.51	1.75	10.60
14054.00	28.00	868.50	867.50	835.60	5443.00	854.71	0.0	857.22	32.00	19.11	2.51	12.72
14054.00	28.00	868.50	867.50	835.60	6319.00	856.01	0.0	858.82	32.00	20.41	2.81	13.45
14054.00	28.00	868.50	867.50	835.60	8548.00	859.43	854.28	862.81	32.00	23.83	3.38	14.76
14104.00	50.00	0.0	0.0	843.00	3664.00	853.95	0.0	854.66	61.35	10.95	0.71	6.99
14104.00	50.00	0.0	0.0	843.00	5443.00	857.38	0.0	858.19	63.50	14.38	0.81	7.49
14104.00	50.00	0.0	0.0	843.00	6319.00	859.00	0.0	859.85	64.49	16.00	0.85	7.65
14104.00	50.00	0.0	0.0	843.00	8548.00	863.07	0.0	863.93	104.54	20.07	0.86	7.82
14300.00	196.00	0.0	0.0	846.70	3664.00	855.32	0.0	856.45	65.63	8.62	1.14	8.64
14300.00	196.00	0.0	0.0	846.70	5443.00	858.39	0.0	859.59	71.78	11.69	1.20	8.96
14300.00	196.00	0.0	0.0	846.70	6319.00	859.80	0.0	861.10	74.78	13.19	1.21	9.03
14300.00	196.00	0.0	0.0	846.70	8548.00	863.69	0.0	864.85	108.27	16.99	1.16	8.96
14550.00	250.00	0.0	0.0	851.20	3664.00	858.99	0.0	860.93	70.82	7.79	1.94	12.15
14550.00	250.00	0.0	0.0	851.20	5443.00	860.91	0.0	863.15	82.30	9.71	2.24	13.31
14550.00	250.00	0.0	0.0	851.20	6319.00	862.00	0.0	864.18	90.99	10.80	2.19	13.31
14550.00	250.00	0.0	0.0	851.20	8548.00	865.07	0.0	866.89	116.19	13.87	1.82	12.56
14800.00	250.00	0.0	0.0	855.70	3664.00	864.61	864.61	867.53	67.30	8.91	2.92	14.40
14800.00	250.00	0.0	0.0	855.70	5443.00	866.70	866.70	869.78	80.84	11.00	3.09	15.42
14800.00	250.00	0.0	0.0	855.70	6319.00	867.41	867.41	870.73	84.97	11.71	3.32	16.19
14800.00	250.00	0.0	0.0	855.70	8548.00	869.11	869.11	872.84	94.86	13.41	3.73	17.62
15930.00	1130.00	0.0	0.0	875.50	3089.00	884.27	0.0	885.07	79.71	8.77	0.80	7.71
15930.00	1130.00	0.0	0.0	875.50	4589.00	885.67	0.0	886.81	82.16	10.17	1.15	9.24
15930.00	1130.00	0.0	0.0	875.50	5327.00	886.42	0.0	887.68	83.47	10.92	1.26	9.72
15930.00	1130.00	0.0	0.0	875.50	7206.00	888.04	0.0	889.62	86.30	12.54	1.57	10.91

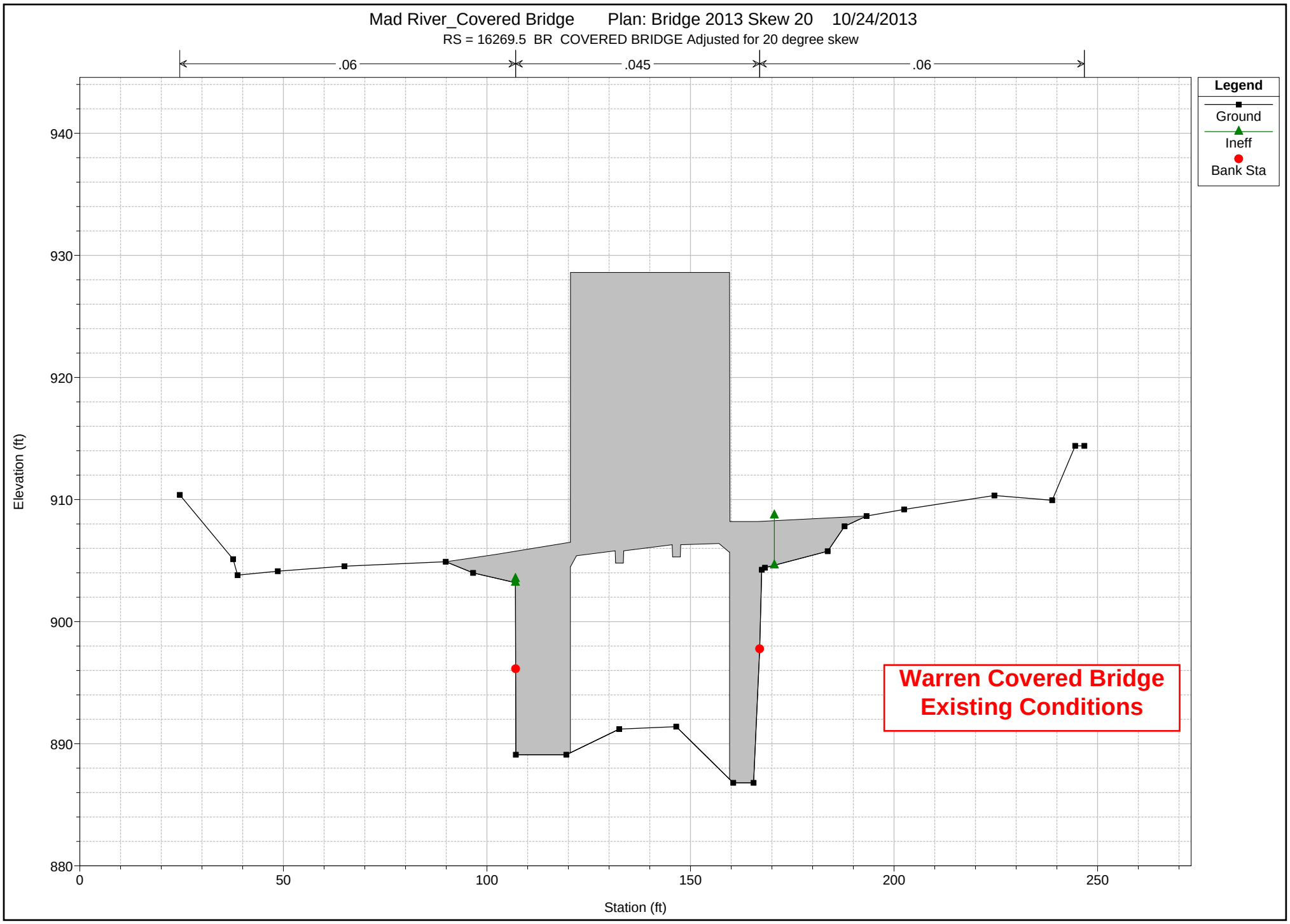
SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE (CFS)	CWSEL	CRIWS	EG	TOPWID	DEPTH	HV	VCH
15969.00	39.00	0.0	0.0	892.20	3089.00	899.14	899.14	901.17	74.17	6.94	2.03	11.97
15969.00	39.00	0.0	0.0	892.20	4589.00	900.46	900.46	902.96	84.84	8.26	2.50	13.38
15969.00	39.00	0.0	0.0	892.20	5327.00	901.04	901.04	903.71	92.51	8.84	2.68	13.92
15969.00	39.00	0.0	0.0	892.20	7206.00	902.46	902.46	905.37	119.32	10.27	2.91	14.78
15971.00	2.00	896.00	893.00	893.00	3089.00	901.24	0.0	901.76	107.88	8.24	0.52	5.89
15971.00	2.00	896.00	893.00	893.00	4589.00	902.55	0.0	903.30	121.40	9.55	0.75	7.12
15971.00	2.00	896.00	893.00	893.00	5327.00	903.06	0.0	903.92	126.71	10.06	0.87	7.68
