

**CONNECTICUT DEPARTMENT OF TRANSPORTATION**  
**Reconstruction of I-84**  
**Washington Avenue to Pierpont Road**  
**Waterbury, CT**  
**ConnDOT Project No. 151-273**  
**Federal Aid Project No. NHI-84-2 (172) 33**



**HYDRAULIC ANALYSIS**  
**FOR DESIGN**  
**REPORT**

**MAD RIVER**

**Waterbury, Connecticut**

**July 2006**  
**Revised October 2013**

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## Study Background

State Project No. 151-273, the Reconstruction of Interstate 84 in the City of Waterbury from Washington Avenue east to Pierpont Road, results in the relocation of the Mad River for an approximate length of 564 meters (1,850 feet) and the construction of six (6) waterway crossings, replacing five (5) existing crossings. These waterway crossings and the limits of the river relocation are shown in Figure 2.

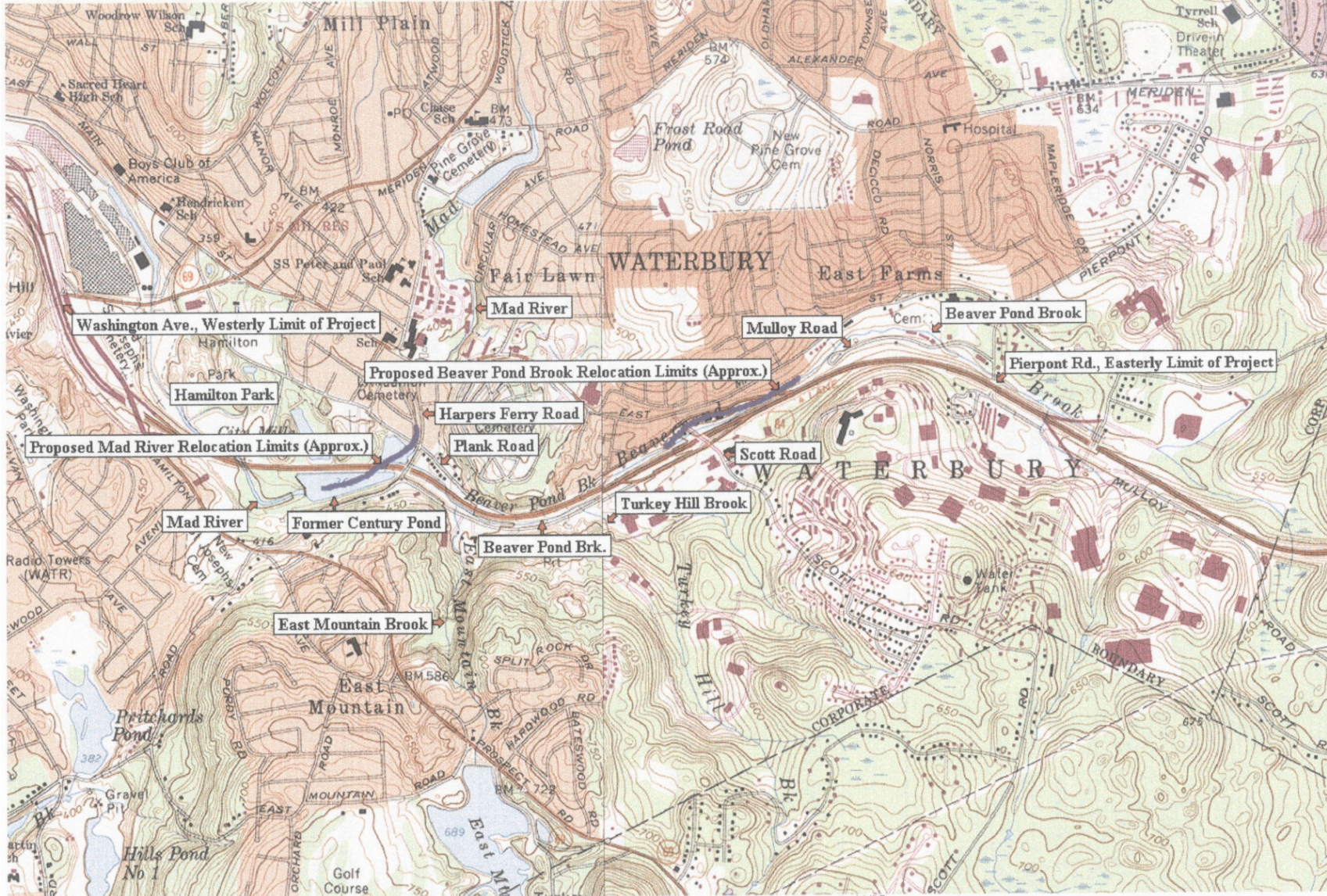
This report has been prepared to describe the effects and consequent changes to the hydraulic characteristic of the Mad River, such as the flood elevations and flow velocities, resulting from the proposed project, based on the hydraulic analyses that were performed and documented herein.

The final hydraulic modeling for the project and related reports have been prepared by the Hydraulic and Drainage Section of the Connecticut Department of Transportation (ConnDOT), based on the design plans for the roadway reconstruction, including the river relocation and hydraulic structures, that were prepared by Ammann & Whitney (formerly Berger, Lehman Associates, P.C. – BLA) of Rye, NY, the prime consultant engineer for State Project No. 151-273.

The survey and design plans for State. Project No. 151-273 were developed in Metric units. Accordingly, all the hydraulic models were developed, analyzed and completed in the Metric. The primary control for the project survey was based on the North American Datum of 1983 (NAD-83) for the horizontal coordinates. All elevation data are referenced to National Geodetic Vertical Datum of 1929 (NGVD-29).

The Mad River was previously studied in detail as a part of the City of Waterbury Flood Insurance Study (FIS), effective date May 1979 in which the regulatory floodplains and floodways were established. Due to the project's involvement in the regulated areas, obtaining a Flood Management Certification (FMC) from the Connecticut Department of Environmental Protection (DEP) is required as well as a Conditional Letter of Map Revision (CLOMR) from the Federal Emergency Management Agency (FEMA). For these requirements, a separate report entitled "*Mad River Floodplain/Floodway Analysis Report for FEMA CLOMR & CTDEP Flood Management Certification*" has been prepared using different hydraulic models developed based on the discharges reported in the FIS and also in U.S. Customary units.

For the ease of distinguishing these different models, the models developed from the FIS discharges are referred to as "Floodway Models"; the models included in this report as "Design Models".

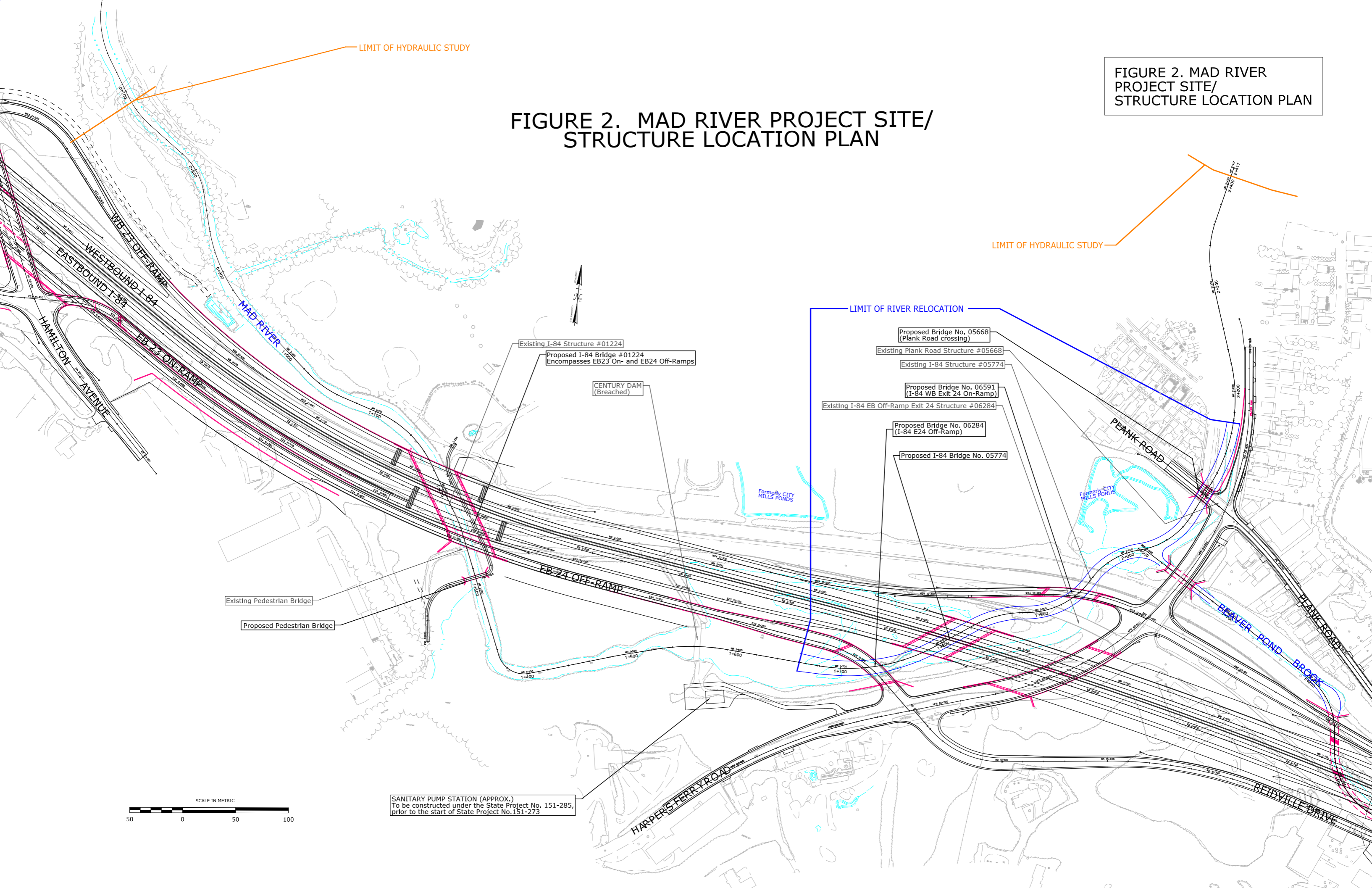


MN  
144°

FIGURE 1 - PROJECT LOCATION PLAN

FIGURE 2. MAD RIVER PROJECT SITE/  
STRUCTURE LOCATION PLAN

FIGURE 2. MAD RIVER PROJECT SITE/  
STRUCTURE LOCATION PLAN



LIMIT OF HYDRAULIC STUDY

LIMIT OF HYDRAULIC STUDY

LIMIT OF RIVER RELOCATION

Existing I-84 Structure #01224  
Proposed I-84 Bridge #01224  
Encompasses EB23 On- and EB24 Off-Ramps

CENTURY DAM  
(Breached)

Proposed Bridge No. 05668  
(Plank Road crossing)

Existing Plank Road Structure #05668

Existing I-84 Structure #05774

Proposed Bridge No. 06591  
(I-84 WB Exit 24 On-Ramp)

Existing I-84 EB Off-Ramp Exit 24 Structure #06284

Proposed Bridge No. 06284  
(I-84 E24 Off-Ramp)

Proposed I-84 Bridge No. 05774

Existing Pedestrian Bridge

Proposed Pedestrian Bridge

SANITARY PUMP STATION (APPROX.)  
To be constructed under the State Project No. 151-285,  
prior to the start of State Project No. 151-273

SCALE IN METRIC  
50 0 50 100

To avoid confusion between existing and proposed crossings in the report, the existing structures are referred to as "Structure" followed by the ConnDOT bridge numbers, whereas proposed crossings are called out either as "Bridge" or "Culvert" depending on the proposed type (e.g. existing Structure No. 01224 versus proposed Bridge No. 01224; see Table 1).

**Table 1- Mad River Structure Numbers**

Structure Number*		Roadway
Existing	Proposed	
Structure No. 01224	Bridge No. 01224	Westerly I-84 crossing
None	none	Pedestrian Crossing
Structure No. 06284 (a.k.a. 05774A)	Bridge No. 06284	I-84 Eastbound Exit 24 Off-Ramp to Harpers Ferry Road
Structure No. 05774	Bridge No. 05774	Easterly I-84 crossing
n/a	Bridge No. 06591	Proposed I-84 Westbound Exit 24 On-Ramp from Harpers Ferry Road
Structure No. 05668	Culvert No. 05668	Plank Road

\*Listed from downstream to upstream

## Discharges

As part of Project No. 151-273, BLA (Ammann & Whitney) has prepared a report entitled "*Hydrologic Report, Mad River*" in which several methods were employed to determine the discharges for various frequency storms. For this hydraulic analysis, the recommended discharges for design indicated in the hydrologic report were utilized. These discharges are shown in Table 2.

**Table 2- Mad River Discharges**

Flooding Source & Location	Drainage Area sq. km. (sq. mi.)	Peak Discharges, cms (cfs)							
		Low Fish Passage *	High Fish Passage *	2-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Downstream of Beaver Pond Brook	62.26 (24.04)	0.103 (3.6)	2.749 (97)	31.15 (1,100)	66.54 (2,350)	100.52 (3,550)	137.34 (4,850)	176.98 (6,250)	269.01 (9,500)
Upstream of Beaver Pond Brook	46.72 (18.46)	0.126 (4.4)	3.659 (129)	21.80 (770)	46.72 (1,650)	70.79 (2,500)	96.28 (3,400)	124.59 (4,400)	188.31 (6,650)

\*The computations for the Low & High Fish Passage discharges are included in the *Final River Relocation Report*.

The table lists two sets of discharges used for this study. The differences in these discharges reflect the additional flow entering the river from the Beaver Pond Brook, which also has been studied and described under a separate report. The confluence with the Beaver Pond Brook is located near the middle of the project site, or approximately one-third way down (400 m) from the upstream limit of this study.

It should be noted that these discharges used for the actual design of the waterway crossings and in-stream stabilization features (Design Model) are higher than the FIS reported discharges used in the above mentioned *Mad River Floodplain/Floodway Analysis Report* for permit requirements (Floodway Model).



## Hydraulic Analysis

The hydraulic analyses for this project were performed using the U. S. Army Corps of Engineers (USACOE) computer program HEC-RAS version 4.1.0. Separate hydraulic models were developed for the existing (pre-project), proposed (post-project) and natural<sup>1</sup> conditions.

In developing the Existing and Proposed Condition models, the hydraulic cross sections were obtained from the project digital terrain models or “surface-models” with reference to one common baseline. This makes comparison of the data feasible in the HEC-RAS environment. However, the orientation and other geometry data such as the distances along the main channel and floodplains are entered consistent with the represented condition. For the common baseline, the stream centerline developed for the final proposed (post-project) condition was used.

The limits of the HEC-RAS models were established in consideration of the proposed construction activities and by estimating the resulting hydraulic effects. For the upstream limit, the Mad River Sta. 2+409 (Section 2409), which is located just downstream of the East Main Street crossing or approximately 320 m (1,050 ft) upstream of the Plank Road crossing (Structure No. 05668), was selected. There is no work proposed in the vicinity of this section; however, this was found to be the most upstream section where the proposed and natural condition profiles converge.

For the downstream limit, the Mad River Sta. 0+714 (Section 0714), which is located approximately 460 meters (1,500 ft) downstream of the westerly I-84 crossing (Structure No. 01224), was chosen. Similarly, there is no work proposed in the river at this location; however, the embankment for the proposed I-84 Westbound Exit 23 Off-Ramp does appear to encroach into the 500-year floodplain. This downstream limit was chosen to demonstrate that the fill for the embankment has minimal effect on the flood elevation. Furthermore, this is the most downstream section where the convergence of the proposed and natural condition profiles occurs. Further downstream of this limit, the river turns northeasterly away from the project site.

Some of the cross sections in both the Existing and Proposed Condition models, particularly upstream of Plank Road, do not extend far enough to fully contain the 500-year flood. Nevertheless, the computed flood elevations are deemed accurate because the flooding beyond the cross section limits do not actively convey the flow due to significant obstructions on the floodplain. These obstructions are reflected in the models using Ineffective Flow Area and Obstruction settings in the HEC-RAS.

To maintain consistency with the Floodway Models prepared for the permit applications and also with the original 1979 FIS analysis, all cross sections in these Design Models were input as if looking upstream. Although the intended purposes for the Floodway and Design Models are

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<sup>1</sup> The natural condition model is intended to show the floodplain in the vicinity of the project as it would be without any artificial encroachments or modifications. The natural profile is generally developed by removing the bridges, culverts and any approach embankments in the existing condition model.

different, much effort was made to keep their geometric data identical, except for the units, as they represent the same physical conditions.

The downstream boundary condition for all the hydraulic models in this study was set to "Rating Curve" using the published water surface elevations in the effective 1979 FIS. As indicated previously, the FIS discharges are different from the discharges used for design and thus used in this report. With the "Rating Curve" option in the HEC-RAS, the program will prorate the published elevations by the differences in the discharge to estimate the starting water surface elevation for each frequency model. Furthermore, as only the 10-, 50-, 100- and 500-year water surface elevations are published, the rating curve is useful in determining the starting elevations for all the other frequency models as well. The upstream boundary condition was set to critical depth.

In performing the analyses, both the subcritical and supercritical conditions were considered (the "Mixed Flow Regime" setting in the HEC-RAS).

Once the analyses were completed, the results were depicted on the flood boundary maps in following pages. Figure 3 shows both the existing and proposed condition flood boundaries based on the 100- and 500-year floods. Figure 4 shows the flood boundaries just for the proposed condition. More detailed discussions on these figures are included in the narratives for the Existing and Proposed Condition models.

The narratives are followed by the tabulated results of the hydraulic analyses which were prepared for comparing the proposed to existing, and the proposed to natural conditions.