15971.00	2.00	896.00	893.00	893.00	7206.00	904.24	0.0	905.37	139.20	11.24	1.13	8.86
15990.00	19.00	0.0	0.0	893.00	3089.00	901.41	0.0	901.90	109.56	8.41	0.49	5.73
15990.00	19.00	0.0	0.0	893.00	4589.00	902.77	0.0	903.47	123.65	9.77	0.70	6.90
15990.00	19.00	0.0	0.0	893.00	5327.00	903.29	0.0	904.10	129.21	10.29	0.81	7.43
15990.00	19.00	0.0	0.0	893.00	7206.00	904.53	0.0	905.58	142.25	11.53	1.04	8.54
16010.00	20.00	0.0	0.0	893.10	3089.00	901.44	0.0	901.98	107.18	8.34	0.54	5.98
16010.00	20.00	0.0	0.0	893.10	4589.00	902.79	0.0	903.57	121.31	9.69	0.77	7.21
16010.00	20.00	0.0	0.0	893.10	5327.00	903.32	0.0	904.21	126.82	10.22	0.89	7.78
16010.00	20.00	0.0	0.0	893.10	7206.00	904.55	0.0	905.72	139.69	11.45	1.18	8.99
16210.00	200.00	0.0	0.0	893.20	3089.00	901.59	0.0	902.46	79.11	8.39	0.87	7.55
16210.00	200.00	0.0	0.0	893.20	4589.00	902.90	0.0	904.26	94.82	9.70	1.36	9.52
16210.00	200.00	0.0	0.0	893.20	5327.00	903.40	0.0	905.02	100.85	10.20	1.63	10.43
16210.00	200.00	0.0	0.0	893.20	7206.00	904.54	0.0	906.82	114.53	11.34	2.29	12.46
16260.00	50.00	0.0	0.0	887.50	3089.00	901.90	0.0	902.58	43.09	14.40	0.68	6.64
16260.00	50.00	0.0	0.0	887.50	4589.00	903.19	0.0	904.40	43.09	15.69	1.21	8.81
16260.00	50.00	0.0	0.0	887.50	5327.00	903.65	0.0	905.15	43.10	16.15	1.51	9.86
16260.00	50.00	0.0	0.0	887.50	7206.00	904.62	0.0	906.98	100.06	17.12	2.36	12.35
16280.00	20.00	901.90	906.00	887.50	3089.00	901.91	0.0	902.60	43.09	14.41	0.68	6.64
16280.00	20.00	901.90	906.00	887.50	4589.00	903.22	0.0	904.42	43.09	15.72	1.20	8.79
16280.00	20.00	901.90	906.00	887.50	5327.00	903.69	0.0	905.19	43.10	16.19	1.50	9.83
16280.00	20.00	901.90	906.00	887.50	7206.00	904.65	0.0	907.04	100.54	17.16	2.39	12.42
16340.00	60.00	0.0	0.0	894.00	3089.00	902.45	0.0	902.78	148.06	8.45	0.33	4.87
16340.00	60.00	0.0	0.0	894.00	4589.00	904.37	0.0	904.79	159.38	10.37	0.41	5.54
16340.00	60.00	0.0	0.0	894.00	5327.00	905.21	0.0	905.66	164.33	11.21	0.45	5.82
16340.00	60.00	0.0	0.0	894.00	7206.00	907.35	0.0	907.86	177.06	13.35	0.51	6.29
16600.00	260.00	0.0	0.0	893.50	3089.00	902.70	0.0	903.06	144.83	9.20	0.36	5.14
16600.00	260.00	0.0	0.0	893.50	4589.00	904.64	0.0	905.04	191.35	11.14	0.40	5.61
16600.00	260.00	0.0	0.0	893.50	5327.00	905.52	0.0	905.91	203.12	12.02	0.39	5.67
16600.00	260.00	0.0	0.0	893.50	7206.00	907.75	0.0	908.10	216.48	14.25	0.36	5.56
17180.00	580.00	0.0	0.0	895.80	3089.00	903.98	0.0	904.51	98.02	8.18	0.54	5.97
17180.00	580.00	0.0	0.0	895.80	4589.00	905.76	0.0	906.42	148.85	9.96	0.66	6.76
17180.00	580.00	0.0	0.0	895.80	5327.00	906.53	0.0	907.22	216.48	10.74	0.68	6.96
17180.00	580.00	0.0	0.0	895.80	7206.00	908.50	0.0	909.10	253.15	12.70	0.60	6.88

59.000

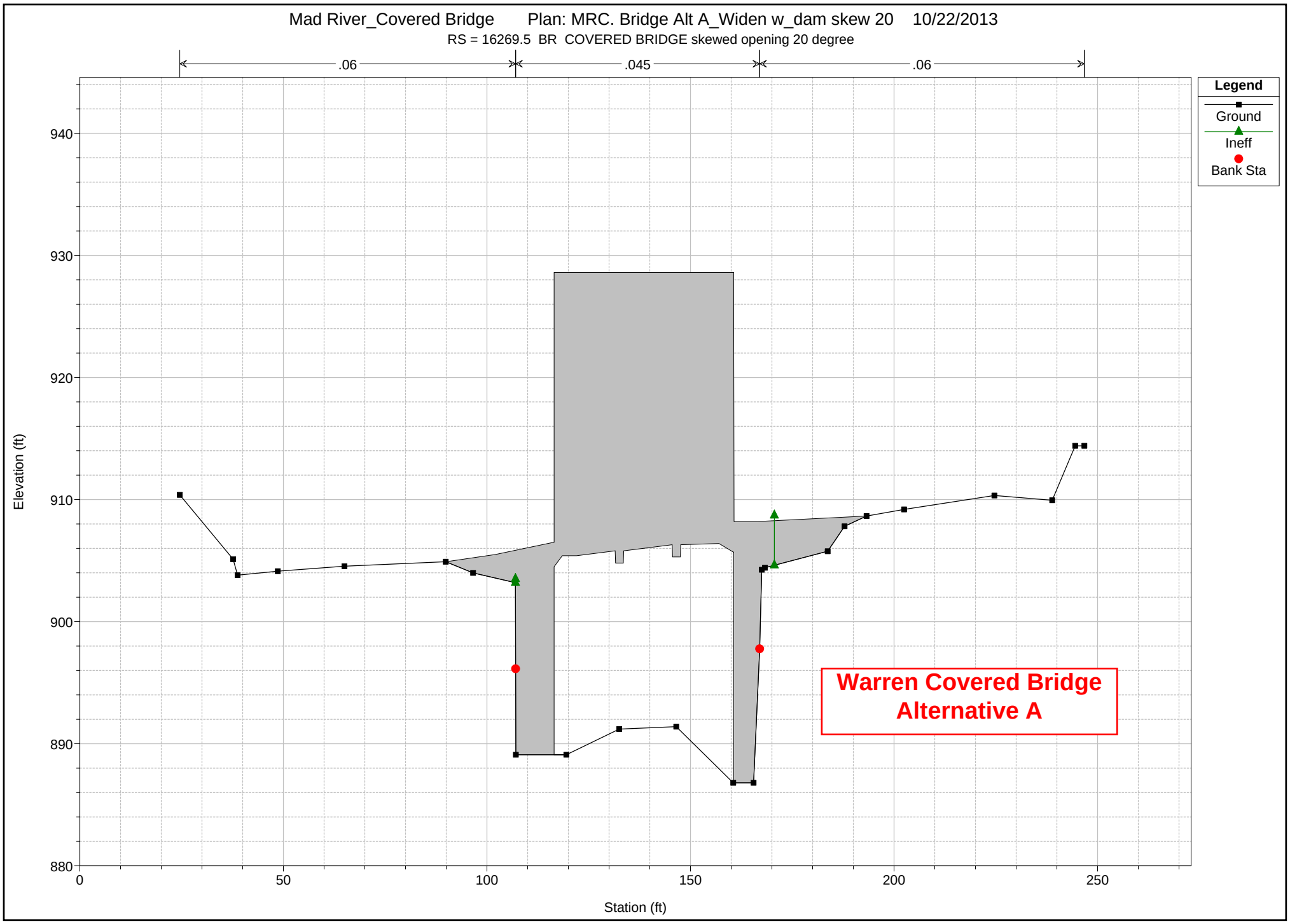
SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE %CFS<	CWSEL	CRIWS	EG	TOPWID	DEPTH	HV	VCH
17990.00	810.00	0.0	0.0	899.30	3089.00	908.34	0.0	908.90	97.02	9.04	0.56	6.89
17990.00	810.00	0.0	0.0	899.30	4589.00	909.93	0.0	910.65	103.26	10.63	0.72	7.77
17990.00	810.00	0.0	0.0	899.30	5327.00	910.55	0.0	911.36	106.22	11.25	0.81	8.22
17990.00	810.00	0.0	0.0	899.30	7206.00	911.78	0.0	912.83	112.92	12.46	1.07	9.41
18291.00	301.00	0.0	0.0	900.00	3089.00	910.72	0.0	911.38	80.88	10.72	0.66	7.04
18291.00	301.00	0.0	0.0	900.00	4589.00	912.42	0.0	913.32	87.66	12.42	0.91	8.38
18291.00	301.00	0.0	0.0	900.00	5327.00	913.12	0.0	914.14	90.48	13.12	1.02	8.95
18291.00	301.00	0.0	0.0	900.00	7206.00	914.63	0.0	915.95	96.50	14.63	1.32	10.27
18341.00	50.00	0.0	0.0	901.10	3089.00	910.59	910.59	912.91	57.04	9.49	2.32	12.23
18341.00	50.00	0.0	0.0	901.10	4589.00	912.27	0.0	914.92	60.15	11.17	2.66	13.08
18341.00	50.00	0.0	0.0	901.10	5327.00	912.94	0.0	915.81	61.40	11.84	2.87	13.60
18341.00	50.00	0.0	0.0	901.10	7206.00	914.34	0.0	917.85	63.98	13.24	3.51	15.04
18379.00	38.00	928.00	925.90	901.10	3089.00	912.70	0.0	913.74	60.94	11.60	1.04	8.20
18379.00	38.00	928.00	925.90	901.10	4589.00	914.89	0.0	916.13	65.02	13.79	1.23	8.91
18379.00	38.00	928.00	925.90	901.10	5327.00	915.82	0.0	917.14	67.16	14.72	1.33	9.25
18379.00	38.00	928.00	925.90	901.10	7206.00	917.85	0.0	919.39	78.54	16.75	1.54	9.95
18440.00	61.00	0.0	0.0	903.80	3089.00	913.15	0.0	914.61	55.23	9.35	1.46	10.08
18440.00	61.00	0.0	0.0	903.80	4589.00	915.19	0.0	917.06	59.68	11.39	1.87	11.56
18440.00	61.00	0.0	0.0	903.80	5327.00	916.06	0.0	918.12	61.57	12.26	2.06	12.20
18440.00	61.00	0.0	0.0	903.80	7206.00	917.96	0.0	920.52	65.73	14.16	2.55	13.71
18500.00	60.00	0.0	0.0	904.00	3089.00	913.77	0.0	915.06	56.15	9.78	1.29	9.51
18500.00	60.00	0.0	0.0	904.00	4589.00	915.82	0.0	917.51	60.62	11.82	1.69	11.01
18500.00	60.00	0.0	0.0	904.00	5327.00	916.71	0.0	918.58	62.57	12.71	1.87	11.64
18500.00	60.00	0.0	0.0	904.00	7206.00	918.67	0.0	920.99	66.84	14.67	2.32	13.10
18650.00	150.00	0.0	0.0	904.80	3089.00	915.17	0.0	915.90	115.42	10.38	0.73	7.36
18650.00	150.00	0.0	0.0	904.80	4589.00	917.66	0.0	918.39	121.40	12.87	0.72	7.67
18650.00	150.00	0.0	0.0	904.80	5327.00	918.75	0.0	919.48	123.99	13.95	0.73	7.83
18650.00	150.00	0.0	0.0	904.80	7206.00	921.21	0.0	921.98	133.77	16.41	0.77	8.24
19770.00	1120.00	0.0	0.0	917.80	3089.00	923.48	923.48	925.52	81.00	5.69	2.04	12.32
19770.00	1120.00	0.0	0.0	917.80	4589.00	924.88	924.88	927.27	95.83	7.08	2.39	13.60
19770.00	1120.00	0.0	0.0	917.80	5327.00	925.52	925.52	927.98	110.88	7.72	2.47	13.95
19779.00	1120.00	0.0	0.0	917.80	7206.00	926.74	926.74	929.55	117.66	8.94	2.81	15.21

SECTION NUMBER	DISCHARGE CFS	CWSEL	CWSEL DIFF EACH Q	CWSEL DIFF EACH SECTION	CWSEL-WSELK	TOPWID	T.W. DIFF	LENGTH
0.0	4556.000	766.154	0.0	0.0	0.0	307.714	0.0	0.0
0.0	6768.000	767.410	1.256	0.0	0.0	337.855	-30.141	0.0
0.0	7857.000	767.919	0.509	0.0	0.0	350.063	-42.349	0.0
0.0	10628.000	769.039	1.120	0.0	0.0	376.939	-69.225	0.0
130.000	4556.000	772.535	0.0	6.481	0.0	541.713	0.0	1130.000
130.000	6768.000	773.498	0.962	6.088	0.0	732.483	-190.770	1130.000
130.000	7857.000	773.864	0.366	5.945	0.0	809.768	-268.055	1130.000
130.000	10628.000	774.664	0.800	5.625	0.0	932.129	-390.416	1130.000
2420.000	4556.000	784.922	0.0	12.286	0.0	207.589	0.0	2290.000
2420.000	6768.000	785.982	1.060	12.484	0.0	225.421	-17.832	2290.000
2420.000	7857.000	786.378	0.396	12.514	0.0	233.306	-25.717	2290.000
2420.000	10628.000	787.145	0.767	12.481	0.0	248.503	-40.913	2290.000
2479.000	4556.000	784.792	0.0	-0.130	0.0	65.000	0.0	30.000

ATTACHMENT C



1 in Horiz. = 30 ft 1 in Vert. = 10 ft



1 in Horiz. = 30 ft 1 in Vert. = 10 ft

Mad River_Covered Bridge Plan: 1) Br2013 Skew20 10/24/2013 2) AltA_w-damskew20 10/22/2013

Mad River Warren

Warren Covered Bridge
Min. Low Chord El.904.5

100-year Profile
Existing Conditions

100-year Profile
Alternative A

Legend

WS 100-year - Br2013 Skew20

WS 100-year - AltA_w-damskew20

Ground

Ground

Elevation (ft)

910

900

890

880

15925 15965 16075 16150 16215 16249 16269.5 16320 16414 16514 16634 16734 16834 16934 17034 17134 17234 17334 17434 17541 17666 17792 17854 17926 17991 18036 18116

16000 17000 18000 19000

Main Channel Distance (ft)

Warren Covered Bridge
Existing Conditions vs Alternative A
100-year Water Surface Profile

1 in Horiz. = 300 ft 1 in Vert. = 5 ft

Mad River_no dam_scour Plan: 1) MBCR_Alt ASkew20 10/24/2013 2) MBCREstscourAltA 10/24/2013

Mad River Warren

Warren Covered Bridge
Min. Low Chord El. 904.5 ft

Existing 100-yr
Water Surface El.
for Alternative A

Future 100-yr Water
Surface El. based on
estimated scour for
Alternative A

Existing Streambed

Future Estimated scour streambed

Legend

- WS 100-year - MBCR_Alt ASkew20
- WS 100-year - MBCREstscourAltA
- Ground
- Ground

Elevation (ft)

910
900
890
880

16000
17000
18000
19000

Main Channel Distance (ft)

1 in Horiz. = 300 ft 1 in Vert. = 5 ft

APPENDIX G

ESTIMATES OF PROBABLE CONSTRUCTION COST

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering ❁ Planning ❁ Development ❁ Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - WEST ABUTMENT REPLACEMENT (CAST-IN-PLACE)