The HEC-RAS input data and output tables are included in the Appendices A and B. An electronic copy of the HEC-RAS data files are also enclosed in the back of this report.

The hydraulic models included in this report are mainly used to:

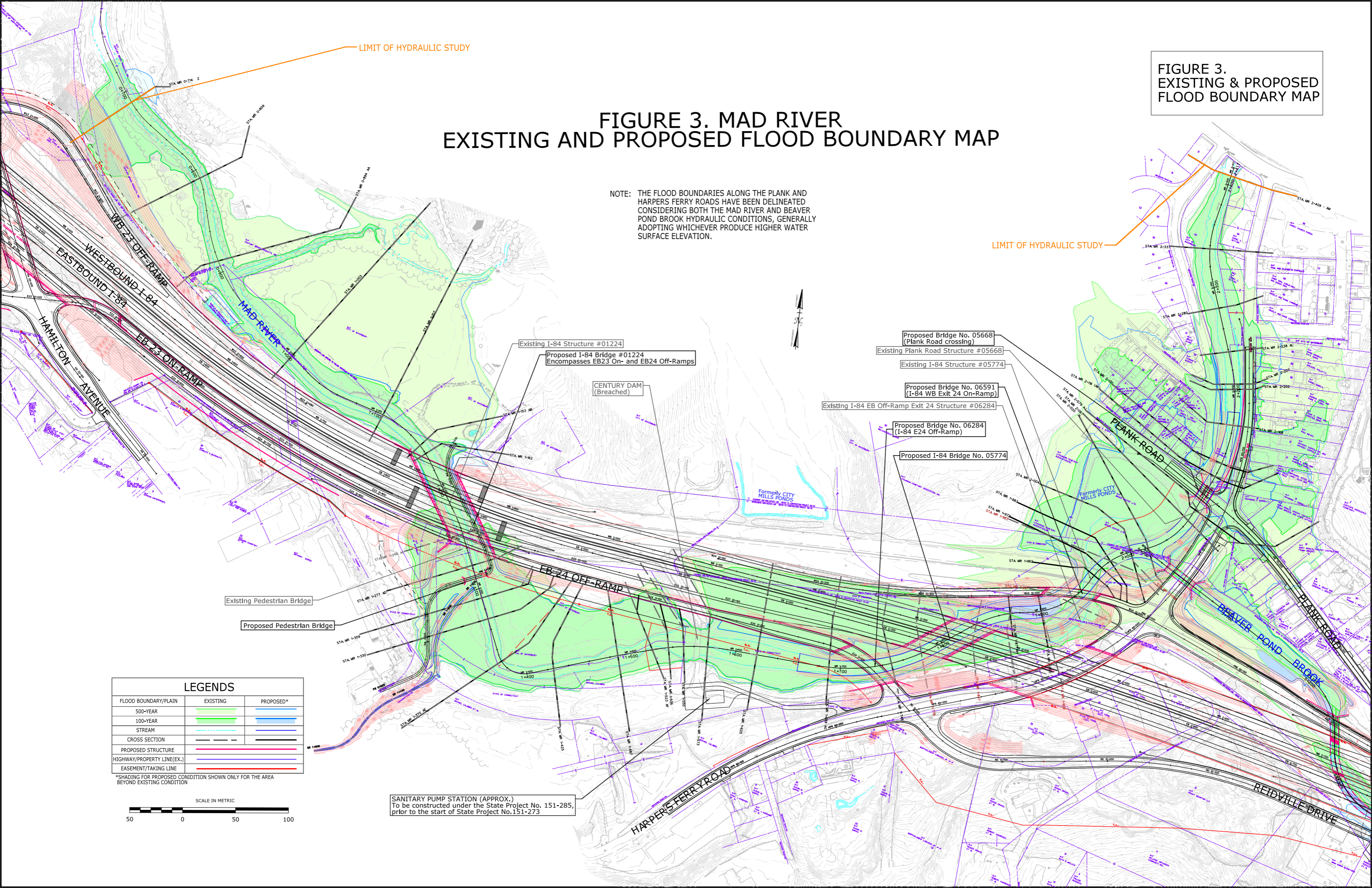
- design five bridges and one culvert along the Mad River, including computing scour depths.
- estimate scour potential along retaining walls adjacent to the watercourse.
- design stable channel sections.
- design fish habitat enhancements.

This report is intended to describe the design aspect of the waterway crossings and the resulting water surface profiles along the river. The stream habitat enhancement features and design elements for channel stability are described in the *Final River Relocation Report*. The scour potential assessment is included in the separate *Final Scour Reports* prepared for the individual, proposed bridge crossings.

**FIGURE 3.  
EXISTING & PROPOSED  
FLOOD BOUNDARY MAP**

# FIGURE 3. MAD RIVER EXISTING AND PROPOSED FLOOD BOUNDARY MAP

NOTE: THE FLOOD BOUNDARIES ALONG THE PLANK AND HARPERS FERRY ROADS HAVE BEEN DELINEATED CONSIDERING BOTH THE MAD RIVER AND BEAVER POND BROOK HYDRAULIC CONDITIONS, GENERALLY ADOPTING WHICHEVER PRODUCE HIGHER WATER SURFACE ELEVATION.



LIMIT OF HYDRAULIC STUDY

- Existing I-84 Structure #01224
- Proposed I-84 Bridge #01224  
Encompasses EB23 On- and EB24 Off-Ramps
- CENTURY DAM  
(Breached)
- Formerly CITY MILLS PONDS
- Proposed Bridge No. 05668  
(Plank Road crossing)
- Existing Plank Road Structure #05668
- Existing I-84 Structure #05774
- Proposed Bridge No. 06591  
(I-84 WB Exit 24 On-Ramp)
- Existing I-84 EB Off-Ramp Exit 24 Structure #06284
- Proposed Bridge No. 06284  
(I-84 E24 Off-Ramp)
- Proposed I-84 Bridge No. 05774

- Existing Pedestrian Bridge
- Proposed Pedestrian Bridge

LEGENDS		
FLOOD BOUNDARY/PLAIN	EXISTING	PROPOSED*
500-YEAR		
100-YEAR		
STREAM		
CROSS SECTION		
PROPOSED STRUCTURE		
HIGHWAY/PROPERTY LINE(EX.)		
EASEMENT/TAKING LINE		

\*SHADING FOR PROPOSED CONIDITION SHOWN ONLY FOR THE AREA BEYOND EXISTING CONIDITION

SCALE IN METRIC

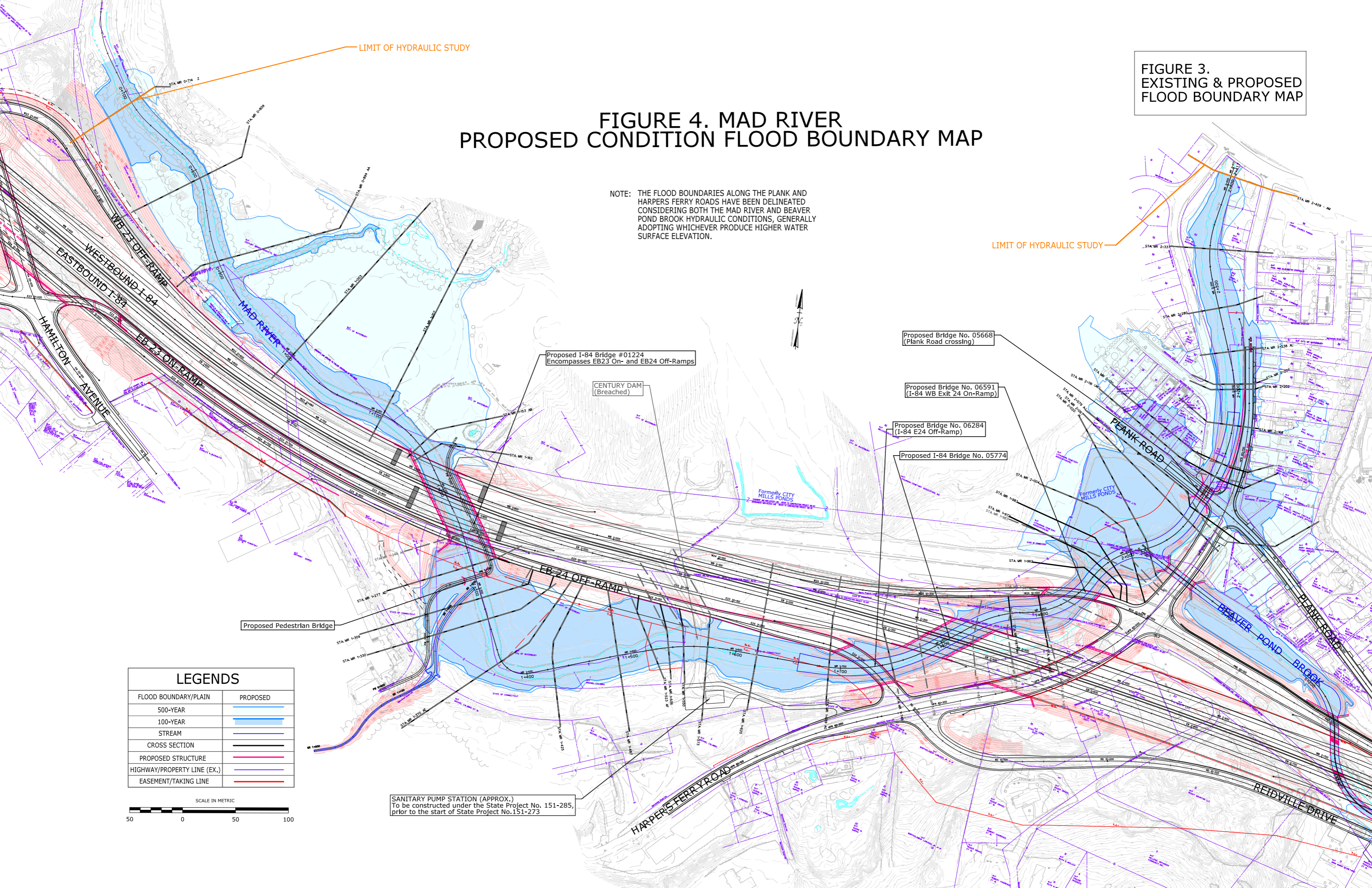
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SANITARY PUMP STATION (APPROX.)  
To be constructed under the State Project No. 151-285,  
prior to the start of State Project No.151-273

FIGURE 3.  
EXISTING & PROPOSED  
FLOOD BOUNDARY MAP

# FIGURE 4. MAD RIVER PROPOSED CONDITION FLOOD BOUNDARY MAP

NOTE: THE FLOOD BOUNDARIES ALONG THE PLANK AND HARPERS FERRY ROADS HAVE BEEN DELINEATED CONSIDERING BOTH THE MAD RIVER AND BEAVER POND BROOK HYDRAULIC CONDITIONS, GENERALLY ADOPTING WHICHEVER PRODUCE HIGHER WATER SURFACE ELEVATION.



LIMIT OF HYDRAULIC STUDY

LIMIT OF HYDRAULIC STUDY

Proposed I-84 Bridge #01224  
Encompasses EB23 On- and EB24 Off-Ramps

CENTURY DAM  
(Breached)

Proposed Bridge No. 05668  
(Plank Road crossing)

Proposed Bridge No. 06591  
(I-84 WB Ext 24 On-Ramp)

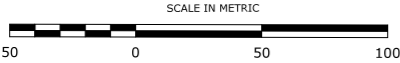
Proposed Bridge No. 06284  
(I-84 E24 Off-Ramp)

Proposed I-84 Bridge No. 05774

Proposed Pedestrian Bridge

SANITARY PUMP STATION (APPROX.)  
To be constructed under the State Project No. 151-285,  
prior to the start of State Project No.151-273

LEGENDS	
FLOOD BOUNDARY/PLAIN	PROPOSED
500-YEAR	
100-YEAR	
STREAM	
CROSS SECTION	
PROPOSED STRUCTURE	
HIGHWAY/PROPERTY LINE (EX.)	
EASEMENT/TAKING LINE	



## Existing (Pre-Project) Condition

There have been several significant changes in the area in recent years. These are:

- Century Dam (a.k.a. Scovill Pond Dam, East Brass Mill Pond Dam, City Mills Pond Dam) was breached in 1998 pursuant to a 1988 administrative order issued by the Connecticut Department of Environmental Protection.
- Following the 1998 breach, the channel upstream of the dam has migrated laterally, and still appears to be changing.
- In 1994 the construction of Structure No. 06284 was completed over the Mad River for the I-84 Eastbound Exit 24 Off-Ramp to Harpers Ferry Road.
- Structure No. 05668 (Plank Road over the Mad River) was replaced in 1987.

Another area of interest is a sanitary pump station which currently exists south of the Mad River at the southwest quadrant of the I-84 interchange with Harpers Ferry Road. This pump station is in conflict with the proposed realignment and widening of the I-84; hence, a new pump station is currently being installed approximately 275 meters (900 feet) southwest of the existing station. The new location is at the southwest quadrant of the new I-84 interchange with Harpers Ferry Road, just south of the breached Century Dam. The sanitary sewer relocation and new pump station construction are being performed under the State Project No. 151-285, and anticipated to be completed prior to the start of the State Project 151-273 construction.

### DEVELOPMENT OF EXISTING CONDITION MODEL

In developing the Existing Condition model, a total of forty (40) stream cross sections were utilized excluding the internal sections at the waterway crossings. These cross sections have been located to accurately portray the existing river; and in some areas, to provide a matching section to a section in the Proposed Condition model. Nonetheless, not all the cross sections in the Proposed Condition model could feasibly be matched with an existing condition section because of the proposed river relocation and the new bridge locations. For example, the Section 1962 in the Proposed Condition model is located within the span of the existing I-84 bridge Structure No. 05774. This bridge is bound by the Sections 1927 and 1983 in the Existing Condition model, and placing a section between them is not possible in the HEC-RAS.

Except for the boundary sections, the location of these cross sections match the sections included in the Floodway Models. A Cross Section Location Plan is included in Appendix E.

The Digital Terrain Model (DTM) surface file from which the cross sections were cut was developed from the project survey information. The project survey/base map was generated with the photogrammetry mapping based on April 1998 flight from Aero-Metric, Inc. (Sheboygan, WI). This was then partially edited with ground survey data from AI Engineers, Inc (Middletown, CT). Where the survey coverage was not sufficient to accurately portray the

geometry of the river, additional hydraulic cross-sectional surveys were performed by Ammann & Whitney initially, then by the ConnDOT survey forces. Relatively recently the Mad River reach from the breached dam to the Plank Road crossing was re-surveyed by AI Engineers, as the river geometry was noticeably changed within that reach.

The bank stations for each section were generally set at the physical location of the top of channel banks. In some situations, however, it had to be set at a point along the channel bank consistent with the Floodway Models. In the Floodway Models, such setting was necessary, as the encroachment stations had to be set on the river bank matching the effective Floodway encroachment width. See the *Mad River Floodplain/Floodway Analysis Report* for more detailed discussion on the Floodway encroachment and bank station setting.

For the main channel, a Manning's roughness coefficient of 0.04 was generally used. However, for some areas, especially near the toe of slopes from upstream of the breached Century Dam to downstream of the Structure No. 06284 (I-84 Eastbound Exist 24 Off-Ramp), the coefficient was lowered to 0.03 where the bare soil was exposed showing signs of active erosion. For the floodplain areas and upper portion of the channel banks, the Manning's roughness coefficients ranging from 0.02 to 0.08 were applied depending on the coverage type.

Throughout the model, the Ineffective Flow Area and Blocked Obstruction features in the HEC-RAS were utilized to incorporate the effects of buildings and other obstructions on the floodplains. At waterway crossings, the ineffective flow areas were set consistent with the recommendations in the HEC-RAS manual.

As modeled, the Existing Condition incorporates all the above-listed recent changes in the area except for the new sanitary pump station, though it will be present in the "existing condition" at the start of the project construction. The new pump station was not included in the Existing Condition model because it was developed from the project survey that was obviously performed prior to the construction of the station. Nonetheless, the analysis of the existing condition shows that its 100-year flood boundary just borders the fill slope from the pump site, as shown on Figure 3, indicating that it will have no effect on the existing floodplain.

## HYDRAULIC CONDITION AT AND IN THE VICINITY OF INDIVIDUAL STRUCTURES

Review of the Existing Condition analysis indicates that two (2) structures among the five (5) existing waterway crossings within the study limits would be overtopped by the 100-year flood. These are the Plank Road crossing and the pedestrian bridge located upstream of the westerly I-84 crossing. In the event of the 500-year flood, the easterly I-84 crossing would also be overtopped by the flow. The hydraulic conditions at these crossings as well as at all the other structures are discussed below.

### Plank Road Crossing, Structure No. 05668:

The structure was replaced by the City of Waterbury in 1987. It is a single span bridge consisting of concrete abutments with a precast concrete deck unit superstructure. The clear span, measured between the abutment faces, is 13.1 m (43 ft). The width of the crossing perpendicular to the roadway baseline is 13.4 m (44 ft).

When considering the flow condition only at the crossing, the hydraulic analysis of the existing condition indicates that the river flow would begin to overtop the crossing at approximately 21-year frequency discharge.<sup>3</sup> As the existing bridge is perched above the approach roadway elevation, the overtopping would occur east of the bridge deck over the intersection with Harpers Ferry Road. However, even before this overtopping condition develops, the analysis indicates that Harpers Ferry Road would be inundated by as low as a 16-year frequency storm (see Appendix D). The roadway runs parallel to the river, separately only by the riverbank. At approximately 70 meters (230 ft) upstream from the crossing, the flood elevation rises above the river bank and spreads onto the roadway. Although the main channel flow elevation recedes below the top of the bank as it approaches the crossing, once the flood enters the roadway, it would be directed toward nearby low lying areas and potentially cause flooding in the surrounding private properties.