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
ALTERNATIVE A - EXPOSED CONCRETE FACING					
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	410	$37.00	$15,170.00
208.30	COFFERDAM EXCAVATION, EARTH	CY	600	$23.00	$13,800.00
208.35	COFFERDAM EXCAVATION, ROCK	CY	205	$140.00	$28,700.00
208.40	COFFERDAM	LS	1	$25,000.00	$25,000.00
501.34	CONCRETE, HIGH PERFORMANCE CLASS B	CY	155	$650.00	$100,750.00
502.10	SHORING SUPERSTRUCTURE	LS	1	$50,000.00	$50,000.00
507.11	REINFORCING STEEL, LEVEL I	LB	15000	$1.50	$22,500.00
507.16	DRILLING AND GROUTING DOWELS	LF	75	$25.00	$1,875.00
541.30	CONCRETE, CLASS C	CY	35	$400.00	$14,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$27,179.50	$27,179.50
				SUBTOTAL =	$298,974.50
				15% +/- CONTINGENCY =	$45,025.50
				ALTERNATIVE A TOTAL =	**$344,000.00**
ALTERNATIVE B - DRY STACKED STONE FACING (ADDITIONAL ITEMS)					
602.25	STONE MASONRY FACING	SY	110	$500.00	$55,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$5,500.00	$5,500.00
				SUBTOTAL =	$60,500.00
				ALTERNATIVE A SUBTOTAL =	$298,974.50
				15% +/- CONTINGENCY =	$53,525.50
				ALTERNATIVE B TOTAL =	**$413,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering ❁ Planning ❁ Development ❁ Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - WEST ABUTMENT REPLACEMENT (MSE)

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
ALTERNATIVE A - EXPOSED CONCRETE FACING					
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	630	$37.00	$23,310.00
208.30	COFFERDAM EXCAVATION, EARTH	CY	800	$23.00	$18,400.00
208.35	COFFERDAM EXCAVATION, ROCK	CY	205	$140.00	$28,700.00
208.40	COFFERDAM	LS	1	$25,000.00	$25,000.00
502.10	SHORING SUPERSTRUCTURE	LS	1	$50,000.00	$50,000.00
507.11	REINFORCING STEEL, LEVEL I	LB	1000	$1.50	$1,500.00
507.16	DRILLING AND GROUTING DOWELS	LF	55	$25.00	$1,375.00
540.10	PRECAST CONCRETE STRUCTURE (MSE WALL ABUTMENT)	LS	1	$65,000.00	$65,000.00
541.30	CONCRETE, CLASS C	CY	15	$400.00	$6,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$21,928.50	$21,928.50
				SUBTOTAL =	$241,213.50
				15% +/- CONTINGENCY =	$35,786.50
				ALTERNATIVE A TOTAL =	**$277,000.00**
ALTERNATIVE B - DRY STACKED STONE FACING (ADDITIONAL ITEMS)					
602.25	STONE MASONRY FACING	SY	110	$300.00	$33,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$3,300.00	$3,300.00
				SUBTOTAL =	$36,300.00
				ALTERNATIVE A SUBTOTAL =	$241,213.50
				15% +/- CONTINGENCY =	$41,486.50
				ALTERNATIVE B TOTAL =	**$319,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.
Randolph, VT 05060 (802) 728-3376
S. Burlington, VT 05403 (802) 878-7661
Springfield, VT 05156 (802) 591-4326
Bedford, NH 03110 (603) 637-1043
Laconia, NH 03246 (603) 524-1166
Engineering • Planning • Development • Management

JOB 621945 - Warren
SHEET NO. 1 OF 1
CALCULATED BY: RHB DATE: 23-Oct-13
CHECKED BY: DATE:
SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - EAST ABUTMENT

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
ALTERNATIVE I - REPLACE ABUTMENT BEARING SEAT CAP					
204.25	STRUCTURE EXCAVATION	CY	34	$50.00	$1,700.00
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	17	$37.00	$629.00
501.34	CONCRETE, HIGH PERFORMANCE CLASS B	CY	17	$600.00	$10,200.00
507.11	REINFORCING STEEL, LEVEL I	LB	2000	$1.50	$3,000.00
507.16	DRILLING AND GROUTING DOWELS	LF	20	$25.00	$500.00
613.12	STONE FILL, TYPE III	CY	20	$40.00	$800.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$1,682.90	$1,682.90
				SUBTOTAL =	$18,511.90
				15% +/- CONTINGENCY =	$2,488.10
				ALTERNATIVE I TOTAL =	**$21,000.00**
ALTERNATIVE II - REPAIR ABUTMENT BEARING SEAT CAP					
507.11	REINFORCING STEEL, LEVEL I	LB	100	$3.00	$300.00
507.16	DRILLING AND GROUTING DOWELS	LF	10	$25.00	$250.00
529.26	REMOVAL OF CONCRETE OR MASONRY	SY	5	$150.00	$750.00
613.12	STONE FILL, TYPE III	CY	20	$40.00	$800.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$660.00	$660.00
900.645	SPECIAL PROVISION (GROUT EAST BRIDGE SEAT)	LS	1	$4,500.00	$4,500.00
				SUBTOTAL =	$5,960.00
				15% +/- CONTINGENCY =	$1,040.00
				ALTERNATIVE II TOTAL =	**$7,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering • Planning • Development • Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - REMOVE AND RESET WALL (FULL)

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	40	$37.00	$1,480.00
208.30	COFFERDAM EXCAVATION, EARTH	CY	85	$23.00	$1,955.00
208.40	COFFERDAM	LS	1	$8,000.00	$8,000.00
602.35	REBUILT STONE MASONRY	CY	65	$600.00	$39,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$5,043.50	$5,043.50
				SUBTOTAL =	$55,478.50
				15% +/- CONTINGENCY =	$8,521.50
				TOTAL =	**$64,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering • Planning • Development • Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - REMOVE AND RESET WALL (PARTIAL)

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	12	$37.00	$444.00
208.30	COFFERDAM EXCAVATION, EARTH	CY	26	$23.00	$598.00
208.40	COFFERDAM	LS	1	$5,000.00	$5,000.00
602.35	REBUILT STONE MASONRY	CY	16	$700.00	$11,200.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$1,724.20	$1,724.20
				SUBTOTAL =	$18,966.20
				15% +/- CONTINGENCY =	$3,033.80
				TOTAL =	**$22,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering • Planning • Development • Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - CAST-IN-PLACE CONCRETE RETAINING WALL

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
ALTERNATIVE A - EXPOSED CONCRETE FACING					
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	290	$37.00	$10,730.00
208.30	COFFERDAM EXCAVATION, EARTH	CY	295	$23.00	$6,785.00
208.35	COFFERDAM EXCAVATION, ROCK	CY	75	$140.00	$10,500.00
208.40	COFFERDAM	LS	1	$10,000.00	$10,000.00
501.34	CONCRETE, HIGH PERFORMANCE CLASS B	CY	80	$650.00	$52,000.00
507.11	REINFORCING STEEL, LEVEL I	LB	10000	$1.50	$15,000.00
507.16	DRILLING AND GROUTING DOWELS	LF	60	$25.00	$1,500.00
541.30	CONCRETE, CLASS C	CY	25	$400.00	$10,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$11,651.50	$11,651.50
				SUBTOTAL =	$128,166.50
				15% +/- CONTINGENCY =	$18,833.50
				ALTERNATIVE A TOTAL =	**$147,000.00**
ALTERNATIVE B - DRY STACKED STONE FACING (ADDITIONAL ITEMS)					
602.25	STONE MASONRY FACING	SY	55	$500.00	$27,500.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$2,750.00	$2,750.00
				SUBTOTAL =	$30,250.00
				ALTERNATIVE A SUBTOTAL =	$128,166.50
				15% +/- CONTINGENCY =	$23,583.50
				ALTERNATIVE B TOTAL =	**$182,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering • Planning • Development • Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - PRECAST CONCRETE MODULAR BLOCK OR MSE WALL