The 100-year flood would overtop the crossing by approximately 0.8 m (over the easterly roadway approach). The overtopping condition at the crossing can be attributed to several factors:

- The profile of Plank Road is relatively low (approximately 2.7 m or 9 ft) compared to the channel invert of the Mad River.
- Upstream of Plank Road, the floodplain of the Mad River has been nearly completely filled in to accommodate roadways and residential developments. The hydraulic capacity of the existing river channel is insufficient to convey the 100-year design discharge which results in overbank flows that inundate Plank Road, Harpers Ferry Road, Brook-Dale Lane and the surrounding residential properties.

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<sup>3</sup> Based on hydraulic gradeline. The HEC-RAS determines the weir flow (overflow) split based on the energy gradeline, in which case the overtopping frequency is approximately 16.5-year. All the overtopping frequencies mentioned in this report is based on the hydraulic gradeline.

- Existing I-84 Structure No. 05774, located approximately 122 m (400 ft) downstream of the Plank Road crossing, causes approximately one meter (3.3 ft) of backwater for the 100-year flood. This backwater extends upstream to Plank Road, reducing the hydraulic capacity of the existing bridge and aggravating roadway overtopping.

The highest computed flow velocity through the crossing was 3.1 m/s (10.2 ft/s), which is based on the 50-year frequency discharge. This was found higher than the velocity from the 20-year discharge of the overtopping condition. This is because of the physical obstructions (modeled as ineffective flow area) in the path of the overflow which forces a larger portion of the flow being conveyed through the bridge opening than as weir flow.

The channel at the inlet is aligned such that it enters at a slight angle along the east abutment which is causing local scour up to 0.76 m (2.5 ft) deep. Conversely, there is an accumulation of sand and gravel along west abutment which protrudes out into the channel and extends downstream.

Downstream of the crossing, there is an area of moderate to heavy embankment erosion at the end of the southeast wingwall. The characteristics of the downstream channel are further described in the next structure section.

#### *Easterly I-84 Crossing, Structure No. 05774:*

This structure is the easterly crossing of Interstate 84 over the Mad River within the project limits, and also the first bridge downstream of the confluence with the Beaver Pond Brook.

The bridge consists of single span, precast concrete box beams constructed as part of the original highway work. It has a clear span length of 15.7 meters (51.5 ft) measured between the abutment faces and a total width of approximately 31 meters (102 ft). Its flared wingwalls, especially at the upstream end, are well protected with larger class riprap.

The analysis of this bridge indicates that, although the 100-year flood would fully submerge the bridge opening at its inlet, its upstream water surface elevation would still be approximately 0.8 m (2.6 ft) below the bridge deck elevation. In the case of the 500-year flood, the flow would overtop the deck by approximately 0.6 m (2 ft). As indicated earlier, the backwater from this bridge extends to the existing Plank Road Structure No. 05668. In the high magnitude floods, the backwater would aggravate overtopping of the roadways and flooding of residential structures in the vicinity of that structure.

The greatest computed flow velocity inside the bridge was 4.8 m/s (15.8 ft/s) occurring at the downstream end for the 500-year discharge. The 100-year flow velocity was 3.7 m/s (12.1 ft/s). There is a Standard Riprap slope protection in front of both the upstream and



downstream wingwalls. At the time of developing this model, the riprap protection appeared stable.

The approach channel, however, appears to be continually evolving. Downstream of the Plank Road crossing, the floodplain west of the main river channel widens significantly. As the capacity of the main channel immediately south of Plank Road quickly reduces to 2- to 5-year flow, the higher flows such as the 100-year would spread onto the widened floodplain reducing the average flow velocity. The main channel, on the other hand, initially maintains its mostly southerly path parallel to Harpers Ferry Road until it reaches the confluence with the Beaver Pond Brook. There it makes a nearly 90° turn westerly, aligning with the outflow direction of the Beaver Pond Brook. Then, as it approaches the upstream end of the easterly I-84 crossing, it turns back by a similar degree toward the southerly direction, aligning with the structure's alignment. Comparing the original to the latest hydraulic survey for this area, the channel along the outer bend of the turn has expanded outward, revealing lateral instability of the meandering channel. The channel thalweg elevation has degraded by as much as 0.9 m (3 ft).

*I-84 Eastbound Exit 24 Off-Ramp to Harpers Ferry Road, Structure No. 06284:*

This bridge crossing is located approximately 18 meters (59 ft) downstream of the above-mentioned I-84 Structure No. 05774. It consists of a single span, curved steel box girder structure constructed in 1994. It has a clear span length of 55.5 m (181 ft) measured along the baseline between the abutment faces.

The construction of this structure along with its abutments and approach ramp required placing fill in the City Mills Pond just downstream of the I-84 crossing which narrowed the width of the channel. Furthermore, due to its close proximity, the ineffective flow regions downstream of the I-84 bridge affect the flow through this off-ramp structure. On the other hand, the structure itself does not pose as an obstruction to the flow, as its abutments and superstructure sit well above not only the 100-year but also the 500-year computed water surface elevation. For example, the underclearance between the 100-year water surface elevation and the bridge's low chord was approximately 2.9 m (9.5 ft); 2.1 m (6.9 ft) to the 500-year flood.

The highest flow velocity through the bridge was 3.41m/s (11.2 ft/s) occurring at the 500-year flood. For the 100-year flood, the velocity was 2.98 m/s (9.8 ft/s).

From roughly the midpoint between the Structures No. 06284 and No. 05774 to the Century Dam, there are signs of erosion along the riverbanks revealing the lateral instability of the river channel, which appears to be still affected by breaching the Century Dam and consequent lowering of the water level. The streambanks are actively eroding, forming several shallow meanders. When the original survey was performed, lateral migration of the channel was evident at approximately 90 meters (300 ft) downstream of the crossing for a 70-m (230ft) long segment in which the river channel widened briefly from roughly 15 to 30 meters (50 to 100 ft) with a small island in the

middle and the northerly bank exposing bare earth. Downstream of this segment, however, the channel narrowed back quickly followed by a steeper channel gradient. There the erosion along the streambanks had begun encroaching into a reported bulky landfill site which was apparently active during the dam breach project. The source of the landfill material is purportedly from the development of the Brass Mill Mall site in Waterbury.

Based on the latest survey, a similar but smaller migrating/braiding section has developed between the previous migrating area and the Eastbound Exit 24 Off-Ramp crossing. The lateral shifting is cutting into the southerly embankment of the westerly approach to the off-ramp crossing. Although the latest structure inspection report indicates there is no evidence of channel change, the comparison of the original to the latest hydraulic survey indicates that the streambed has degraded by roughly 0.5 m (1.6 ft)

#### Century Dam:

The partially breached Century Dam is located approximately 350 m (115 ft) downstream of the Structure No. 06284. The remnants of the dam still forms a weir in the river, as its lateral center portion protrudes approximately 0.3 to 0.6 m above the thalweg of the upstream channel. Then, the channel bottom drops approximately 2 meters immediately downstream, forming a scour hole. Considering these geometric conditions, the dam was modeled as an inline weir structure.

The hydraulic model shows the velocity would drop from 2.42 to 1.89 m/s (7.9 to 6.2 ft/s), as the flow passes over the dam and endures the drop. The 100-year flood elevation would be approximately 2.7 m (9 ft) above the top of the weir at the upstream face of the dam; then, drop by 2 m (6.6 ft) at the downstream end of the scour hole.

Approximately 170 meters (560 ft) downstream of the dam, the river turns northwesterly by roughly 90 degrees.

#### Pedestrian Bridge (Upstream of I-84 Westerly Bridge No. 01224):

The existing pedestrian crossing consists of a steel through-girder bridge with a concrete deck founded on concrete abutments on spread footings. It has a clear span length of approximately 21 m (69 ft) measured between the abutment faces, total outside width of 3.3 m (11 ft) and inside lane width of 2.4 m (8 feet). The crossing is located approximately 310 m (1,020 ft) downstream of the dam, or approximately 40 m (130 ft) upstream of existing I-84 Structure No. 01224.

The bridge's superstructure is located 3.2 m (10 ft) above the streambed. Its deck elevation is roughly even with the adjacent easterly floodplain whereas the westerly floodplain is slightly lower. According to the analysis, the bridge would convey the 10-year discharge with a minimum underclearance of 0.45 m (1.48 feet). The 15-year

discharge (see Appendix D) would begin to rise over the bank and spread westerly onto the floodplain. At this discharge, the computed flow velocity through the bridge was 2.06 m/s (6.76 ft/s).

The overflow could begin to occur over the floodplain where the ground elevation is lower than the low chord of the bridge. Until the flow could reach the low chord, the "low flow" condition through the crossing and "weir flow" on the floodplain would exist simultaneously. For this condition, the HEC-RAS program only reported the hydraulic condition under the bridge, which was computed using the energy equation.

Only when the discharge is over 99.7 m<sup>3</sup>/s (3520 cfs), or greater than 23.5-year frequency, the water surface would rise above the low chord. For such condition, the HEC-RAS program used the sluice gate (pressure flow) equation until the weir over the bridge became submerged; then, it reverted to using the energy equation only. In the Mad River model, the 25- and 50-year discharge conditions were computed using the sluice gate equations, whereas the "energy only" method was applied for the 100- and 500-year discharge conditions.

The computed 100-year water surface elevation was approximately 0.9 m (3 ft) above the bridge deck. The flow velocity through the bridge was 1.41 m/s (4.63 ft/s). Due to its relatively close proximity to the westerly I-84 bridge, this bridge affects the headwater of the downstream bridge.

#### Westerly I-84 Crossing, Structure No. 01224:

Existing Structure No. 01224 is the westerly I-84 crossing over the Mad River within the project limits. The crossing, which has a center in-river pier, is a two span bridge with a rolled steel beam superstructure erected as part of the original construction of I-84. It has a total span length of approximately 30.5 m (100 ft) measured between the abutment faces. The analysis shows that the bridge adequately conveys the 100-year flow with approximately 2.7 m (8.9 ft) of clearance below the superstructure. Due to the pier, it is susceptible to catching debris which was not accounted for in the analysis.

Upstream of the bridge, the main channel does not have sufficient capacity to convey the flood flow, and thus causes overflow onto the floodplain. The nearby upstream pedestrian bridge exacerbates the condition forcing more flow onto the floodplain. The path from the pedestrian bridge continues northerly on the east side of the river, and then passes under the I-84 through a tunnel consisting of an approximately 3 m (10 ft) wide by 3 m (10 ft) high concrete box. The 100-year flow on the floodplain would enter the tunnel at a depth of roughly 0.5 m. However, as the tunnel sits at an upward gradient from south to north, it would not function as a hydraulic culvert. Furthermore, as the upstream flood elevation was not be high enough to completely clear the north end of the tunnel, there would be no active conveyance of the flow through the tunnel.

The flow entering the bridge, on the other hand, would undergo significant contraction causing energy loss, and consequent increase in the headwater. As the flow passes through the bridge with diminishing effects of the contraction and of the pedestrian bridge, the 100-year water surface would drop by nearly 1.03 meter (3.4 ft) while the velocity increases by 1.33 m/s, from 3.05 to 4.38 m/s (10.0 to 14.4 ft/s). The subcritical flow entering the bridge would transition to critical flow at 24 meters (79 feet) downstream of the bridge, and it would undergo supercritical condition further downstream before returning to back to subcritical condition. Due to such hydraulic condition, scour holes have formed on both sides of the pier – more severely on the west side. Nonetheless, the existing riverbanks, which are armored with large riprap, appear to be in good condition.

The results of the hydraulic analysis, specifically the water surface elevation and velocity data for the existing condition are tabulated in Tables 3 and 4 for the 100- and 500-year discharges respectively. These tables also contain the result of the proposed condition analysis for comparison, and are included in the narrative section for the Proposed Condition. The data particularly for the waterway crossings are summarized in Table 6 which is include in the *Summary* section.

For all the other flood magnitudes and for more detailed results of the analyses, see the HEC-RAS output tables included in Appendix B.

## AREAS OF FLOODING

The map shown in Figure 3 has been prepared showing both the existing and proposed flood boundaries based on the 100- and 500-year floods. The existing condition boundaries have been delineated using the flood elevations determined at each cross section plotted along the contour lines developed from the project survey. Between the cross sections, the flood boundaries were interpolated.

The delineated width of flood generally matches the computed top width of flow except where the flood rises above the available data in a cross section. In such cases, the flood boundaries were extended to where the flood elevation matches the ground elevation. As indicated earlier, the computed elevation is still deemed adequate, as the area beyond the data included in a cross section does not contribute to the active conveyance of flow due to the significant constrictions.

Reviewing the existing 100-year flood boundary, the flooding upstream and in the vicinity of the Plank Road crossing is most notable, as it affects not only the adjacent roadways but also twenty-nine (29) private properties<sup>4</sup>. Although the crossing does attribute to the flooding as its

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<sup>4</sup> The number excludes the ones affected by the Beaver Pond Brook flow. See the *Hydraulic Analysis For Design Report, Beaver Pond Brook*. It also excludes all the private properties that were acquired or in the process of being acquired by the State for this project. It is noted that the flood boundaries, especially the 500-year flood, along the Plank Road east of Harpers Ferry Road, along the eastern side of Harpers Ferry Road and in the vicinity of the

backwater sets the high tailwater condition for the upstream channel, the primary attributing factor is the insufficient hydraulic capacity of the channel, as described previously in the narrative for the structure. This is evident in the Natural Condition analysis in which the flood flow still rises above the riverbanks and causes flooding even with the crossing structure removed. More detailed discussion on the natural condition is included later.

There are two other areas where the 100-year flood affects private properties. One area is between the breached dam and the westerly I-84 crossing, where there are two private properties located south of the river. The property is located immediately downstream of the dam and currently undeveloped and land-locked due to the lack of access.

Downstream of the existing westerly I-84 crossing (Structure No. 01224), the 100-year flood would spread northerly beyond the river bank, onto the predominantly grass fields of Hamilton Park, a City of Waterbury property. As this field is primarily used for recreational activities such as baseball and soccer, such flood is not anticipated to be life threatening.

At the downstream limit of the study, again on the south side of the river, an existing private bridge crossing just downstream of the study limit seems to cause the 100-year flood to rise above the channel bank and spread onto the southerly floodplain where there is the last affected private property. Although the hydraulic model indicates the width of the spread on the floodplain is approximately 45 m for a length of approximately 85 m along the river, it may not be accurate, as it is located near the downstream limit of the study where the set boundary condition is likely to control the water surface elevation.

In the case of the 500-year flow, the flooding at the above mentioned areas would experience wider and more severe flooding with increased flood elevations. In addition, at the easterly I-84 crossing (Structure No. 05774), the flow would overtop the highway and combine with the overflow from the Beaver Pond Brook east of Harpers Ferry Road. This would result in approximately 300-meter long section of the highway being inundated by the overflow.

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Harpers Ferry Road overpass over I-84 have been delineated considering both the Mad River and Beaver Pond Brook hydraulic models - generally adopting whichever produce higher water surface elevation.

## Proposed (Post-Project) Condition

### DEVELOPMENT OF PROPOSED CONDITION MODEL

The Proposed Condition Model has been developed from thirty-eight (38) stream cross sections, excluding internal sections at the waterway crossings. As described previously, the total number of cross-sections is different compared to the Existing Condition because not all the sections in the Existing Condition model could feasibly be matched with a proposed condition section due to the proposed river relocation and the new bridge locations.

The number of cross section within the main relocation limits is fourteen (14). Although most of these sections have a corresponding section in the existing condition model (by the River Station number), their exact location and orientation are not truly the same due to the relocation. In placing these Proposed Condition sections, the intent was to have at least one common point or intersection with an existing cross section where the comparison of the pre- and post-project conditions may be critical while abiding by the general practices of cutting sections - normal to direction of flow and sufficient coverage to contain all flow ranges of the study. This ensures that the cross sections in the Existing and Proposed Condition models at a common river station are placed at a reasonably comparable location.

Some of the sections were at first cut from the DTM surface file of the project survey; then, modified to reflect the proposed changes. For other sections, particularly within the proposed relocation limits, a merged three-dimensional surface file of the proposed design over the original survey was used.

The Manning's roughness coefficient for the main channel including the relocation limits was set at 0.04 consistent with the exiting condition model. This is within the recommended range of roughness for the proposed Standard Riprap channel banks, gravel streambed with occasionally placed boulders, and other in-stream features. See the *Final River Relocation Report* and the design plans for the detailed aspect of the proposed river channel design.

The Ineffective Flow Area and Blocked Obstruction settings were consistently used to reflect the buildings and other obstructions on floodplains as well as at the waterway crossing.

## COMPARISON OF WATER SURFACE PROFILE AND AREA OF FLOODING TO EXISTING CONDITION

As indicated earlier, the Figure 3 depicts both the existing and proposed condition flood boundaries illustrating how this project affects the area of flooding in the event of the high magnitude storms. In addition, a map showing only the proposed condition flood boundaries has been prepared to provide a clearer depiction of the post-construction condition, which is shown in Figure 4. Whereas the existing flooding limits were drawn based on the contour lines developed from the project survey, the proposed condition flooding limits were established based on the design contour lines provided by Ammann & Whitney. These flooding limits match the computed top width of flow at most cross sections included in the model. In some cases, however, the flooding would occur wider than the computed width if it rises beyond the available data in a cross section. In such cases, the flood boundaries were extended to where the flood elevation matches the ground elevation. Between the cross sections, the flood boundaries were interpolated.

For the comparison of the flood profiles, Figures 5 and 6 have been prepared for the 100- and 500-year floods respectively. These were developed based on the data reflected in the Tables 3 and 4.