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
204.30	GRANULAR BACKFILL FOR STRUCTURES	CY	375	$37.00	$13,875.00
208.30	COFFERDAM EXCAVATION, EARTH	CY	320	$23.00	$7,360.00
208.35	COFFERDAM EXCAVATION, ROCK	CY	75	$140.00	$10,500.00
208.40	COFFERDAM	LS	1	$10,000.00	$10,000.00
507.11	REINFORCING STEEL, LEVEL I	LB	225	$1.50	$337.50
507.16	DRILLING AND GROUTING DOWELS	LF	60	$25.00	$1,500.00
541.30	CONCRETE, CLASS C	CY	8	$400.00	$3,200.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$8,277.25	$8,277.25
900.675	SPECIAL PROVISION (UNIT BLOCK RETAINING WALL)	SY	80	$450.00	$36,000.00
				SUBTOTAL =	$91,049.75
				15% +/- CONTINGENCY =	$13,950.25
				TOTAL =	**$105,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering ❁ Planning ❁ Development ❁ Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - SUPERSTRUCTURE

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
203.15	COMMON EXCAVATION	CY	210	$12.00	$2,520.00
301.15	SUBBASE OF GRAVEL	CY	160	$35.00	$5,600.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	105	$130.00	$13,650.00
522.25	STRUCTURAL LUMBER AND TIMBER, TREATED	MFBM	0.4	$12,000.00	$4,800.00
522.30	NONSTRUCTURAL LUMBER, UNTREATED	MFBM	0.3	$12,000.00	$3,600.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$3,631.63	$3,631.63
900.670	SPECIAL PROVISION (CEDAR SHAKE ROOF)	SF	745	$8.25	$6,146.25
				SUBTOTAL =	$39,947.88
				15% +/- CONTINGENCY =	$6,052.13
				TOTAL =	**$46,000.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

DuBois & King inc.

- Randolph, VT 05060 (802) 728-3376
- S. Burlington, VT 05403 (802) 878-7661
- Springfield, VT 05156 (802) 591-4326
- Bedford, NH 03110 (603) 637-1043
- Laconia, NH 03246 (603) 524-1166

Engineering • Planning • Development • Management

JOB 621945 - Warren

SHEET NO. 1 OF 1

CALCULATED BY: RHB DATE: 23-Oct-13

CHECKED BY: DATE:

SCALE:

OPINION OF PROBABLE CONSTRUCTION COST - GUARDRAIL/SIGNING

ITEM NO.	DESCRIPTION	UNIT	QUANT.	UNIT PRICE	AMOUNT
621.21	HD STEEL BEAM GUARDRAIL, GALVANIZED	LF	100	$100.00	$10,000.00
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$1,060.00	$1,060.00
675.20	TRAFFIC SIGNS, TYPE A	SF	50	$12.00	$600.00
				SUBTOTAL =	$11,660.00
				15% +/- CONTINGENCY =	$1,840.00
				TOTAL =	**$13,500.00**

Note:

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that our Opinion of Probable Construction Costs are made on the basis of our professional judgment and experience. D&K makes no warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from the Opinion of Probable Construction Cost provided herein.

APPENDIX H

1980 VTRANS BRIDGE IMPROVEMENT DRAWINGS

INDEX OF SHEETS

STANDARD SHEETS

E-3	Dec. 15, 1978 (R)
E-7	Sept. 5, 1978 (R)
G-4	May 29, 1979 (R)

STATE OF VERMONT
AGENCY OF TRANSPORTATION

PROPOSED IMPROVEMENT
BRIDGE PROJECT

TOWN OF WARREN
COUNTY OF WASHINGTON

ROUTE NO: T.H. 3, Cl. 2 **BRIDGE NO:** 6

PROJECT LOCATION: This project is located in the town of Warren on T.H. 3 over the Mad River, 40 feet westerly of the intersection of T.H. 3 and T.H. 4.

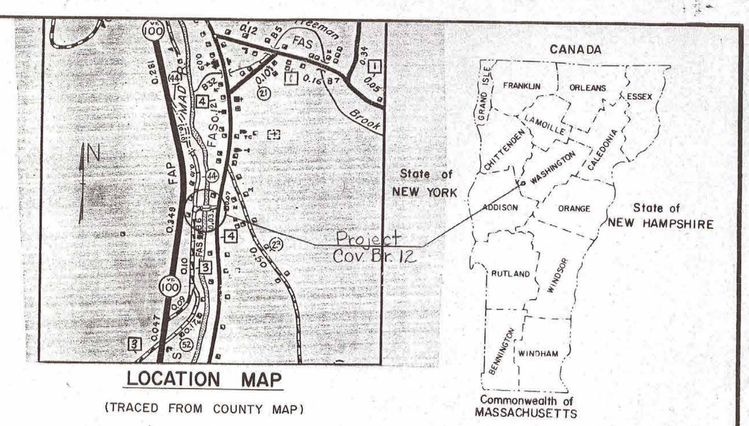
PROJECT DESCRIPTION: This project shall consist of the construction of concrete slabs w/ backwalls and wingwalls at each end. Raising the east end of bridge 6" to allow regrading roadway surface away from bridge. Installation of new plank guardrail and cosmetic repairs.

LENGTH OF STRUCTURE:	62.0	FEET
LENGTH OF PARTICIPATION ROADWAY:	20.0	FEET
LENGTH OF NON-PARTICIPATION ROADWAY:		FEET
LENGTH OF PROJECT:	82.0	FEET

RECORD PLANS & MATERIAL SUPPLIERS

CONTRACTOR- R.E. MOULTON & SON, INC. BOX 276 HARDWICK, VT.
CONTRACT DATED- 10-7-80 CONSTRUCTION BEGAN- 10-7-80
CONSTRUCTION COMPLETED- 1-21-81 ACCEPTED- 1-26-81
GRANULAR BACKFILL FOR STRUCTURES- TOWN OF WARREN PIT
SUBBASE OF GRAVEL- TO OF WARREN PIT
BITUMINOUS CONCRETE PAVEMENT- FRANK W. WHITCOMB CONT. CORP. WILLISTON, VT.
CONCRETE CLASS "B"- A. G. ANDERSON CO, INC. BERLIN, VT.
REINF. STEEL- K-ROSS BUILDING SUPPLY CENTER, INC LEBANON, NH.
WATER REPELLENT- SYNTHETIC BUILDING PRODUCTS MASPETH, NY.
GUARD RAIL- LAFAYETTE G. SHELDON, INC. KELLOGG RD. ESSEX JCT., VT.
CEDAR SHINGLE ROOFING- REGINA CLOAK CO., LTD. WINDSOR QUE. CANADA
RESILIENT ANCHORS- ROOFMATE FULL LT RECORD PLANS- CLAYTON J. ADAIR

NOTE: ANY FURTHER INFORMATION CONCERNING FINAL QUANTITIES, AMOUNTS OR OTHER DETAILS RELATIVE TO THIS PROJECT MAY BE FOUND IN EITHER THE FIELD BOOKS OR THE ESTIMATE FILE.



LOCATION MAP

(TRACED FROM COUNTY MAP)