As illustrated in these figures, the proposed 100-year flood profile is found generally lower than the existing condition profile. The most significant decrease occurs in the range of 0.70 to 0.77 meter (2.3 to 2.5 feet) for the reach between the Plank Road (Culvert No. 05668) and the existing easterly I-84 crossing (Structure No. 05774), with the largest decrease occurring upstream of the I-84 bridge. This decrease can be associated to the relocation of the I-84 bridge further downstream, thereby removing the obstruction at the existing location. Actually, there will be a new waterway crossing Bridge No. 06591 (Exit 24 On-Ramp) proposed near the downstream face of the existing I-84 structure. However, as it spans well above the flood elevation, the flow will be less constricted through the new bridge than the existing structure, as evident in the decrease in the water surface elevation. As the result, the limits of flooding in the private properties abutting the former City Mill Pond west of the river will be reduced (see Figure 3).

In the event of the 500-year, the decrease at this location will range from 1.06 to 1.11 meters (3.48 to 3.64 feet) with the greatest decrease again occurring at the upstream of the existing easterly I-84 crossing site. With such decrease, the I-84 crossing in the proposed condition will no longer be overtopped by the "super flood".

At and upstream of the Plank Road crossing, the 100-year water surface elevation will also be reduced by as much as 0.72 meter (2.36 feet). This largest decrease will occur approximately 43 meters (140 ft; Cross Section 2168) upstream of the proposed culvert. The decrease at the crossing will be 0.35 meter (1.15 feet). The decreases at the upstream reach are attained mainly from three factors. These are the enlarged waterway opening; increased hydraulic capacity of the upstream channel as the result of relocation and reconstruction; and lowered tailwater condition due to the reduced constriction at the existing easterly I-84 crossing site.

The water surface profiles of the existing and proposed conditions will converge at approximately 232 meters (760 ft; Cross Section 2337) upstream of the Plank Road crossing according to the analysis. Downstream of this location at Section 2280, where there is no proposed work, the analysis also shows an increase of 0.01 meter (0.03 ft) for the 100-year flow. At the next downstream Section 2238, the profiles converge back limiting the affected area of the increase. Except for the roadways, the increase occurs within an undeveloped area where it poses no appreciable adverse impact. In the case of the 10-, 25- and 50-year discharges, the model shows decreases in the water surface elevation, countering the increase in the 100-year. For the 2-, 5 and 500-year discharges, the existing and proposed flood profiles converge at Section 2280 with decreases in the downstream sections. Considering these findings, the 0.01 meter increase in the 100-year flood will have no significant, adverse impact, if it occurs at all. It is possible that the increase may also be resulting from the computation tolerances arising from the lowered water surface elevation further downstream. It is evident by bounding sections where there are no increases.

Due to the overall decrease in the 100-year flood elevation upstream of the Plank Road crossing, the number of private properties that are inundated by the flood will be nearly cut in half to fifteen (15)<sup>5</sup>. The flood inundation area from the 500-year discharge will also be greatly reduced, as shown in Figure 3.

Approximately 150 meters (500 feet) downstream of the existing easterly I-84 crossing site or the proposed Westbound Exit 24 On-Ramp Bridge No. 06591, a replacement I-84 Bridge No.05774 will be constructed. The river leading to this new proposed bridge from the old one will be shaped as a trapezoidal channel with a minimum bottom width of 12 meters (40 ft) and 2:1(h:v) side slopes, which is required due to the realignment of I-84 and consequent partial filling in the former City Mill Pond upstream of the breached Century Dam. These changes result in increases in the 100-year water surface elevation upstream of the bridge (Figure 5). The maximum increase is 0.57 meter (1.87 ft) at the Cross Section 1900, just downstream of the existing Eastbound Exit 24 Off-Ramp. As the increase is contained within the new channel banks and the ConnDOT right-of-way, it will not adversely affect any roadways, buildings and adjacent private properties.

As it approaches and passes through the proposed easterly I-84 crossing (Bridge No. 05774), the proposed condition flood profile declines below the existing condition, then rises back shortly above the existing just upstream of (by 0.17 m or 0.56 ft) and through the proposed Exit 24 Off-Ramp crossing (Bridge No. 06284). The hydraulic conditions at these proposed bridges are discussed more details in the narratives for the individual structures.

Downstream of the off-ramp bridge, the proposed condition profile again deeps below the existing and remains lower until it reaches 84 meters (275 ft) upstream of the proposed pedestrian bridge, or 200 meters (656 ft) downstream of the breached dam. It was indicated previously that a private undeveloped property south of the river immediately downstream of the breached Century Dam would be affected by the 100-year flood flow in the existing condition. Although the flood elevation will be lowered in the proposed condition, the decrease (0.21 meter or 0.69 feet) is not sufficient to have any significant reduction in the flooding area.

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<sup>5</sup> As indicated earlier, the number excludes the ones affected by the Beaver Pond Brook flow.



Upstream of the proposed pedestrian bridge, the 100-year flood elevation is generally computed lower than the existing condition. There is a brief increase of 0.04 m approximately 140 m or at Section 1425 before the decrease begins to occur. However, this occurs within the undeveloped State owned property.

Downstream of the proposed pedestrian bridge through the proposed westerly I-84 crossing (Bridge No. 01224), the 100-year flood profile will mostly be lower than the existing profile, except under the I-84 bridge at the downstream end. Also, at 16 and 62 meters downstream of the I-84 crossing (Cross Sections No. 1153 and 1107), the results show 0.01 and 0.03 meter increases respectively in the flood elevation. These increases will modestly expand the limit of the flooding onto the open field of Hamilton Park, as shown on Figure 3. Nevertheless, considering the intended usage of the park, it will not increase the potential for creating life threatening situations or damages to private properties.

The models show that the downstream convergence of the proposed and existing flood profiles occurring approximately 166 meters (545 ft) downstream from the westerly I-84 crossing at Section 1003, or 292 meters (958 ft) upstream from the downstream limit of the hydraulic study. This shows that the fill slope in the floodplain from the construction of the Westbound Exit 23 Off-Ramp has minimal effect on the 100-year flood elevation.

Within the studied limits, the overall area inside the 100-year flood boundary will be reduced by approximately 28% from 111,140 m<sup>2</sup> (27.5 acres) to 80,370 m<sup>2</sup> (19.9 acres). In the case of the 500-year flood, the areal reduction will be approximately 21% from 181,210 m<sup>2</sup> (44.8 acres) to 143,770 m<sup>2</sup> (35.5 acres). The effects of the loss of flood storage are discussed in the section following the descriptions for the individual structures.

The Tables 3 and 4 showing the results of the Existing and Proposed Conditions hydraulic analyses accompanied by Figures 5 and 6 illustrating the differences in the flood profiles are provided in the following pages. These show the 100-year design and 500-year check flood profiles. As indicated previously, for all the other flood magnitudes and for more detailed results of the analyses, see the HEC-RAS output tables in Appendix B.

The hydraulic conditions at the proposed waterway crossings are further discussed below.

#### HYDRAULIC CONDITION AT AND IN THE VICINITY OF INDIVIDUAL STRUCTURES

Review of the Proposed Condition analysis indicates that two (2) waterway structures among the six (6) within the studied limits will still be overtopped by the 100-year flood, though to lesser extent. The overtopped structures are the Plank Road crossing and the pedestrian bridge located upstream of the westerly I-84 crossing. These structures will obviously be overtopped by the 500-year flood as well, but no other crossing will be overtopped which represents one (1) less than the existing condition. The post-project hydraulic conditions at these crossings as well as at all the other structures are discussed below.

Plank Road Crossing, Culvert No. 05668:

This structure will consist of a triple-barrel concrete box culvert; each barrel will be 4 meters (4.1 ft) wide by 2.7 meters (8.9 ft) high. The width of the structure, measured along the proposed river baseline, will be 14.0 meters (46 ft). The top edge of the culvert inlets will be beveled to improve the entrance loss coefficient to 0.2. The proposed culvert barrels will be fitted with 220-mm (8.7-inch) high concrete baffles and backfilled with 600 mm (2 ft) of gravel streambed material to facilitate fish passage. The computed composite Manning's Roughness Coefficient inside the culvert is 0.028. The computation is included in Appendix C.

The proposed structure will provide a 12% increase in the waterway opening (from 22.5 to 25.2 sq. m.), and thus will alleviate the potential for the roadway-overtopping flow condition. It can convey approximately up to the 70-year frequency discharge<sup>6</sup>, as opposed to the 20-year frequency in the existing condition (see Appendix D). However, the upstream channel will reach its capacity at approximately the 54-year discharge, above which overflow will begin to occur onto Harpers Ferry Road. This is still an improvement as such condition occurs at approximately 16-year frequency in the existing condition.

The 100-year flood will continue to overtop the roadway, as it does in the existing condition. However, the overflow will be reduced to 30.91 m<sup>3</sup>/s from 53.75 m<sup>3</sup>/s in flow rate, and to 115.20 M (377.95 FT) from 115.55 M (379.1 FT) in elevation. As described earlier, the reduction leads to a significantly less number of private properties being inundated by the flood flow. In the case of the 500-year flow, the flood elevation over the crossing will be reduced to 116.01 M (380.9 FT) from 116.55 M (382.4 FT).

One of the reasons the culvert crossing is proposed rather than a bridge is that it is capable of withstanding overtopping flows with less potential damage as compared to a bridge.

Alternatives that would eliminate the overtopping condition are impractical within the scope of this highway project. Such alternatives would necessitate taking numerous residential properties in total and raising the superstructure of the Plank Road crossing above the 100-year flood elevation to eliminate overtopping flows. This would require corresponding increases in the roadway profiles of Plank Road, Harpers Ferry Road and Brookdale Drive. This is complicated by the need to maintain access to the adjacent residences and provide positive drainage of these properties.

The flow velocity through the crossing will be increased in the proposed condition. Among the studied range of frequencies, the 36-year discharge (or when the energy gradeline is at the overtopping elevation) produced the highest flow velocity through the

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<sup>6</sup> Based on hydraulic gradeline. The HEC-RAS determines the weir flow (overflow) split based on the energy gradeline, in which case the overtopping frequency is approximately 36-year. All the overtopping frequencies mentioned in this report is based on the hydraulic gradeline.

culvert at 4.09 m/s (13.4 ft/s), as opposed to 3.1 m/s (10.2 ft/s) in the Existing Condition model. At such high velocity condition, the gravel streambed material will likely be washed away exposing the baffles installed at the bottom, as well as increasing the waterway opening size. With the baffles exposed, the composite roughness changes to 0.035 (see Appendix C); the resulting highest velocity will then reduce to 3.53 m/s occurring at the 50-year discharge, at which the energy gradeline reaches close to the overtopping elevation. This condition was assessed using the HY8 Energy program based on the FHWA Hydraulic Engineering Circular No. 14 (HEC-14). It was found that a riprap basin using Standard Riprap would be adequate for the condition. However, as the flow expands rapidly adopting to the channel geometry downstream of the culvert, the velocity will naturally decrease. For example, at the immediate downstream Section 2079, the highest velocity in the proposed condition drops to 2.89 m/s (9.5 ft/s), occurring at the 10-year discharge. Thus, a toed-in Standard Riprap Revetment is proposed for the river bank protection instead of the riprap basin. The computation based the HEC-11 procedure (Revetment Design) indicates that the revetment will be adequate for the anticipated flow conditions. The channel stability computations for the entire limits of the proposed river relocation are included in the *Final River Relocation Report*.

I-84 Westbound I-84 Exit 24 On-Ramp Crossing, Bridge No. 06591:

This structure will be needed for a new on-ramp from Harpers Ferry Road, as the existing interchange does not include an on-ramp to the Westbound I-84.

The proposed Bridge No.06591 will be a single span bridge on a curved alignment with a clear span of approximately 48 meters (157 feet) measured along the roadway baseline between the abutment faces. The width of the structure, perpendicular to the roadway baseline, will be 8.9 meters. The roadway will be at a 45° skew to the river baseline. To account for this skew and the curved alignment, the proposed conditions analysis assumed the minimum hydraulic clear span of the structure to be 28.65 m (94 ft).

The downstream face of the bridge is located at close proximity to the downstream face of existing easterly I-84 crossing (Structure No. 05774) over the Mad River, which will be removed (relocated) as indicated previously. Compared to the existing condition at this location (downstream face), the 100-year water surfaces will not change much (an increase of 0.01 m while there is significant decrease upstream). In the case of the 500-year flood, the decrease continues at the downstream face section, as the flow will pass under the proposed bridge whereas it would overtop the I-84 structure in the existing condition.

The bridge abutments are located such that they will not obstruct the flow up to the 100-year flood. Therefore, the proposed bridge will not cause any significant upstream backwater conditions. In addition, the superstructure will be elevated well above the river such that a minimum underclearance (at the downstream-westerly end of the structure) of approximately 4.7 m (15.5 ft) to the 100-year water surface elevation, and

3.7 m (12.3 ft) to the 500-year water surface elevation will be attained. These resulting water surface elevations are lower than the existing condition.

Although the flood flows up to the 100-year discharge will not be obstructed by the bridge abutments, significant contraction of flow will occur approximately 15 meters (50 ft) upstream of the proposed crossing. The degree of contraction will be less than the existing condition with the removal of the I-84 Structure No. 05774 from its current location; nonetheless, because of the remnants of the existing I-84 embankment, the flood flow will continually be forced to reduce its width drastically - from 134 meters (440 ft) near the confluence with the Beaver Pond Brook (RS 2020) to 25 meters (82 ft) where the former City Mill Pond narrows to the channelized river section. According to the hydraulic analysis, the 100-year flow velocity increases from 1.2 m/s (3.9 ft/s) at RS 2020 to 2.1 m/s (6.9 ft/s) at the beginning of the channelized section (RS 1962), then to 2.9 m/s (9.5 ft/s) through the bridge opening. The flow velocity through the bridge opening for the 500-year discharges will be 3.1 m/s (10.2 ft/s). To minimize contraction scour that may affect the bridge, this area will be protected with rounded stone riprap installed along the channel invert (between stations MR 1+940 and 1+970). This will reduce the potential head-cutting upstream of the bridge due to the contraction of flow at the entrance of the relocated channel.

The scour potential in the vicinity of the proposed bridge based on these hydraulic conditions has been investigated and discussed in the separately prepared *Scour Report, Bridge No. 06591*. As indicated earlier, the scour assessment and related discussions for all the proposed bridge structures are included in the Scour Reports prepared for the individual bridges.

*Easterly I-84 Crossing, Bridge No. 05774:*

Located approximately 150 m (500 ft) downstream (along the relocated river) from the existing I-84 Structure No. 05774, this new bridge will be a single span, welded steel plate girder bridge with a clear span of 26 m (85 ft) perpendicular to the abutment faces. The width measured perpendicular to the roadway baseline will be approximately 40 meters (132 ft), or 57 m (188 ft) along the river baseline.

As the geometry of the river will be changed at the proposed bridge site, exact comparison of the flood elevations to the existing condition is not possible. Nevertheless, the locations of the upstream and downstream faces of the bridge are considered most comparably to the Sections 1837 and 1778 respectively of the Existing Condition model. Comparing the 100-year water surface elevations at these locations, the results indicate that, even with the placement of a new waterway crossing where none currently exists, the design flood profile will be mostly lowered with only a slight increase at the upstream end. The computed differences were 0.02 m (0.07 ft) increase and 0.28 m (0.92 ft) decrease for the upstream and downstream faces respectively. This can be attributed to the proposed grade of the relocated river which will be on a constant downgrade. In the existing condition, the river is on an adverse grade (upward gradient) downstream of

these sections potentially causing more energy loss. As the flow approaches the adverse grade it sets the flood profile at a constant elevation (flat grade) through these sections. The flat versus on-grade profiles produced the increase and decrease over the segment.

The 100-year flow will pass through the proposed bridge with minimal constriction resulting in a minimum underclearance of 0.66 m (2.17 ft), which is to the low chord at the downstream-westerly end of the structure.

For the 500-year flow, the water surface elevation will also be higher at the downstream end. The increases are 0.57 m (1.87 ft) and 0.13 m (0.43 ft) at the upstream and downstream faces respectively. These increases may be explained by the channelization of the river section which narrows the width of the flood resulting in the rise of the water surface. There will also be some head losses due to the obstructions caused by the abutments.

The flow velocity through the bridge opening will be 3.0 m/s (9.8 ft/s) and 3.42 m/s (11.2 ft/s) respectively for the 100- and 500-year discharges.

*I-84 Eastbound Exit 24 Off-Ramp to Harpers Ferry Road, Bridge No. 06284:*

As the new alignment of the off-ramp will traverse the former City Mills Pond located upstream of the breached Century Dam, the replacement bridge will be located approximately 190 meters (625 feet) downstream (southwesterly) of the existing off-ramp Structure No. 06284.

The proposed structure will be a single span bridge with a clear span of approximately 51.5 meters (169 ft) measured along the roadway baseline between the abutment faces. The width of the structure, perpendicular to the roadway baseline, will be 14.3 m (47 ft). The roadway will be on a curved alignment at approximately a 43° skew to the river baseline.

The superstructure will be elevated well above the river with a minimum underclearance of approximately 6.5 m (21.3 ft) to the 100-year, and 5.8 m (18.9 ft) to the 500-year water surface elevations. Moreover, the flood flows will mostly be contained within the main channel resulting in only minor losses from contraction. Accordingly, the backwater from this bridge will not affect the proposed I-84 Bridge No. 05774 which will be located relatively close at approximately 40 m (130 feet) upstream.

Comparing the proposed 100-year flood profile to the existing profile between the Sections 1689 and 1748 reveals that the new bridge will cause increases of 0.23 m (0.75 ft) and 0.35 m (1.15 ft) at the upstream and downstream faces respectively. As shown on the Figures 3 and 5, the increase will occur for a short distance along the river, mainly inside the bridge, and are well contained within the main channel banks and within the ConnDOT right of way. The increase can be attributed to the geometric changes in the river. In the Existing Condition profile plot, the water surface begins to make a steeper

decline at Section 1778, approximately 40 meters (130 ft) upstream of the new bridge which appears to be caused by the riverbed grade change downstream of Section 1689. In the Proposed Condition plot, the similar decrease does not occur until the flow passes through the proposed bridge.

The flow velocity through the bridge opening will be 2.98 m/s (9.78 ft/s) and 3.44 m/s (11.29 ft/s) respectively for the 100- and 500-year discharges.

#### Century Dam:

Along the remaining, protruding lateral portion of the breached dam, approximately one-half of the length will be removed to the upstream streambed elevation. Downstream of the dam, a rock ramp fishway will be constructed for fish passage, requested by the CTDEEP.

With the existing concrete vertical side walls remaining in place, the other half of the lateral portion of dam combined with the several boulder weirs spanning across the proposed rock ramp will continually act as a weir and constrict flow. The proposed work, however, will lower the 100-year flood elevation by 0.18 m (0.59 ft) at this location. A similar amount of reduction (0.14 m) will be attained in the 500-year flood.

#### Pedestrian Bridge:

Due to the realignment and widening of I-84, a new pedestrian bridge will be constructed 28 meters (92 feet) upstream of its present location. The proposed superstructure will be a prefabricated, steel truss bridge founded on cast-in-place concrete abutments supported by spread footings. It will have a clear span length of 20.6 meters (67.6 feet, measured between the abutment faces) with an inside lane width of 3 meters (10 feet) and overall width of approximately 3.5 meters (11.5 ft). The crossing will be a part of the pedestrian walkway that will follow the easterly bank of the Mad River under the new I-84 Bridge No. 01224 to Hamilton Park, instead of crossing the highway via the existing 3 m wide concrete box, which will be abandoned.

Similar to the existing pedestrian bridge, the elevation of the new bridge deck will be relatively low to minimize both the need for high approach embankments and fill in the floodplain. The bridge will convey the 10-year flow with 0.15 meter (0.5 ft) of underclearance. According to the analysis, the overtopping flood will have an estimated recurrence interval of 19 years (see Appendix D). The 100-year flood elevation will be approximately one meter (3 feet) above the bridge approaches.

As the pedestrian bridge will be constructed where no structure currently exists, it signifies placing more physical constriction to the flow at this location. Nonetheless, the analysis indicates that the resulting water surface elevations will be actually lower than the existing condition. For the 100-year discharge it will be lowered by approximately

0.11 m (0.36 ft) at the upstream and 0.22 m (0.72 ft) at the downstream faces, and by 0.28 m (0.92 ft) at the further downstream Section 1227. This is because of the differing downstream conditions. Downstream of the proposed pedestrian bridge, the new westerly I-84 Bridge No. 01224 is proposed in close proximity such that its upstream face will be placed where the existing pedestrian bridge is located. The proposed I-84 bridge will present less constriction than the existing pedestrian bridge such that it generates a lower backwater toward the location of the new pedestrian bridge. Moreover, the existing pedestrian bridge is affected by the backwater from the existing I-84 structure which is hydraulically inferior compared to the proposed I-84 bridge due to the constriction caused by its piers. This causes greater rise over the existing pedestrian bridge than the similarly configured proposed bridge. This is evident in the results of the analysis which shows approximately 63% of the 100-year flow going over the existing bridge, whereas the weir flow will be approximately 44% over the proposed bridge. Nonetheless, as the proposed pedestrian bridge will be placed further upstream of the existing structure where no hydraulic crossing is currently present, the increases in the upstream reach seem unavoidable for certain flow conditions such as the 50-year event. In the 50-year event, the increase will be as much as 0.28 m (0.92 ft). On the other hand, there will be decreases in other studied conditions such the 2- (by 0.11 m), 5- (by 0.17 m), 10- (by 0.2 m), 25- (by 0.02 m) and 500-year (by 0.2 m).

Back to the 100-year design discharge condition, with the more flow conveyed by the bridge opening, the flow velocity through the opening will be increased in the proposed condition. For the 100-year discharge, the proposed velocity will be 2.39 m/s (7.8 ft/s), which is 0.98 m/s (3.2 ft/s) higher than through the existing bridge. Among the studied discharges, the 50-year velocity was highest at 2.5 m/s (8.2 ft/s). For these flow conditions, the scour potential has been investigated and discussed in the separately prepared *Scour Report, Pedestrian Bridge Crossing*. The substructure of the bridge has been designed considering the anticipated scour depth.

The structural design of the bridge also considered the anticipated 100-year flood overtopping condition assuming the following loading conditions:

- Buoyancy
- Unbalanced Hydrostatic Pressure- aggravated by the collection of debris on the upstream face of the truss
- Hydrodynamic Loading- caused by the channel flow velocity
- Normal Impact Load- assuming a 1000 pound mass traveling at the channel flow velocity and a 1 second time of impact
- Special Impact Load- caused by a 100 pound load times the overall length of the truss acting horizontally over any one foot wide horizontal strip assuming a 1 second time of impact

Both the above loading conditions and the hydraulic analyses assumed that the proposed truss will be susceptible to debris clogging and, therefore, will completely block the passage of flow. In reality, the likelihood of such condition developing, especially for every 100-year event, is not high. Hence, the actual water elevations may be lower.

Westerly I-84 Bridge No. 01224:

Due to the proposed highway widening, this bridge will replace existing I-84 Structure No. 01224 over the Mad River. The new crossing will be a single span, welded steel plate girder bridge with spill-through type concrete abutments, eliminating the need for the existing center pier. The minimum span of the bridge will be 29.2 meters (95.8 feet) measured between the abutment faces. The roadway will be skewed approximately 60° to the watercourse. The width of the crossing (measured along the river baseline) will be increased from 40 meters (131 feet) to 91 meters (298 feet) to accommodate two additional lanes along the Interstate and the realignments of the Eastbound Exit 23 On-Ramp and the Exit 24 Eastbound Off-Ramp. Even with the wider bridge, it is anticipated that the constriction through the crossing will be lowered primarily due to the elimination of the existing in-water pier. The elimination will also reduce the scour potential, improve aquatic habitat and reduce the potential for debris clogs.

The widening will be accomplished mostly on the upstream side of the crossing, and will necessitate extending the existing riprap revetments likewise. It will also require relocating the pedestrian bridge approximately 28 meters (92 feet) upstream as well as the existing walkway it carry to under the proposed I-84 bridge, as described previously.

As the flow enters and transitions from upstream to downstream ends of the proposed bridge, the change in the water elevation as well as the velocity will be smaller compared to the existing condition due to less constriction. While the water surface elevation will drop approximately 0.74 m (2.4 ft) through the bridge, the change in velocity will be 0.89 m/s (from 2.58 to 3.47 m/s). This produces the minimum superstructure underclearance of approximately 2.2 meters (7.2 feet) for the 100-year flow at the downstream face of the bridge. Compared to the existing condition, this elevation is 0.27 meter (0.9 ft) higher. The resulting downstream end velocity will be 0.91 m/s (3 ft/s) lower than the existing condition.

Immediately downstream of the bridge (at Section 1162), the existing and proposed profiles will virtually converge (the proposed condition elevation is actually 0.01 m lower than the existing condition) limiting the increase to a short distance along the river and within the main channel inside the State's Non-Access Highway Line. Accordingly, no other measure to lower the water surface is proposed.

For the 500-year discharge, the minimum underclearance will be approximately 2 meters (6.6 feet), again at the downstream end. The resulting water surface elevation, on the other hand, will be approximately 0.14 meter (0.46 ft) lower than for the existing bridge. The flow velocity will be 4.72 m/s (15.5 ft/s) which is also lower than the existing condition by 0.35 m/s (1.15 ft/s).

The results of the hydraulic analysis for all the proposed waterway crossings are summarized in Table 6 include in the *Summary* section.



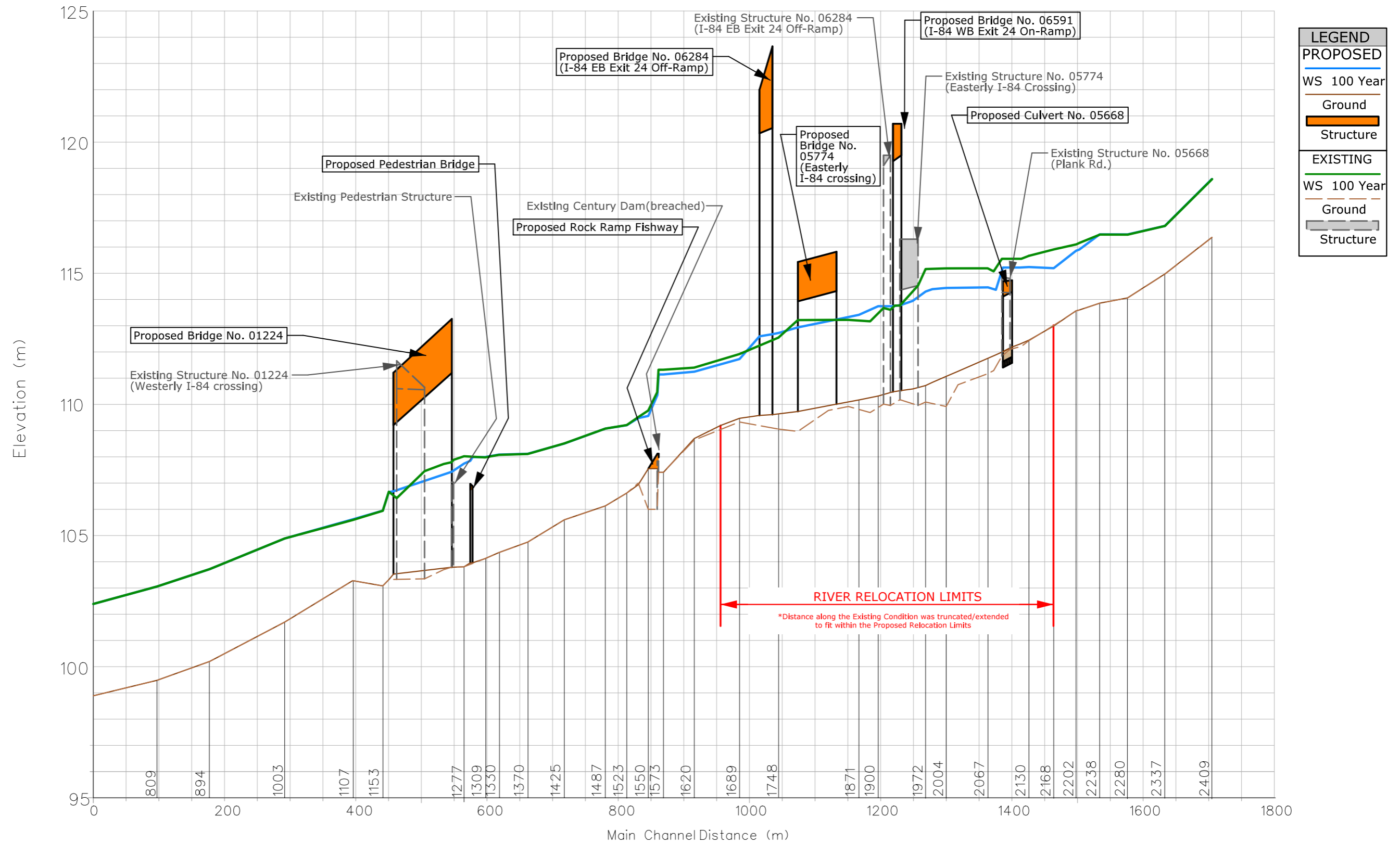
**TABLE 3. Proposed versus Existing Condition  
100-Year Discharge (CT DOT Q)  
Mad River, Waterbury**

NGVD-29

FEMA Sta.	River Sta.	Metric							English					
		Existing Condition		Proposed Condition		Difference		Existing Condition		Proposed Condition		Difference		
		W.S. Elev. (m) (1)	Velocity (m/s) (2)	W.S. Elev. (m) (3)	Velocity (m/s) (4)	W.S. Elev. (m) (3) - (1)	Velocity (m/s) (4) - (2)	W.S. Elev. (ft) (5)	Velocity (fps) (6)	W.S. Elev. (ft) (7)	Velocity (fps) (8)	W.S. Elev. (ft) (7) - (5)	Velocity (fps) (8) - (6)	
AM	5143.0	2409	118.59	4.31	118.59	4.31	0.00	0.00	389.08	14.1	389.08	14.1	0.00	0.0
		2337	116.80	4.87	116.80	4.87	0.00	0.00	383.20	16.0	383.20	16.0	0.00	0.0
		2280	116.47	3.97	116.48	3.96	0.01	-0.01	382.12	13.0	382.15	13.0	0.03	0.0
AL	5142.0	2238	116.48	2.30	116.48	2.28	0.00	-0.02	382.15	7.5	382.15	7.5	0.00	-0.1
		2207	116.16	2.73	115.91	3.33	-0.25	0.60	381.10	9.0	380.28	10.9	-0.82	2.0
		2202	116.10	2.75	115.86	3.24	-0.24	0.49	380.91	9.0	380.12	10.6	-0.79	1.6
		2168	115.91	2.29	115.19	3.72	-0.72	1.43	380.28	7.5	377.92	12.2	-2.36	4.7
		2130	115.67	2.05	115.23	2.33	-0.44	0.28	379.50	6.7	378.05	7.6	-1.44	0.9
AK	5141.0	2116	115.55	2.60	115.20	2.25	-0.35	-0.35	379.10	8.5	377.95	7.4	-1.15	-1.1
REPLACE	2095.5 (PR2098.5)	Proposed Plank Road Culvert No. 05668 (Existing Structure No. 05668)												
AJ	5140.0	2079	115.07	2.61	114.34	2.59	-0.73	-0.02	377.53	8.6	375.13	8.5	-2.40	-0.1
		2067	115.19	1.34	114.44	1.25	-0.75	-0.09	377.92	4.4	375.46	4.1	-2.46	-0.3
AI	5139.0	2020	115.19	0.74	114.42	1.20	-0.77	0.46	377.92	2.4	375.39	3.9	-2.53	1.5
		2004	115.19	0.74	114.42	1.15	-0.77	0.41	377.92	2.4	375.39	3.8	-2.53	1.3
		1983	115.16	0.90	114.37	1.42	-0.79	0.52	377.82	3.0	375.23	4.7	-2.59	1.7
		1972			114.28	1.75					374.93	5.7		
		1962			114.15	2.09					374.51	6.9		
REMOVE	1953.5	Existing I-84 Structure No. 05774 (Easterly I-84 crossing over the Mad River)												
NEW	1938.5	Proposed Bridge No. 6591 (I-84 Westbound Exit 24 On-Ramp from Harpers Ferry Road)												
		1927	113.77	2.78					373.26	9.1				
REMOVE	1916.5	Existing Structure No. 06284 (a.k.a. 05774A; I-84 EB Exit 24 Off-Ramp to Harpers Ferry Road)												
		1900	113.17	3.41	113.74	2.30	0.57	-1.11	371.29	11.2	373.16	7.5	1.87	-3.6
AH	5138.0	1871	113.22	2.49	113.42	2.93	0.20	0.44	371.46	8.2	372.11	9.6	0.66	1.4
		1837	113.22	1.93					371.46	6.3				
NEW	1807.5	Proposed I-84 Bridge No. 05774 (Proposed easterly I-84 bridge over the Mad River)												
		1778	113.22	1.61					371.46	5.3				
		1748	112.55	3.83	112.72	3.06	0.17	-0.77	369.26	12.6	369.82	10.0	0.56	-2.5
NEW	1727.5	Proposed Bridge No. 06284 (I-84 E24 Off-Ramp Exit to Harpers Ferry Road)												
AG	5137.0	1689	111.92	3.94	111.73	4.22	-0.19	0.28	367.19	12.9	366.57	13.8	-0.62	0.9
		1620	111.40	2.38	111.25	2.74	-0.15	0.36	365.49	7.8	364.99	9.0	-0.49	1.2
		1573	111.32	2.14	111.14	2.36	-0.18	0.22	365.22	7.0	364.63	7.7	-0.59	0.7
MINOR MOD.	1561.5	Breached Century Dam (CTDEP Dam No. 15103)												
		1536	109.77	1.89	109.56	3.57	-0.21	1.68	360.14	6.2	359.45	11.7	-0.69	5.5
		1536	109.52	2.61	109.48	2.92	-0.04	0.31	359.32	8.6	359.19	9.6	-0.13	1.0
AF	5136.0	1523	109.21	2.95	109.21	2.99	0.00	0.04	358.30	9.7	358.30	9.8	0.00	0.1
		1487	109.08	2.17	109.08	2.17	0.00	0.00	357.87	7.1	357.87	7.1	0.00	0.0
		1425	108.51	3.06	108.55	2.97	0.04	-0.09	356.00	10.0	356.14	9.7	0.13	-0.3
AE	5135.0	1370	108.11	3.28	108.06	3.44	-0.05	0.16	354.69	10.8	354.53	11.3	-0.16	0.5
		1330	108.08	2.20	107.98	2.44	-0.10	0.24	354.59	7.2	354.27	8.0	-0.33	0.8
		1309	107.98	2.39	107.89	2.52	-0.09	0.13	354.27	7.8	353.97	8.3	-0.29	0.4
NEW	1288.5	Proposed Pedestrian Bridge												
AD	5134.0	1277	108.02	1.46	107.74	1.84	-0.28	0.38	354.40	4.8	353.48	6.0	-0.92	1.2
REMOVE	1260.5	Existing Pedestrian Crossing												
AC	5133.0	1246	107.73	2.46					353.45	8.1				
REPLACE	1198.5 (PR1214.5)	Proposed I-84 Bridge No. 01224 encompassing E23 On- and E24 Off-Ramps (Existing Structure No. 01224)												
		1162	106.67	3.36	106.66	3.36	-0.01	0.00	349.97	11.0	349.93	11.0	-0.03	0.0
AB	5132.0	1153	105.94	4.56	105.95	4.56	0.01	0.00	347.57	15.0	347.61	15.0	0.03	0.0
		1107	105.59	3.99	105.62	3.93	0.03	-0.06	346.42	13.1	346.52	12.9	0.10	-0.2
		1003	104.89	3.55	104.89	3.55	0.00	0.00	344.13	11.6	344.13	11.6	0.00	0.0
AA	5131.0	894	103.72	4.10	103.72	4.10	0.00	0.00	340.29	13.5	340.29	13.5	0.00	0.0
		809	103.06	3.96	103.06	3.96	0.00	0.00	338.12	13.0	338.12	13.0	0.00	0.0
Z	5130.0	714	102.39	3.65	102.39	3.65	0.00	0.00	335.93	12.0	335.93	12.0	0.00	0.0