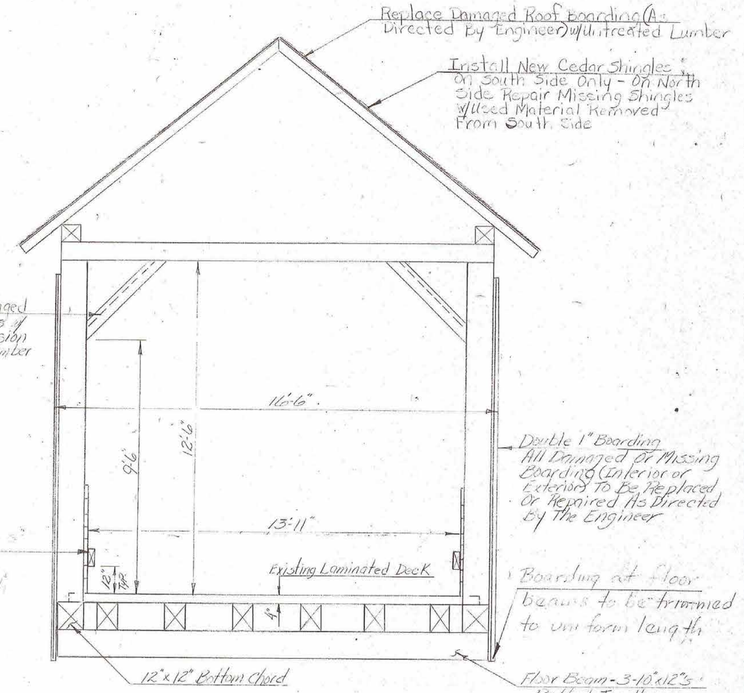
GENERAL NOTES

1. This structure shall be posted by the Town for a live load of not more than 10,000 lbs.
2. All materials and construction shall conform to State of Vermont, Dept. of Highways, Standard Specifications for Highway and Bridge Construction, dated March 1976 and its latest revisions.
3. Allowable Design Stresses:
   Concrete Cl. "B" - f'c 3500 psi. fc 1400 psi
   Reinf. Steel - Grade 40 Tens. 20000 psi Comp. 16000 psi
4. All exposed edges of concrete shall be chamferred 1" x 1".
5. All replaced boarding shall be fastened with 8d galvanized nails. Other nailing shall be done as directed by the Engineer. Payment to be included in the bid price for Untreated Lumber.
6. Costs of signs and barricades to be subsidiary to contract items.
7. All new structural lumber & timber shall be Eastern Spruce or Southern Pine, select structural or No. 1 grade, rough sawn to nominal dimensions.
8. All dimensions on plans shall be field checked prior to ordering materials.
9. The contractor shall be allowed to close the bridge to traffic. The selectmen shall be given (7) days notice of intent to close the bridge.
10. A "Bridge Closed" sign (B-5), Standard E-3, shall be erected by the Contractor on T.H. 3 at its intersection with Vt. Rte. 100. This sign is in addition to signs required at the project site and shall be maintained by the Contractor.

CONVENTIONAL SIGNS

COUNTY LINE
TOWN LINE
LIMITS OF ACCESS
POINT OF ACCESS
FENCE LINE
STONE WALL
TRAVELED WAY
GUARD RAIL
RAILROAD
SURVEY LINE
CULVERT
POWER POLE
TELEPHONE POLE
TREES
CONTROL OF ACCESS
PROPERTY LINE
R.O.W. TAKING LINE
SLOPE RIGHTS
TOP OF CUT
TOE OF SLOPE

11. During construction the Contractor shall exercise every reasonable precaution to prevent pollution, siltation or discharge of raw concrete or debris into the Mad River as directed by Spec. Sub-sect. 104.10 & 104.11.
12. Turf establishment work shall be done as directed by the Engineer w/ payment subsidiary to other contract items.
13. Costs of any additional cutting or bending of reinforcing steel shall be subsidiary to Item 507.15, Reinforcing Steel.
14. Before project is accepted the Contractor shall thoroughly clean all sand and debris from the structure with payment for the cleaning subsidiary to other contract items.
15. Where lumber or timber is designated as "treated" on this project, it shall mean Untreated material coated with a minimum of (2) liberally brushed applications of any standard commercial brand wood preservative (other than creosote). Payment for treating will be subsidiary to Untreated Lumber and Timber, Item 611.20, unless otherwise noted.



TYPICAL BRIDGE SECTION

3/16" = 1'-0"

SUBMITTED BY ORDER OF THE STATE TRANSPORTATION BOARD

APPROVED S. J. Gray DATE 8-27-80
DIR. OF ENGINEERING AND CONSTRUCTION

RECEIVED MAY 04 1981 VT. HIGHWAY DEPT. DISTRICT 6

WARREN PROJECT No. COV. BR. 12

SHEET 1 OF SHEETS

D-10

ITEM	NO. PIECES	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	J	K	R	O
1						ABUT. NO. 1											
2																	
3	42	5	5-1	1A501	17		3-1	2-0	/								
4	14	5	3-10	1A502	20		1-4	0-9	1-9								
5	14	5	3-6	1A503	17		1-6	0-6	1-6								
6	13	5	23-3	1A504	Str												
7	7	5	13-3	1A505	Str												
8	26	5	3-1	1A506	Str												
9	12	5	8-9	1A507	Str												
10	12	5	5-6	1A508	Str												
11																	
12																	
* 13	49	8	9-2	1A801	1	0-11	8-3					/		0-8			
14																	
15																	
16																	
17																	
18																	
19																	
20																	

ITEM	NO. PIECES	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	J	K	R	O
21						ABUT. No. 2											
22																	
23	31	5	5-0	2A501	17		3-0	2-0	/								
24	14	5	4-0	2A502	17		1-3	1-6	1-3								
25	14	5	3-6	2A503	17		1-6	0-6	1-6								
26	6	5	28-6	2A504	Str												
27	7	5	13-3	2A505	Str												
28	17	5	3-0	2A506	Str												
29	12	5	2-9	2A507	Str												
30	6	5	3-9	2A508	Str												
* 31	7	5	8-6	2A509	Str												
32																	
33																	
* 34	21	6	5-5	2A601	1	0-8	4-9					/		0-7			
35																	
36																	
37																	
38																	
39																	
40																	

ITEM	NO. PIECES	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	J	K	R	O
41																	
42																	
43																	
44																	
45																	
46																	
47																	
48																	
49																	
50																	
51																	
52																	
53																	
54																	
55																	
56																	
57																	
58																	
59																	
60																	

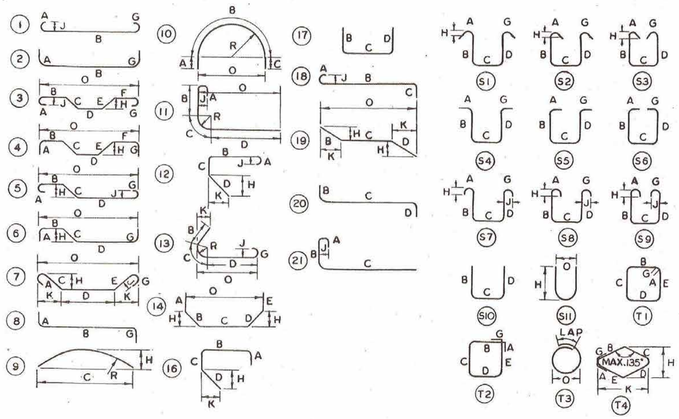
ASTM STANDARD REINFORCING BARS				
BAR SIZE DESIGNATION	WEIGHT POUNDS PER FOOT	NOMINAL DIMENSIONS ROUND SECTION		
		DIAMETER INCHES	CROSS SECTIONAL AREA SQ. INCHES	PERIMETER INCHES
#3	.376	.375	.11	1.178
#4	.668	.500	.20	1.571
#5	1.043	.625	.31	1.963
#6	1.502	.750	.44	2.356
#7	2.044	.875	.60	2.749
#8	2.670	1.000	.79	3.142
#9	3.400	1.128	1.00	3.544
#10	4.303	1.270	1.27	3.990
#11	5.313	1.410	1.56	4.430
#14	7.65	1.693	2.25	5.32
#18	13.60	2.257	4.00	7.09

BRIDGE QUANTITY SHEET

STATE OF VERMONT
DEPARTMENT OF HIGHWAYS
BRIDGE DIVISION

NO.	ITEM	UNIT	QUANTITY BREAKDOWN										TOTAL	FINAL
			Super-structure		Abut. 1		Abut. 2							
202.30	Partial Removal of Structure	Eq	1										1	1
202.40	Removal & Disposal of Exist. Guard Rail	L.F.			70		50						120	120
203.15	Common Excavation	C.Y.			13		5						20	14.2
204.25	Structure Excavation	CY			50		25						75	53
204.30	Granular Backfill for Structures	CY			15		10						25	14
301.15	Subbase of Gravel	CY			26		14						40	34.8
406.25	Bituminous Concrete Pavement	Ton			5		1						6	6.05
501.25	Conc. Cl. "B"	CY			15		8						23	20.3
502.10	Shoring Superstructure	LS	1										1	1
507.15	Reinforcing Steel	Lb			2190		880						3070	3087
514.10	Water Repellent	Gal.			2		1						3	8
611.20	Untreated Lumber & Timber	MBF	2.0										2.0	3.40
621.10	Guard Rail, Plank w/Wood Posts	LF			64		64						128	132
665.20	Cedar Shingle Roofing	S.F.	800										800	774
506.98	STRUCTURAL STEEL 20"x6" SA A-15-31	LBS	0										0	1218
611.20	UNTREATED LUMBER & TIMBER (MOD) 20"x6" SA 11-28-	MBF	0										0	3.32
900	EXTRA WORK ORDER #1 REPAIR OF BOTTOM CHORD ENDS & LEFT CENTER	LS	0											