- existing structure to be removed     
  - proposed structure replacing existing at the same location or at close proximity  
 - proposed structure in new location     
  - existing structure to be remain

Figure 5. The 100-Year Flood Profile Plot: Proposed vs. Existing Conditions



**FIGURE 5**

**TABLE 4. Proposed versus Existing Condition  
500-Year Discharge (CT DOT Q)  
Mad River, Waterbury**

NGVD-29

FEMA Sta.	River Sta.	Metric						English						
		Existing Condition		Proposed Condition		Difference		Existing Condition		Proposed Condition		Difference		
		W.S. Elev. (m) (1)	Velocity (m/s) (2)	W.S. Elev. (m) (3)	Velocity (m/s) (4)	W.S. Elev. (m) (3) - (1)	Velocity (m/s) (4) - (2)	W.S. Elev. (ft) (5)	Velocity (fps) (6)	W.S. Elev. (ft) (7)	Velocity (fps) (8)	W.S. Elev. (ft) (7) - (5)	Velocity (fps) (8) - (6)	
AM	5143.0	2409	119.22	4.86	119.22	4.87	0.00	0.01	391.14	15.9	391.14	16.0	0.00	0.0
		2337	117.12	5.84	117.12	5.84	0.00	0.00	384.25	19.2	384.25	19.2	0.00	0.0
		2280	117.19	3.94	117.19	3.94	0.00	0.00	384.48	12.9	384.48	12.9	0.00	0.0
AL	5142.0	2238	116.85	2.55	116.82	2.60	-0.03	0.05	383.37	8.4	383.27	8.5	-0.10	0.2
		2207	116.73	2.33	116.70	2.44	-0.03	0.11	382.97	7.6	382.87	8.0	-0.10	0.4
		2202	116.68	2.32	116.20	3.76	-0.48	1.44	382.81	7.6	381.23	12.3	-1.57	4.7
		2168	116.62	1.80	115.72	3.92	-0.90	2.12	382.61	5.9	379.66	12.9	-2.95	7.0
		2130	116.54	1.46	116.00	2.00	-0.54	0.54	382.35	4.8	380.58	6.6	-1.77	1.8
AK	5141.0	2116	116.55	1.84	116.01	1.93	-0.54	0.09	382.38	6.0	380.61	6.3	-1.77	0.3
REPLACE	2095.5 (PR2098.5)	Proposed Plank Road Culvert No. 05668 (Existing Structure No. 05668)												
AJ	5140.0	2079	116.50	1.89	115.39	2.38	-1.11	0.49	382.22	6.2	378.58	7.8	-3.64	1.6
		2067	116.53	1.34	115.46	1.29	-1.07	-0.05	382.32	4.4	378.81	4.2	-3.51	-0.2
AI	5139.0	2020	116.53	0.84	115.45	1.35	-1.08	0.51	382.32	2.8	378.77	4.4	-3.54	1.7
		2004	116.53	0.84	115.44	1.32	-1.09	0.48	382.32	2.8	378.74	4.3	-3.58	1.6
		1983	116.50	0.97	115.38	1.66	-1.12	0.69	382.22	3.2	378.54	5.4	-3.68	2.3
		1972			115.27	2.02					378.18	6.6		
		1962			115.13	2.29					377.72	7.5		
REMOVE	1953.5	Existing I-84 Structure No. 05774 (Easterly I-84 crossing over the Mad River)												
NEW	1938.5	Proposed Bridge No. 6591 (I-84 Westbound Exit 24 On-Ramp from Harpers Ferry Road)												
		1927	114.69	3.07					376.28	10.1				
REMOVE	1916.5	Existing Structure No. 06284 (a.k.a. 05774A; I-84 EB Exit 24 Off-Ramp to Harpers Ferry Road)												
		1900	113.41	4.67	114.75	2.50	1.34	-2.17	372.08	15.3	376.48	8.2	4.40	-7.1
AH	5138.0	1871	113.55	3.34	114.45	3.04	0.90	-0.30	372.54	11.0	375.49	10.0	2.95	-1.0
		1837	113.58	2.52					372.64	8.3				
NEW	1807.5	Proposed I-84 Bridge No. 05774 (Proposed easterly I-84 bridge over the Mad River)												
		1778	113.58	2.07					372.64	6.8				
		1748	113.48	2.55	113.45	3.51	-0.03	0.96	372.31	8.4	372.21	11.5	-0.10	3.2
NEW	1727.5	Proposed Bridge No. 06284 (I-84 E24 Off-Ramp Exit to Harpers Ferry Road)												
AG	5137.0	1689	112.50	4.32	112.34	4.76	-0.16	0.44	369.10	14.2	368.57	15.6	-0.53	1.4
		1620	112.22	2.55	112.07	2.83	-0.15	0.28	368.18	8.4	367.68	9.3	-0.49	0.9
		1573	112.09	2.55	111.95	2.72	-0.14	0.17	367.75	8.4	367.29	8.9	-0.46	0.6
MINOR MOD.	1561.5	Breached Century Dam (CTDEP Dam No. 15103)												
		1536	110.23	2.47	109.94	4.33	-0.29	1.86	361.65	8.1	360.70	14.2	-0.95	6.1
		1536	109.90	3.24	109.90	3.51	0.00	0.27	360.56	10.6	360.56	11.5	0.00	0.9
AF	5136.0	1523	109.69	3.28	109.66	3.39	-0.03	0.11	359.88	10.8	359.78	11.1	-0.10	0.4
		1487	109.55	2.54	109.54	2.55	-0.01	0.01	359.42	8.3	359.38	8.4	-0.03	0.0
		1425	109.09	3.21	108.95	3.49	-0.14	0.28	357.91	10.5	357.45	11.5	-0.46	0.9
AE	5135.0	1370	109.03	2.54	108.83	2.88	-0.20	0.34	357.71	8.3	357.05	9.4	-0.66	1.1
		1330	109.01	1.81	108.79	2.13	-0.22	0.32	357.64	5.9	356.92	7.0	-0.72	1.1
		1309	108.93	2.18	108.73	2.24	-0.20	0.06	357.38	7.2	356.73	7.3	-0.66	0.2
NEW	1288.5	Proposed Pedestrian Bridge												
AD	5134.0	1277	108.95	1.45	108.67	1.81	-0.28	0.36	357.45	4.8	356.53	5.9	-0.92	1.2
REMOVE	1260.5	Existing Pedestrian Crossing												
AC	5133.0	1246	108.76	2.31					356.82	7.6				
REPLACE	1198.5 (PR1214.5)	Proposed I-84 Bridge No. 01224 encompassing E23 On- and E24 Off-Ramps (Existing Structure No. 01224)												
		1162	106.44	5.63	106.95	4.46	0.51	-1.17	349.21	18.5	350.89	14.6	1.67	-3.8
AB	5132.0	1153	106.99	3.93	106.69	4.82	-0.30	0.89	351.02	12.9	350.03	15.8	-0.98	2.9
		1107	106.04	3.08	106.04	3.08	0.00	0.00	347.90	10.1	347.90	10.1	0.00	0.0
		1003	105.65	2.67	105.67	2.62	0.02	-0.05	346.62	8.8	346.69	8.6	0.06	-0.2
AA	5131.0	894	104.58	4.16	104.58	4.19	0.00	0.03	343.11	13.6	343.11	13.7	0.00	0.1
		809	103.61	4.81	103.66	4.77	0.05	-0.04	339.93	15.8	340.09	15.7	0.16	-0.1
Z	5130.0	714	102.40	5.09	102.91	4.36	0.51	-0.73	335.96	16.7	337.63	14.3	1.67	-2.4

- existing structure to be removed     
  - proposed structure replacing existing at the same location or at close proximity  
 - proposed structure in new location     
  - existing structure to be remain

Figure 6. The 500-Year Flood Profile Plot: Proposed vs. Existing Conditions

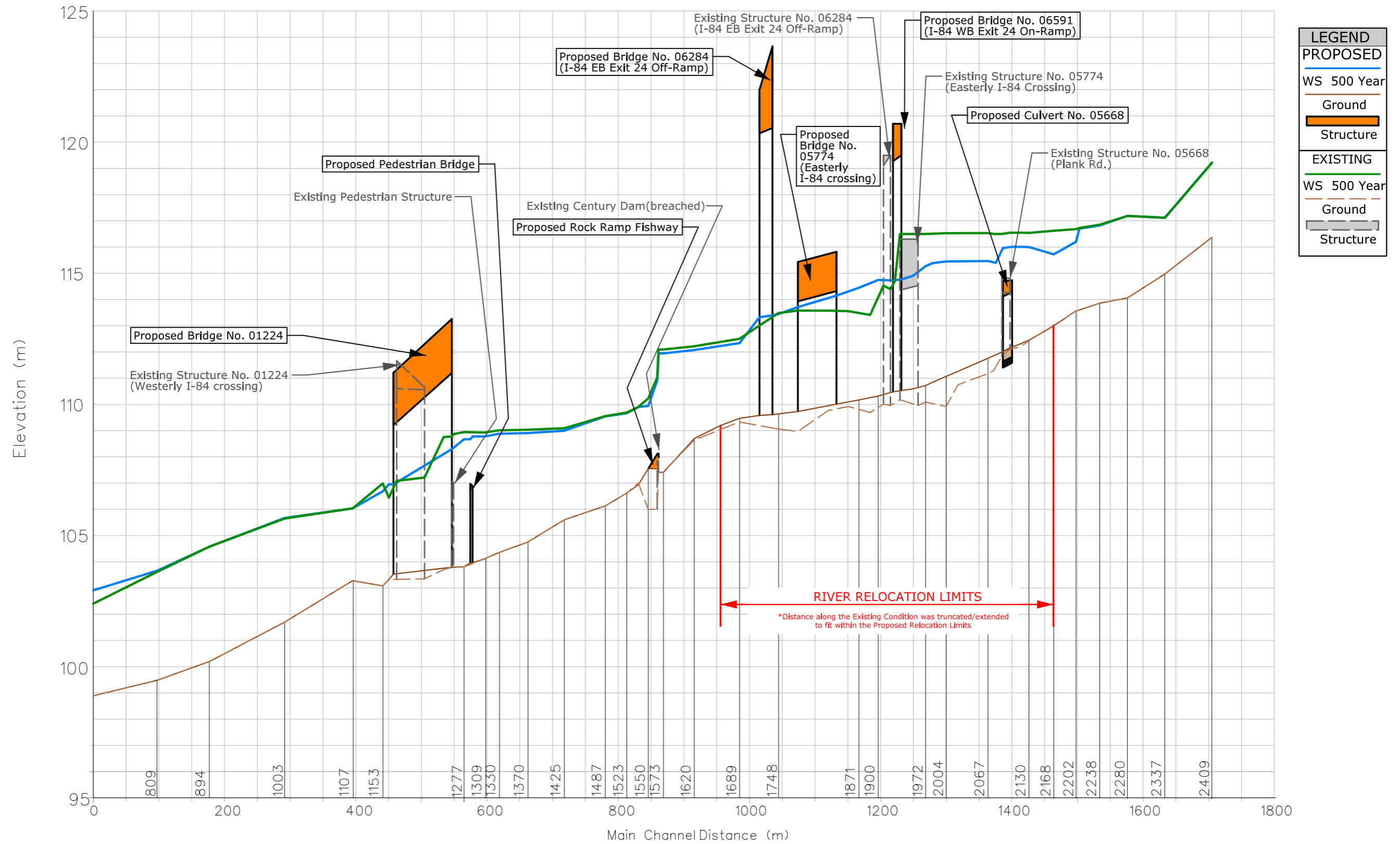


FIGURE 6

## EFFECTS ON STORAGE AND DISCHARGES

To accommodate the proposed southerly realignment and widening of the I-84 along with all the other proposed work, significant portions of the existing floodplains will be filled along the Mad River within the project limits. The most dramatic change will occur in the former City Mill Pond situated at the southwest quadrant of the I-84 and Harpers Ferry Road interchange, in which the area inside the 100-year flood boundary between the existing I-84 structure (or proposed WB Exit 24 On-Ramp bridge) to the Century Dam will be reduced by approximately 57% from 26,880 m<sup>2</sup> (6.64 acres) to 11,620 m<sup>2</sup> (2.87 acres). As indicated earlier, the overall reduction in the 100-year flood area along the river will be approximately 28%.

Such reduction in the floodplain storage area combined with larger waterway openings of the proposed bridges will less effectively detain the flood flow, and thus could generally result in an increase in the peak-discharge. However, with the proposed improvements, it is anticipated that the increase will be a negligible amount, if not a decrease occurs instead. The decrease can occur as the increase is more than compensated by the faster time-to-peak from the Beaver Pond Brook. Before explaining this, the flow conditions upstream of the Mad River and Beaver Pond Brook confluence is needed to be discussed.

First, starting at the upstream limit of the river relocation, the flood storage capacity upstream of the Plank Road crossing will be increased, as the relocation will result in a wider channel. However, with the larger proposed waterway opening, the added capacity becomes negligible resulting in no significant change in the peak discharge downstream of the crossing.

Approximately 70 meters downstream of the Plank Road crossing, the Beaver Pond Brook converges into the Mad River. As the watershed area of the Mad River is approximately 3.2 times larger than of the Beaver Pond Brook, the time-to-peak for the Mad River flow would be longer than the time for the Beaver Pond Brook. Now, as the results of the proposed work along the Beaver Pond Brook under this project, especially the removal of the Westbound Exit 25 Off-ramp bridge, the peak discharge from the brook will be increased while the time-to-peak to the confluence will be shortened. However, the Mad River's time entering the confluence will remain nearly unchanged. This means that when the peak flow from the Mad River reaches the confluence, potentially lower discharge from the Beaver Pond Brook will enter, as the brook's peak flow should already have passed through sooner than it does in the existing condition. The hydraulic improvements along the river downstream of the confluence will ensure that the peak discharge from the Beaver Pond Brook will pass through the project site without much detention, helping to maintain the time differential to the Mad River's peak flow.

Downstream of the confluence, as the flow reaches the easterly I-84 crossing (Structure No. 05774), the existing structure constricts the flow causing some detention, and thus reduces the peak flow. In the proposed condition, the flow will encounter the new Westbound Exit 24 On-Ramp Bridge No. 06591 first, then the realigned I-84 Bridge No. 05774. With the larger opening sizes of these bridges, the detention and the amount of reduction in the peak discharge will be less than the existing condition. However, as the peak discharge entering this location is anticipated to be less than the existing condition, the exiting peak discharges downstream of the easterly I-84 crossing will not be much different between the existing and proposed conditions.

Downstream of the I-84 crossing in both the existing and proposed conditions, there is the Eastbound Exit 24 Off-Ramp crossing which is located relatively close to the I-84 structure and situated well above the anticipated flood elevations. This crossing will have a negligible effect on the peak discharge in both conditions.

Downstream of the off-ramp crossing to the Century Dam, the floodplain will be filled in significantly as described earlier. The resulting effects on the peak discharge would be as significant if the dam is still in place. However, since the dam was breached in 1998, the effects of the proposed fill will be minimal. The dam can be considered as an outlet to a pond created by the floodplain (former City Mill Pond). As the outlet opening size was greatly expanded with the breach, the detention became minimal. Accordingly, reducing an already minimal detention will not provide any significant reduction in the peak flow, if occurs at all.

Further downstream, the existing pedestrian bridge poses a considerable constriction as it becomes submerged in the high magnitude floods. Yet, the bridge does not provide much detention as the restricted flow does not have to rise much to flow around and over the structure. Once the overflow begins to occur, the effects of detention diminishes. Similarly, the proposed pedestrian bridge will be configured such that the minimum overflow elevation will be not much higher than the low chord elevation limiting the detention of flow. Therefore, no significant reduction to the peak discharge is anticipated in the proposed condition, as it is in the existing condition.

Downstream of the pedestrian bridge, the westerly I-84 structure currently exists in close proximity. Although the width of the flow has to narrow significantly at the I-84 crossing, especially for the high magnitude floods, the hydraulic analysis indicates that the upstream water surface elevation is controlled by the pedestrian bridge; thus, so is the detention of flow. As discussed previously, the detention at the pedestrian crossing is minimal indicating that the peak discharge directed to this site will not be much different than the discharge exiting the I-84 structure. This will also be the case in the proposed condition because of the relatively close distance between the proposed westerly I-84 and pedestrian bridges.

In summarizing the above, it can be concluded that any changes in the peak discharge conveyed to the downstream region of the project area can mainly be attributed to the changing hydraulic conditions upstream of the easterly I-84 crossing. With the quicker time-to-peak from the Beaver Pond Brook, the peak discharge directed to the crossing will be lowered. However, with the reduced detention from the proposed I-84 bridge, the reduction in the peak discharge will likely be negated. Therefore, it is anticipated that the downstream peak discharge beyond the project limit will not be changed significantly.

## Natural Condition

### DEVELOPMENT OF NATURAL CONDITION MODEL

Section 9.3.6 of the ConnDOT 2000 *Drainage Manual* recommends, for large structures (drainage area greater than 25.9 km<sup>2</sup>), that the proposed 100-year water surface profile should be no more than one foot above the natural profile. This design criterion has been established to insure that proposed structures do not cause excessive upstream backwater.