TYPICAL BAR BENDS



NOTES

1. UNLESS OTHERWISE DESIGNATED, ALL BAR REINFORCEMENT FOR CONCRETE IN SIZES UP TO AND INCLUDING NO. 18 SHALL CONFORM TO THE REQUIREMENTS OF THE "SPECIFICATIONS FOR DEFORMED BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT," AASHTO M 31 (ASTM A 615), GRADE 40.
2. FOR TYPICAL BENDING DETAILS, RECOMMENDED PIN DIAMETER "D" OF BENDS AND HOOKS AND OTHER STANDARD PRACTICE SEE CURRENT CONCRETE REINFORCING STEEL INSTITUTE "MANUAL OF STANDARD PRACTICE."
3. BARS WHICH REQUIRE MORE ACCURATE BENDING THAN STANDARD PRACTICES SHOULD HAVE LIMITS INDICATED.
4. ALL DIMENSIONS ARE OUT TO OUT OF BAR EXCEPT "A" AND "G" ON STANDARD 180° AND 135° HOOKS.
5. "J" DIMENSION ON 180° HOOKS TO BE SHOWN ONLY WHERE NECESSARY TO RESTRICT HOOK SIZE, OTHERWISE STANDARD HOOKS ARE TO BE USED.
6. "H" DIMENSION ON STIRRUPS TO BE SHOWN ONLY WHEN NECESSARY TO MAINTAIN CLEARANCES.
7. WHERE SLOPE DIFFERS FROM 45° DIMENSIONS "H" AND "K" MUST BE SHOWN.

* DENOTES ONE EXTRA BAR ADDED FOR TESTING PURPOSES.

REV. NO.	MADE BY	DATE	DESCRIPTION
1	J. WOOD	8/11/75	AASHO CHANGED TO AASHTO AND GRADE 40 CHANGED TO GRADE 60.

STATE OF VERMONT
DEPARTMENT OF HIGHWAYS

TOWN OF WARREN	BRIDGE NO. 6
	LOG STA.
HIGHWAY NO. T.H. 3	SURV. STA.
BRIDGE QUANTITY SHEET 8	
REINFORCING STEEL SCHEDULE	
DESIGNED BY R. Whitcomb	DRAWN BY R. Whitcomb
CHECKED BY D Burley DATE 8-80	BRIDGE DESIGN SUPERVISOR R.S. Haupt DATE 8-80
PROJECT WARREN	PROJECT NO. COV.BR. #12
BRIDGE SHEET NO.	SHEET 2 OF 4

BR 6

Edge T.H. 4

Splashwalls This End To be Dismantled & Straightened See Note #3 Sht. 4

6'-2" Thick

~ABUT. #1~

New R.C. Slab

Begin Deck New F.G. El. 105.2±

9'-4"±

New R.C. Backwall

32' New Guard Rail Plank w/(5) Wood Posts - See Sht. Sht. C-4 For Details - (Existing Guard Rail To Be Remved)

Begin Bottom Chord

Begin Chord

Treated Bearing Blocks Of Same Width As Bottom Chord w/ Min. Of 12" Length And 2" Thickness To Be Placed At End Of Bottom Chord At All Corners

FLOW MAD RIVER

~ABUT. #2~

New R.C. Slab

5'±

End of Deck F.G. El. 103.7

New R.C. Backwall

End Bottom Chord

~ Bottom Chord ~

32' Guard Rail Plank w/Wood Posts (Typ. Ea. Corner) - Actual Alignment To Be Designated By Engineer In Field

T.B.M. Ass. Elev 100.0 Top Corner Wingwall

20'± Blend Subbase & 2" Bit. Conc. Pvt. Into Existing

Grade To Low Point 12'± From Deck

3/8"/Ft.

~Sub base of Gravel~

1/4"/Ft.

Elev. 101.7

Existing Deck Elev. To Be Raised Approx. 6" This End Only

Existing Loose Decking To Be Relayed w/ Damaged Boards Replaced As Directed By The Engineer (Est. 500 B.F. To Be Relayed)

1" Gap Between Deck & Backwall (Typ.)

6'

Repave w/2" Bit. Conc. Pvt.

~Subbase of Gravel~

5'

Min. 1' Gran Backfill Below Slab

New R.C. Slab & Backwall

New Bearing Beam Member Treated 5"x12"x 16'-2"

Top Member of Existing Bearing Beams To Be Removed, Treated w/Wood Preservative & Replaced - Bottom Existing Member To Be Removed & Discarded

Remove Existing Bearing Beam, Treat w/Wood Preservative & Replace

New R.C. Slab & Backwall

Gran Ekfill For Struc

~Existing Abut. #1~

~Existing Abut. #2~

Water Line Elev.

℄ ELEVATION - BELOW F.G. ONLY

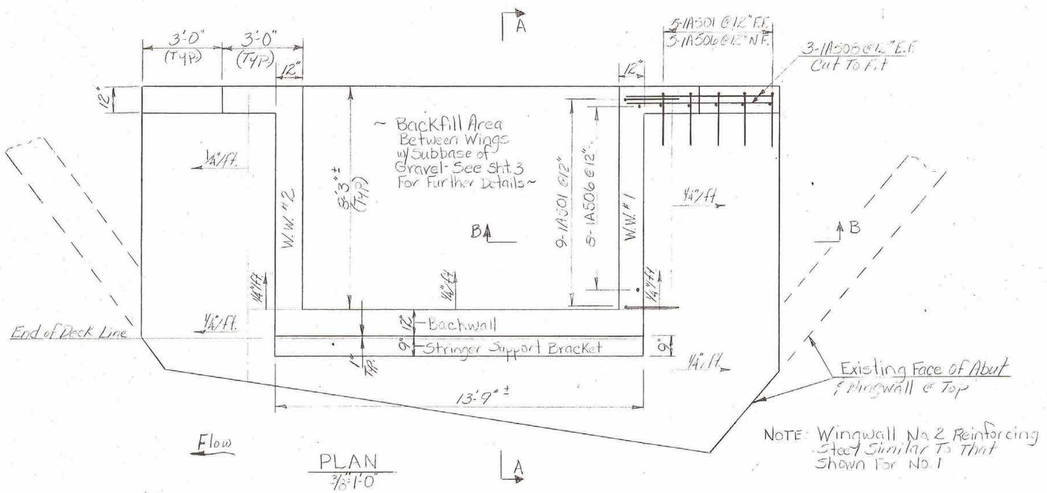
1" = 5'-0"

STATE OF VERMONT
AGENCY OF TRANSPORTATION

TOWN OF WARREN	Bridge No. 6
	Log Sta.
HIGHWAY NO. T.H. 3	Surv. Sta.
PLAN & PARTIAL ELEVATION	
COV. BR. #12 OVER THE MAD RIVER	
Designed by R. Whitcomb	Drawn by R. Whitcomb
Checked by D. Burley date 8-80	Bridge Design Supervisor R.S. Haupt date 8-80
PROJECT WARREN	PROJECT NO. COV. BR. #12
Bridge Sheet No.	Sheet 3 of 4

BRUNING 44-131 40151

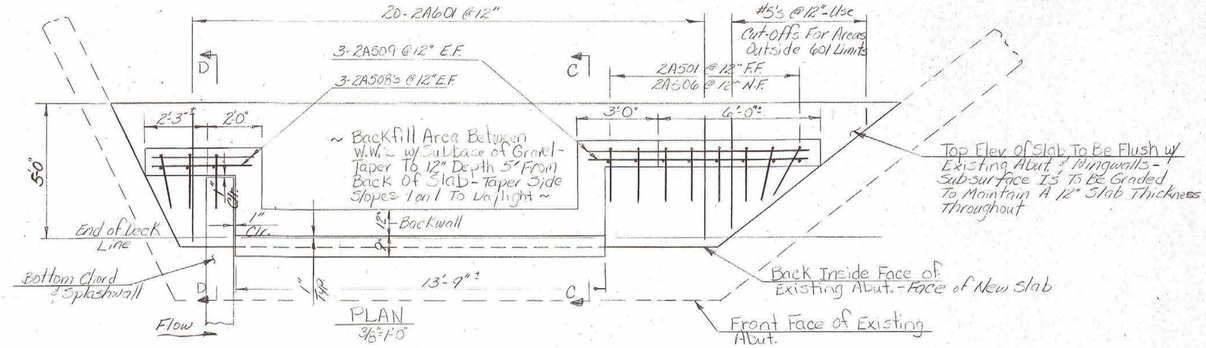
BR-6



PLAN
3/8"=1'-0"

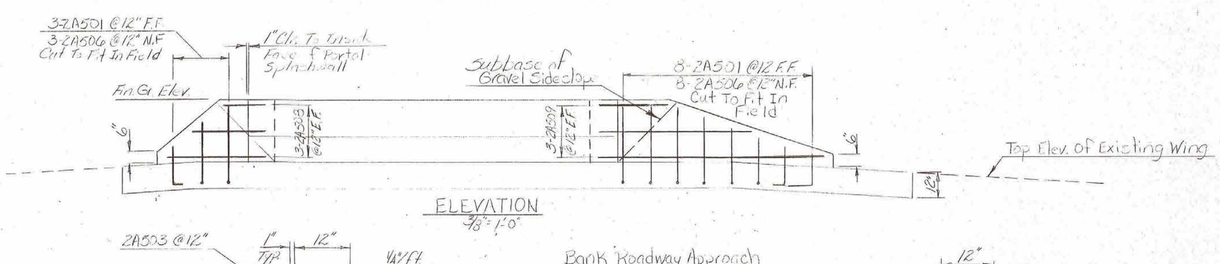
NOTE: Wingwall No. 2 Reinforcing Steel Similar To That Shown For No. 1

ABUT. No. 1

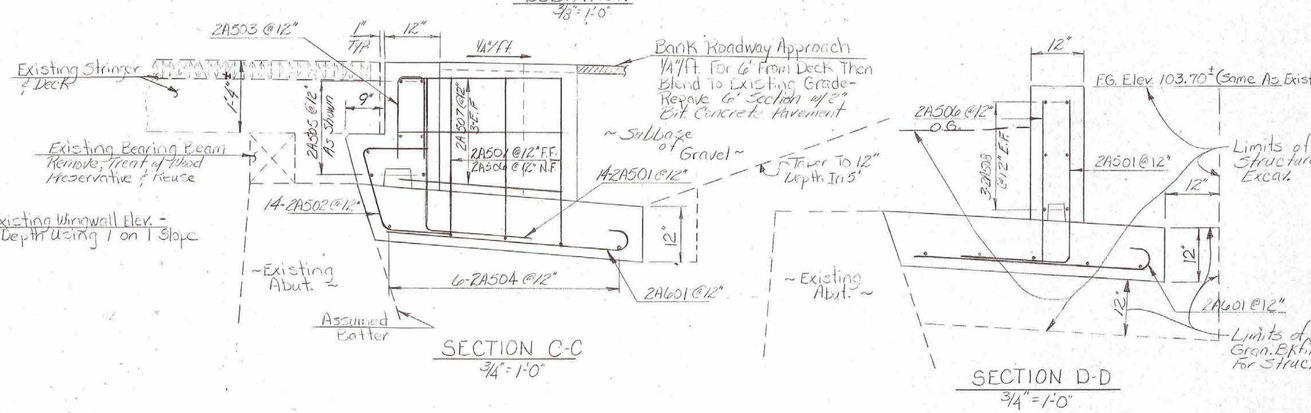


PLAN
3/8"=1'-0"

ABUT. No. 2

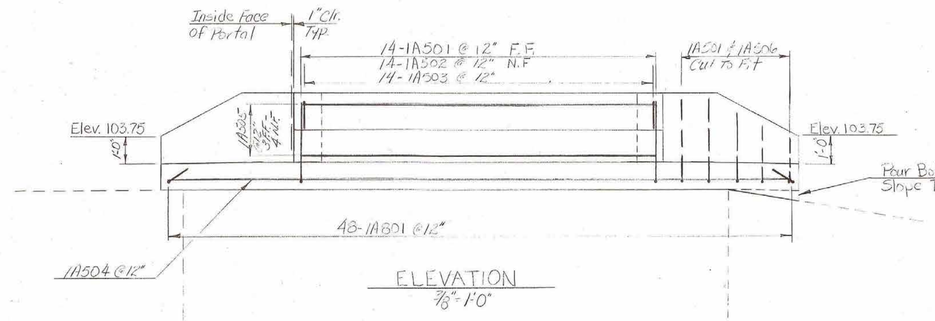


ELEVATION
3/8"=1'-0"

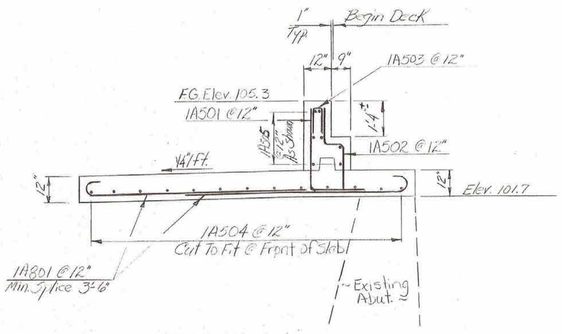


SECTION C-C
3/4"=1'-0"

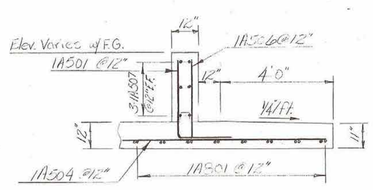
SECTION D-D
3/4"=1'-0"



ELEVATION
3/8"=1'-0"



SECTION A-A
3/8"=1'-0"



SECTION B-B
3/8"=1'-0"

NOTES

1. Minimum clearance for all reinforcing steel shall be 3".
2. Payment for removal, treating and replacement of bearing beams shall be included in bid for Item 202.30, Partial Removal of Structure.
3. Portal splashwalls at east end of bridge shall be dismantled, w/ any broken or rotted members replaced, and rebuilt w/ proper alignment. Any structural members to be replaced shall be treated, w/ bracing to be untreated. Payment for replacing parts will be for Untreated Lumber & Timber, Item 611.20, w/ payment for dismantling & strengthening under Item 202.30, Partial Removal of Structure.
4. Payment for repair of loose or damaged decking will be under Item 611.20, Untreated Lumber & Timber.
5. The Structures Div. shall be notified when excavation for slabs is complete for abutment inspection purposes.
6. Structure Excav. limits shall be from existing ground to bottom of 12" undercut vertically and 12" outside slab limits horizontally. All other excav. shall be paid as Common Excavation.
7. All new, exposed concrete to be coated w/ Water Repellent, Item 514.10.
8. Payment for final grading of approaches shall be subsidiary to Item 406.25, Bit. Conc. Pavement.

STATE OF VERMONT
AGENCY OF TRANSPORTATION

TOWN OF WARREN	Bridge No. 6
HIGHWAY NO. TH. 3	Log Sta.
	Surv. Sta.
SUBSTRUCTURE DETAILS	
COV. BR. #12 OVER THE MAD RIVER	
Designed by R. Whitcomb	Drawn by R. Whitcomb
Checked by D Burley date 8-80	Bridge Design Supervisor R.S. Haupt date 8-80
PROJECT WARREN	PROJECT NO. COV. BR. #12
Bridge Sheet No.	Sheet 4 of 4

BRUNING 44-131 40151

BR-6