It is often difficult to model "natural" cross sections in urban areas where typically, over a long period of time, watercourses have been repeatedly realigned and altered with significant fill placed within their floodplains. For the Mad River, a Natural Conditions model was at first created by first deleting all existing bridges, bridge approach embankments and accompanying ineffective flow areas from the Existing Condition model. Then, a secondary Natural Condition model was also developed incorporating segments of the relocated channel geometry from the Proposed Condition. The proposed channel was not used in its entirety as it defeats the intended purpose of comparing to the "natural" channel geometry - only where the relocation is so significant that the comparison of the water surface elevation between the Natural and Proposed Conditions is considered not feasible, as they represent completely different physical locations. The secondary Natural Condition model allows to evaluate the effects of the proposed structures in the river.

### WATER SURFACE PROFILE COMPARISON TO PROPOSED CONDITION

The comparisons of the proposed to natural condition 100-year flood profiles are shown on Figure 7 and in Table 5. The profile plots show that there are primarily three locations where the increase over the natural profile will be greater than 0.3 m (one foot). These occur at the Plank Road crossing, upstream of the breached dam, and upstream of the proposed pedestrian bridge.

The increase at the Plank Road crossing will be as much as 0.93 m (3.05 ft) when considering the relocated channel as the natural condition. Based on the existing channel geometry, the proposed condition flood profile is found lower than the natural condition upstream of the crossing. As the flood flow reaches the upstream end of the river relocation, it will be conveyed through a wider section of the river than the existing condition. Although the backwater from the proposed culvert raises the water surface, it is compensated by the wider channel than the natural width resulting in the lower proposed condition flood profile than the natural condition. However, as the flow reaches and goes over the crossing, the flood elevation will rise higher than the natural condition by approximately 0.32 m (1.03 ft) at the upstream and 0.77 m (2.52 ft) at the downstream faces. The increase is due to the inadequate hydraulic capacity of the proposed culvert and its higher invert than the natural channel bed. The proposed culvert invert at its outlet is 0.4 m (1.3 ft) higher than the existing riverbed.

As indicated earlier, the alternative that would lower the water surface profile sufficiently to 0.3-m (one-foot) range of the natural profile is not practical for this site because of the resulting additional potential impact on the private properties. Furthermore, the increase over the one-foot is primarily confined over the crossing. Therefore, the cost of placing a larger structure would outweigh the benefit.

The increase upstream of the dam (Section 1573) will be 1.28 m (4.2 ft), and primarily due to the remaining, existing weir portion and concrete vertical side walls which constricts the flow. In order to lower the water surface within 0.3 m (one foot) of the natural condition, these existing features would have to be completely removed. This will necessitate the removal of upstream sediments as well which are potentially contaminated. Furthermore, it would likely affect a private property southwest (downstream) of the dam requiring additional easements or take under this project. As the backwater from the constriction does not adversely affect any upstream structures, neighboring private properties or roads, the removal was not considered under this project.

The increase upstream of the pedestrian bridge will be 0.53 m (1.74 ft). One of the options to reduce the increase below 0.3 m (one foot) is to raise the structure and provide a longer span. However, this would require filling in the floodplain to construct high approach embankments which negate some of the benefits. Relocating it further upstream toward the dam or downstream of the I-84 crossing may be considered, but would likely mean an increase over the existing condition that may affect a private property or the Hamilton Park. As proposed, the increase is over an undeveloped area owned by the State and the City of Waterbury, and is thus deemed the most practical design option.

There is one other location besides the three above that an increase greater than one foot will occur. It is between the Westbound Exit 24 On-Ramp (Bridge No. 06591) and the easterly I-84 crossing (Bridge No. 05774). The maximum increase here is 0.98 m (3.22 ft) when comparing to the natural profile based on the existing river geometry. When comparing to the "natural" profile based on the relocated channel geometry, there will instead be a decrease of 0.06 m (0.2 ft). As the intended purpose of comparing the proposed and natural condition profiles is to assess and limit the backwater effect of a hydraulic crossing, the increase resulting from the river relocation should be disregarded. Accordingly, the later mentioned decrease is considered for this location.



**TABLE 5. Proposed versus Natural Condition  
100-Year (CT DOT) Discharge Water Surface Elevation  
Mad River, Waterbury**

NGVD-29

FEMA Sta.	River Sta.	Metric						English				
		Natural 1 (from EX)	Natural 2 (using relocated PR segm.)	Proposed	Difference		Natural 1 (from EX)	Natural 2 (using relocated PR segm.)	Proposed	Difference		
		(m) (1)	(m) (2)	(m) (3)	(3) - (2)	(3) - (1)	(ft) (5)	(ft) (6)	(ft) (7)	(7) - (6)	(7) - (5)	
AM	5143.0	2409	118.59	118.59	118.59	0.00	0.00	389.08	389.08	389.08	0.00	0.00
		2337	116.79	116.79	116.80	0.01	0.01	383.17	383.17	383.20	0.03	0.03
		2280	116.47	116.49	116.48	-0.01	0.01	382.12	382.19	382.15	-0.03	0.03
AL	5142.0	2238	116.48	116.48	116.48	0.00	0.00	382.15	382.15	382.15	0.00	0.00
		2207	116.16	116.30	115.91	-0.39	-0.25	381.10	381.56	380.28	-1.28	-0.82
		2202	116.10	116.20	115.86	-0.34	-0.24	380.91	381.23	380.12	-1.12	-0.79
		2168	115.91	115.57	115.19	-0.38	-0.72	380.28	379.17	377.92	-1.25	-2.36
		2130	115.65	114.69	115.23	0.54	-0.42	379.43	376.28	378.05	1.77	-1.38
AK	5141.0	2116	115.36	114.27	115.20	0.93	-0.16	378.48	374.90	377.95	3.05	-0.53
REPLACE	2095.5 (PR 2098.5)	Proposed Plank Road Culvert No. 05668 (Existing Structure No. 05668)**										
AJ	5140.0	2079	114.00	114.19	114.34	0.15	0.34	374.02	374.64	375.13	0.49	1.11
		2067	114.05	114.30	114.44	0.14	0.39	374.18	375.00	375.46	0.46	1.28
AI	5139.0	2020	114.05	114.29	114.42	0.13	0.37	374.18	374.97	375.39	0.43	1.21
		2004	114.06	114.29	114.42	0.13	0.36	374.21	374.97	375.39	0.43	1.18
		1983	114.01	114.25	114.37	0.12	0.36	374.05	374.84	375.23	0.39	1.18
		1972		114.20	114.28	0.08			374.67	374.93	0.26	
		1962		113.96	114.15	0.19			373.89	374.51	0.62	
REMOVE	1953.5	Existing I-84 Structure No. 05774 (Easterly I-84 crossing over the Mad River)										
NEW	1938.5	Proposed Bridge No. 6591 (I-84 Westbound Exit 24 On-Ramp from Harpers Ferry Road)										
		1927	113.56					372.57				
REMOVE	1916.5	Existing Structure No. 06284 (a.k.a. 05774A; I-84 EB Exit 24 Off-Ramp to Harpers Ferry Road)										
		1900	112.76	113.80	113.74	-0.06	0.98	369.95	373.36	373.16	-0.20	3.22
AH	5138.0	1871	112.99	113.55	113.42	-0.13	0.43	370.70	372.54	372.11	-0.43	1.41
		1837	112.97					370.64				
NEW	1807.5	Proposed I-84 Bridge No. 05774 (Proposed easterly I-84 bridge over the Mad River)										
		1778	112.95					370.57				
		1748	112.81	112.81	112.72	-0.09	-0.09	370.11	370.11	369.82	-0.30	-0.30
NEW	1727.5	Proposed Bridge No. 06284 (I-84 E24 Off-Ramp Exit to Harpers Ferry Road)										
AG	5137.0	1689	111.92	111.92	111.73	-0.19	-0.19	367.19	367.19	366.57	-0.62	-0.62
		1620	110.22	110.22	111.25	1.03	1.03	361.61	361.61	364.99	3.38	3.38
		5136.8	109.86	109.86	111.14	1.28	1.28	360.43	360.43	364.63	4.20	4.20
MINOR MOD	1561.5	Breached Century Dam (CTDEP Dam No. 15103)										
		5136.2	1550*	SEE NOTE BELOW	109.56			SEE NOTE BELOW	359.45			
		1536	109.48	109.48	109.48	0.00	0.00	359.19	359.19	359.19	0.00	0.00
AF	5136.0	1523	109.23	109.23	109.21	-0.02	-0.02	358.37	358.37	358.30	-0.06	-0.06
		1487	109.08	109.08	109.08	0.00	0.00	357.87	357.87	357.87	0.00	0.00
		1425	108.52	108.52	108.55	0.03	0.03	356.04	356.04	356.14	0.10	0.10
AE	5135.0	1370	107.99	107.99	108.06	0.07	0.07	354.30	354.30	354.53	0.23	0.23
		1330	107.61	107.61	107.98	0.37	0.37	353.05	353.05	354.27	1.21	1.21
		1309	107.36	107.36	107.89	0.53	0.53	352.23	352.23	353.97	1.74	1.74
NEW	1288.5	Proposed Pedestrian Bridge										
AD	5134.0	1277	107.53	107.53	107.74	0.21	0.21	352.79	352.79	353.48	0.69	0.69
REMOVE	1260.5	Existing Pedestrian Crossing										
AC	5133.0	1246	107.27	107.27				351.94	351.94			
REPLACE	1198.5 (PR 1214.5)	Proposed I-84 Bridge No. 01224 encompassing E23 On- and E24 Off-Ramps (Existing Structure No. 01224)										
		1162	106.50	106.50	106.66	0.16	0.16	349.41	349.41	349.93	0.53	0.53
AB	5132.0	1153	105.94	105.94	105.95	0.01	0.01	347.57	347.57	347.61	0.03	0.03
		1107	105.59	105.59	105.62	0.03	0.03	346.42	346.42	346.52	0.10	0.10
		1003		104.92	104.89	-0.03			344.23	344.13	-0.10	
AA	5131.0	894	103.72	103.72	103.72	0.00	0.00	340.29	340.29	340.29	0.00	0.00
		809		103.06	103.06	0.00			338.12	338.12	0.00	
Z	5130.0	714	102.39	102.39	102.39	0.00	0.00	335.93	335.93	335.93	0.00	0.00

Natural 1: Developed from the Existing Condition model by removing all the existing man-made structures that cross the Mad River within the studied reach. The breached Century Dam was also removed completely from the model.

Natural 2: Where the river will be relocated/realigned significantly such that the representative cross sections for the proposed condition had to be cut from different locations than the the existing/natural condition models, the direct comparison of the water surface profiles between the proposed and natural conditions is not viable. Accordingly, a secondary natural condition model was created by incorporating the proposed channel geometry to the initial natural condition model from Section 1689 (120m upstream of Century Dam) to 2020 (downstream of the confluence with the Beaver Pond Brook). Within this segment, the proposed retaining walls along the river were also removed.

Notes:

\* Section 1550 was removed in the natural condition models as it represented a deep scour hole cause by the dam. Without the dam, such scour hole would not have been formed.

\*\* This table is intended to show the combined effects of all the proposed structures over the natural condition (no waterway crossings) within the study limits. For the backwater caused by the culvert and only by the culvert at the location, see Table 6.

- existing structure to be removed
- proposed structure replacing existing at the same location or at close proximity
- proposed structure in new location
- existing structure to be remain

Figure 7. The 100-Year Flood Profile Plot: Proposed vs. Natural Conditions

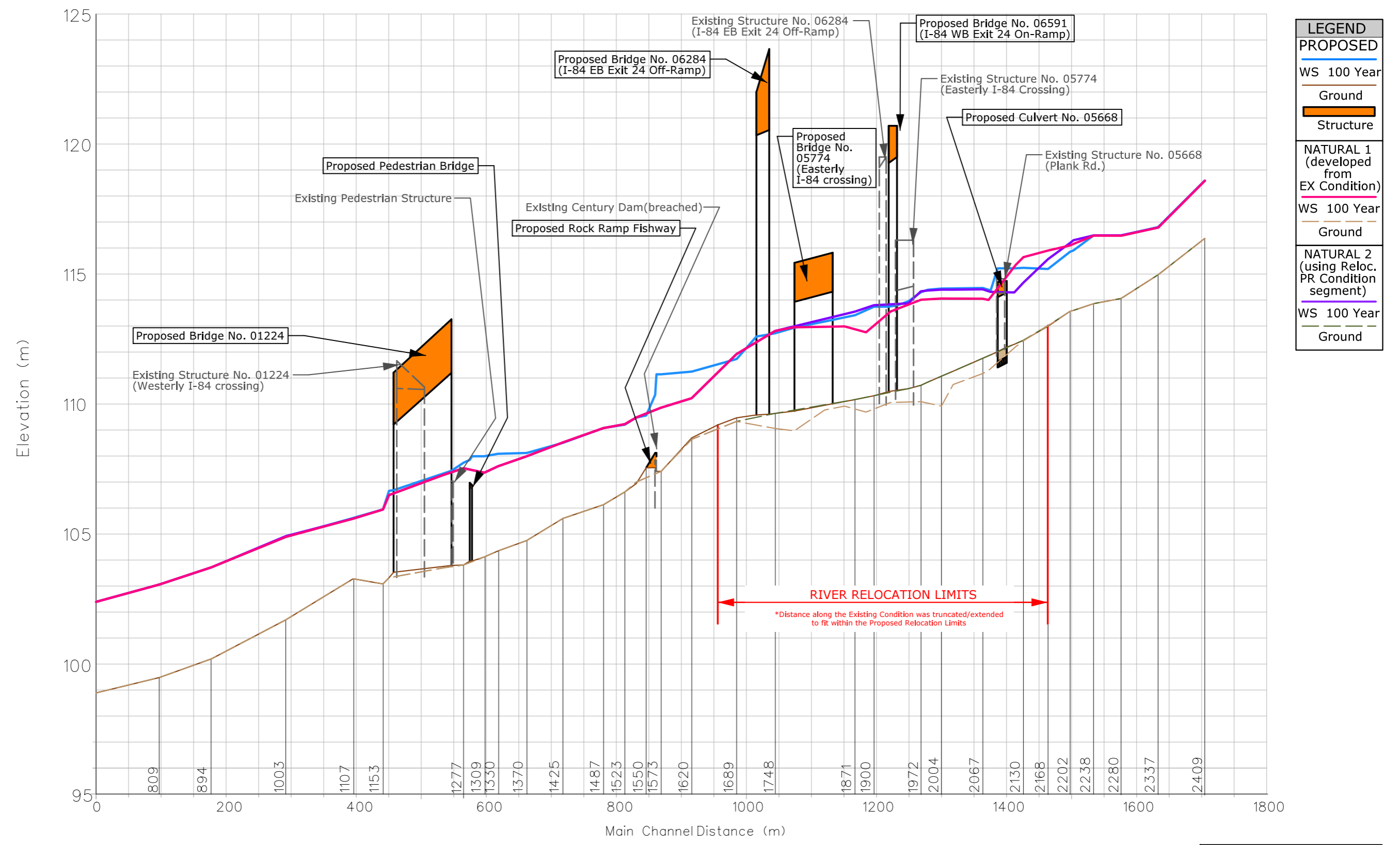


FIGURE 7

## Water Handling (Temporary Hydraulic Facilities)

A separate report has been prepared for the water handling aspect of the river relocation. The report details a water handling plan of which the intent is to suggest a method of construction for the Contractor that will enable him to complete his work, provide protection of his work during construction and minimize potential flooding of adjacent roadways and properties. See the *Temporary Hydraulic Facilities* reports for details.

### Summary

The resulting hydraulic conditions at all the proposed waterway structures over the Mad River under the State Project No. 151-273 are summarized in Table 6. As shown in the table, this hydraulic study indicates that four (4) of the six (6) proposed waterway structures will adequately convey the 100-year design discharge with a minimum vertical clearance of 0.3 m (1.0 ft) to the upstream control features.

For the other two crossings which are the Plank Road culvert and the pedestrian bridge upstream of the westerly I-84 crossing, the analysis validates that these provide an improved hydraulic condition compared to the existing condition. Especially with the proposed Plank Road culvert along with the river relocation work in the vicinity improves the condition such that the number of private properties affected by the overflow will be reduced from twenty-nine (29) to fifteen (15)<sup>7</sup>. Even for the properties that will continually be affected in the proposed condition, the extent of the flooding (limits and/or depth) will be reduced.

The alternatives to these structures that would eliminate the overtopping condition were investigated and determined impractical within the scope of this highway project. For instance, in the case of the Plank Road culvert, it would necessitate taking numerous residential properties in total and raising the superstructure. For the pedestrian bridge, the superstructure has to be raised along with lengthening the span which will result in an increase in the flood elevation due to the required additional filling of the floodplain. Considering these assessments, the proposed designs are deemed most practical.

This hydraulic study also demonstrates that the proposed changes under this project will mostly result in decreases in the 100-year flood elevation. Where increases occur, they are mostly within the relocated river segment. Outside of the relocation limits, the increases are mostly minor, often within the computational tolerance, or predominantly occur inside a structure and diminish immediately downstream. There are two notable locations where the increases occur. One of these locations is approximately 61 meters downstream of the westerly I-84 Bridge No. 01224 (Section 1107) where the increase is merely 0.03 m. Although the 100-year flood spreads 136 meters wide northerly from the baseline of the river, the inundation occurs on the recreational field of the Hamilton Park, a City of Waterbury property. Thus, it has no adverse impact on any roads, buildings and private properties. The other location is between the

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<sup>7</sup> As indicated earlier, the number excludes the ones affected by the Beaver Pond Brook flow.

proposed Bridges No. 06591 (Westbound Exit 24 On-Ramp) and No. 05774 (easterly I-84 crossing) where the maximum increase will be 0.57 m (1.87 ft) at Section 1900. The segment falls within the relocated section of the river, and the flood flow here will be contained in the trapezoidal channel within the ConnDOT right of way. Therefore, the increase at this location also has no adverse impact on any roads, buildings and adjacent private properties.

There are mainly three locations where the 100-year flood profile will be greater than 0.3 m (one foot) above the "natural" condition profile (no man-made crossings in the brook). These occur at the Plank Road culvert, the breached Century Dam and the pedestrian bridge. As indicated earlier, the proposed design is considered the most practical option for each location without having to take additional private properties. Nonetheless, the greater-than-one-foot increases in the 100-year flood elevation over the "natural" condition require an exemption from the State requirements.

**Table 6. Summary of Hydraulic Conditions At Waterway Crossings Over Mad River Based on The 100-Year Design Discharge**

**METRIC UNITS** NGVD-29

Structure(Bridge/Culvert)		PROPOSED										EXISTING												
No.	Crossing Road	Upstream			Downstream			U/S Control Elevation	Free-board to U/S control	Bridge Opening Velocity/Culvert Outlet Velocity	Overtop. Freq. if less than 100 year	Upstream			Downstream			U/S Control Elevation	Free-board to U/S control	Bridge Opening Velocity/Culvert Outlet Velocity	Overtop. Freq. if less than 100 year			
		Water Surface Elevation	Backwater** (if culvert)		Water Surface Elevation	Low Chord	Under-clearance					Water Surface Elevation	Low Chord	Under-clearance	Water Surface Elevation	Backwater** (if culvert)						Water Surface Elevation	Low Chord	Under-clearance
			Low Chord (for brdg)	Under-clearance (for brdg)												Low Chord (for brdg)	Under-clearance (for brdg)							
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m/s)	(year)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m/s)	(year)				
05668	Plank Road	115.20	0.87		114.34	n/a (culvert)			114.8	Exceeds	3.72	70*	115.55	114.2	none	115.55	114.1	none	114.83	Exceeds	3.08	21*		
06591	WB Exit 24 On-Ramp	113.83	118.6	4.8	113.78	118.5	4.7	116.5	2.7	2.89	N/A	N/A (does not exist)												
05774	I-84 (Easterly Crossing)	113.24	114.0	0.8	112.94	113.6	0.7	115.2	2.0	3.00	N/A	115.16	114.4	none	113.77	114.2	0.43	115.4	0.2	3.18	N/A			
06284	EB Exit 24 Off-Ramp	112.68	119.8	7.1	112.60	119.1	6.5	114.5	1.8	2.98	N/A	113.61	116.5	2.89	113.67	116.5	2.83	115.3	1.7	2.98	N/A			
(none)	Pedestrian Bridge	107.89	106.5	none	107.79	106.5	none	106.9	Exceeds	2.39	19*	107.89	106.9	none	107.79	106.9	none	106.7	Exceeds	1.41	15*			
01224	I-84 (Westerly Crossing)	107.43	111.0	3.6	106.69	108.9	2.2	112.6	5.2	3.47	N/A	107.45	110.2	2.7	106.42	110.2	3.8	112.2	4.8	4.38	N/A			

**ENGLISH UNITS** NGVD-29

Structure(Bridge/Culvert)		PROPOSED										EXISTING												
No.	Crossing Road	Upstream			Downstream			U/S Control Elevation	Free-board to U/S control	Bridge Opening Velocity/Culvert Outlet Velocity	Overtop. Freq. if less than 100 year	Upstream			Downstream			U/S Control Elevation	Free-board to U/S control	Bridge Opening Velocity/Culvert Outlet Velocity	Overtop. Freq. if less than 100 year			
		Water Surface Elevation	Backwater** (if culvert)		Water Surface Elevation	Low Chord	Under-clearance					Water Surface Elevation	Low Chord	Under-clearance	Water Surface Elevation	Backwater** (if culvert)						Water Surface Elevation	Low Chord	Under-clearance
			Low Chord (for brdg)	Under-clearance (for brdg)												Low Chord (for brdg)	Under-clearance (for brdg)							
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(year)	(m)	(m)	(m)	(m)	(m)	(ft)	(ft)	(ft/s)	(year)					
05668	Plank Road	377.95	2.9		375.13	n/a (culvert)			376.6	Exceeds	12.20	70*	379.10	374.7	none	379.10	374.3	none	376.7	Exceeds	10.10	21*		
06591	WB Exit 24 On-Ramp	373.45	389.1	15.6	373.29	388.8	15.5	382.2	8.8	9.48	N/A	N/A (does not exist)												
05774	I-84 (Easterly Crossing)	371.52	374.0	2.5	370.53	372.7	2.2	377.9	6.4	9.84	N/A	377.82	375.3	none	373.26	374.7	1.4	378.6	0.8	10.43	N/A			
06284	EB Exit 24 Off-Ramp	369.68	393.0	23.4	369.42	390.7	21.3	375.7	6.0	9.78	N/A	372.73	382.2	9.5	372.93	382.2	9.3	378.3	5.5	9.78	N/A			
(none)	Pedestrian Bridge	353.97	349.4	none	353.64	349.4	none	350.7	Exceeds	7.84	19*	353.97	350.7	none	353.64	350.7	none	350.1	Exceeds	4.63	15*			
01224	I-84 (Westerly Crossing)	352.46	364.2	11.7	350.03	357.3	7.3	369.4	17.0	11.38	N/A	352.52	361.4	8.9	349.14	361.5	12.4	368.2	15.6	14.37	N/A			

\* Based on hydraulic gradeline. The HEC-RAS determines the weir flow (overflow) split based on the energy gradeline, in which case the overtopping frequencies are lower. See the narrative for the individual structures for more details.

## **Appendix A**

### **Hydraulic Backup: HEC-RAS Input Report**

Proposed Condition, Design Discharge

## *Proposed Condition, Design Discharges*

HEC-RAS Version 4.1.0 Jan 2010  
 U. S. Army Corps of Engineers  
 Hydrologic Engineering Center  
 609 Second Street  
 Davis, California

```

X      X  XXXXXX   XXXX      XXXX      XX      XXXX
X      X  X        X      X      X  X  X  X      X
X      X  X        X      X      X  X  X  X      X
XXXXXXXX XXXX      X      XXX XXXX      XXXXXX   XXXX
X      X  X        X      X      X  X  X  X      X
X      X  X        X      X      X  X  X  X      X
X      X  XXXXXX   XXXX      X      X  X  X      XXXXX
  
```

\*\*\*\*\*

### PROJECT DATA

Project Title: Mad River, 151-273, Metric  
 Project File : 151273MR\_DOT\_Metric.prj  
 Run Date and Time: 10/4/2013 9:56:08 AM

Project in SI units

### Project Description:

RI-84 Reconstruction, Waterbury, Washington Ave. to Pierpont Rd., DOT Project 151-273, Mad River

All cross sections are looking upstream. Expand AND scroll through all description boxes to review complete annotations. Recommend using

"View Cross Sections" when comparing the EXISTING, NATURAL and PROPOSED conditions, instead of "Profile Plot". Due to the relocation of the brook, the overall channel length in the proposed condition differs from the existing. This makes comparing these different models in the Profile Plot impractical, which matches the downstream end adequately, but the upstream end would be off by the difference in the total channel length.

\*\*\*\*\*

### PLAN DATA

Plan Title: PROPOSED (New Survey), ConnDOT Q  
 Plan File : D:\PROJECT\151-273\Hydraulics\DOT\Mad River\_DOT  
 DESIGN\_Rev03\151273MR\_DOT\_Metric.p15

Geometry Title: PROPOSED (New Survey)  
 Geometry File : D:\PROJECT\151-273\Hydraulics\DOT\Mad River\_DOT  
 DESIGN\_Rev03\151273MR\_DOT\_Metric.g12

Flow Title : ConnDOT Q's  
 Flow File : D:\PROJECT\151-273\Hydraulics\DOT\Mad River\_DOT  
 DESIGN\_Rev03\151273MR\_DOT\_Metric.f01

### Plan Description:

Starting TW: Rating Curve from FIS FEMA Section Z (RS 5130) data.

### Plan Summary Information:

Number of: Cross Sections = 38 Multiple Openings = 0

Culverts = 1 Inline Structures = 1  
 Bridges = 5 Lateral Structures = 0

Computational Information

Water surface calculation tolerance = 0.003  
 Critical depth calculation tolerance = 0.003  
 Maximum number of iterations = 40  
 Maximum difference tolerance = 0.3  
 Flow tolerance factor = 0.001

Computation Options

Critical depth computed only where necessary  
 Conveyance Calculation Method: At breaks in n values only  
 Friction Slope Method: Average Conveyance  
 Computational Flow Regime: Mixed Flow

\*\*\*\*\*

FLOW DATA

Flow Title: ConnDOT Q's  
 Flow File : D:\PROJECT\151-273\Hydraulics\DOT\Mad River\_DOT  
 DESIGN\_Rev03\151273MR\_DOT\_Metric.f01

Flow Data (m3/s)

\*\*\*\*\*  
 \* River Reach RS \* Fish Low Pass. Fish High Pass. 2  
 Year 3 Year 5 Year 10 Year 25 Year 50 Year \*  
 \* Mad River Reach 1 2409 \* .103 2.749  
 21.8 28.6 35 46.72 70.79 96.28 \*  
 \* Mad River Reach 1 2020 \* .126 3.659  
 31.15 40.7 49.9 66.54 100.52 137.34 \*  
 \*\*\*\*\*  
 \* River Reach RS \* 100 Year 500 Year \*  
 \* Mad River Reach 1 2409 \* 124.59 188.31 \*  
 \* Mad River Reach 1 2020 \* 176.98 269.01 \*  
 \*\*\*\*\*

Boundary Conditions

\*\*\*\*\*  
 \* River Reach Profile \* Upstream  
 Downstream \*  
 \*\*\*\*\*  
 \* Mad River Reach 1 Fish Low Pass. \* Cri ti cal  
 Rating Curve #1 \*  
 \* Mad River Reach 1 Fish High Pass. \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 2 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 3 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 5 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 10 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 25 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 50 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 100 Year \* Cri ti cal  
 Cri ti cal \*  
 \* Mad River Reach 1 500 Year \* Cri ti cal  
 Cri ti cal \*  
 \*\*\*\*\*  
 \*\*\*\*\*

Rating Curve #1

\*\*\*\*\*  
 \* Flow \* Elev \*  
 \* (m3/s) \* (m) \*  
 \*\*\*\*\*



\* 66.54 \* 100.91 \*  
 \* 114.97 \* 101.77 \*  
 \* 141.3 \* 102.19 \*  
 \* 220.16 \* 102.635 \*  
 \*\*\*\*\*

\*\*\*\*\*

GEOMETRY DATA

Geometry Title: PROPOSED (New Survey)  
 Geometry File : D:\PROJECT\151-273\Hydraulic\DOT\Mad River\_DOT  
 DESIGN\_Rev03\151273MR\_DOT\_Metric.g12

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2409

INPUT

Description: FEMA STATION 5143, CROSS SECTION AM  
 D/S of East Main Street

Station Elevation Data num= 72

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-45.36	120	-38.06	119.99	-31.45	119.81	-31.16	119.81	-29.94	119.82
-29.93	119.8	-29.18	119.83	-28.02	119.71	-27.96	119.66	-25.72	119.84
-24.33	119.93	-24.27	119.93	-20.62	119.72	-19.84	119.68	-19.68	119.8
-19.66	119.81	-19.29	119.87	-17.99	119.86	-16.99	119.85	-15.52	119.91
-15.45	119.91	-15.15	119.92	-14.64	119.79	-11.87	119.1	-11.44	117.86
-10.71	117.27	-9.31	116.71	-6.61	116.43	-4.21	116.37	-.37	116.68
2.62	116.56	3.02	116.82	3.3	117.71	3.69	118.73	4.69	118.8
15.05	120.01	17.04	120.26	17.05	120.26	17.91	120.46	25.65	120.36
25.99	120.31	30.03	120.05	32.11	120.02	32.14	119.98	32.17	119.9
32.58	119.91	32.9	119.93	33.13	119.94	36.17	120.08	39.72	120.09
40.46	120.09	40.59	120.1	40.63	120.2	40.65	120.23	40.72	120.23
40.94	120.24	42.06	120.25	42.11	120.25	42.37	120.26	43.02	120.29
46.58	119.73	47.58	119.7	48.25	119.72	49.02	119.74	50.19	119.84
56.92	120.27	58.62	120.24	59.93	120.26	61.34	120.28	63.26	120.44
64.23	120.56	65.2	120.5						

Manning's n Values num= 8

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-45.36	.02	-19.84	.04	-16.99	.08	-11.44	.04	3.69	.08
17.04	.04	30.03	.02	42.06	.04				

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 -11.87 3.69 75.2 71.8 69.4 .3 .5

Ineffective Flow num= 4

Sta L	Sta R	Elev	Permanent
-45.36	-36.6	122	F
-36.6	-15.15	119.93	F
4.74	16	120	F
16	65.2	122	F

Blocked Obstructions num= 1

Sta L	Sta R	Elev
16.9	25.6	123

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2337

INPUT

Description: 85m D/S of East Main St.

Station Elevation Data num= 80

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-37.26	119.19	-36.31	119.18	-36.22	119.18	-32.28	119.16	-32.26	119.14
-31.76	119.15	-31.38	119.13	-28.21	118.93	-28.13	119.03	-28.1	119.02
-28.08	119.06	-27.8	119.09	-19.23	118.55	-18.32	118.57	-16.32	117.37
-14.89	116.98	-13.06	116.43	-9.79	116.34	-8.48	116.34	-7.12	116.17
-6.83	115.91	-6.23	115.34	-2.13	115.1	0	115.01	.94	114.97

1.88	115.06	3.98	115.22	4.76	115.27	4.99	115.29	5	115.29
5.07	115.31	5.23	115.34	5.45	115.37	8.03	116.01	9.68	116.42
10.89	116.57	15.53	117.15	15.64	117.2	15.99	117.22	16.76	117.28
19.13	117.52	19.19	117.45	19.23	117.39	23.24	117.54	24.24	117.56
24.25	117.58	24.32	117.68	25.13	117.66	25.21	117.66	28.06	117.72
30.18	117.89	30.22	117.86	30.34	117.76	34.36	117.9	34.44	117.9
34.49	117.91	35.46	117.93	35.51	117.93	35.6	117.93	35.65	117.93
35.66	117.93	35.73	117.92	35.77	117.92	36.5	117.97	38.46	118.05
39.49	118.08	39.5	118.08	39.89	118.09	42.86	117.96	44.47	117.91
44.63	117.98	44.65	118.02	45.08	118.02	46.29	118.01	46.34	118.01
49.3	118.09	50.93	118.12	53.18	118.19	58.85	118.39	59.4	118.4

Manning's n Values num= 11

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-37.26	.04	-36.31	.02	-28.21	.04	-27.8	.08	-9.79	.04
9.68	.08	19.23	.02	24.24	.08	30.34	.02	44.47	.04
49.3	.06								

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-8.48	9.68	58.8	56.9	54.2	.1	.3
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-37.26	-35.8	120	F
23.1	59.4	120	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2280

INPUT

Description: New BLA surveyed cross section  
 Ineffective at left end of the cross section models the residences along Brookdale Drive and the Ineffective at the right end represents the structures along Harpers Ferry Road.

Station Elevation Data num= 77

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-27.11	117.31	-26.38	117.3	-26.32	117.28	-25.39	117.23	-24.98	117.21
-24.94	117.17	-24.87	117.08	-23.98	117.14	-21.91	117.27	-20.31	117.15
-19.33	117.08	-18.81	117.02	-18.76	117.08	-18.71	117.15	-17.36	117.08
-16.91	117.06	-8.04	115.73	-5.01	115.24	-4.27	115.01	-3.58	114.98
-3	114.92	-2.76	114.41	-2.74	114.37	-2.55	114.15	-2.08	114.12
-1.83	114.11	.01	114.07	.66	114.06	.87	114.06	3.34	114.16
4.67	114.23	7.06	114.35	7.09	114.36	8.04	114.92	9.5	115.73
16.68	116.21	16.85	116.22	24.2	116.83	24.83	116.83	25.09	116.85
27.49	116.95	28.77	117	30.2	116.99	34.47	116.96	34.5	117.1
34.57	117.1	35.64	117.1	35.68	117.1	36.82	117.12	36.86	117.13
36.99	117.13	38.05	117.23	38.27	117.25	38.88	117.28	39	117.28
39.12	117.29	40.5	117.47	40.66	117.49	40.69	117.49	40.85	117.5
40.86	117.5	40.9	117.51	40.91	117.51	41.16	117.53	41.2	117.53
41.35	117.55	41.39	117.55	42.03	117.57	42.15	117.59	42.29	117.6
42.41	117.61	42.42	117.61	42.43	117.69	42.44	117.86	42.45	117.75
42.8	117.88	43.35	118.2						

Manning's n Values num= 10

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-27.11	.04	-26.38	.02	-18.81	.04	-16.91	.08	-3.58	.04
9.5	.08	24.2	.04	25.09	.02	36.82	.04	40.5	.02

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-5.01	9.5	42	42.3	43	.1	.3
-------	-----	----	------	----	----	----

Ineffective Flow num= 5

Sta L	Sta R	Elev	Permanent
-27.11	-27	118.5	F
-27	-21.91	117.27	F
-18.71	-21.3	117.15	F
28.77	34.5	117	F
42.4	43.35	119	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2238

INPUT  
 Description: FEMA Station 5142, Cross Section AL  
 Ineffective area at left end  
 of the cross section models the residences along Brookdale Drive,  
 and at the right end represents the structures along Harpers Ferry  
 Road.

Station Elevation Data		num= 77		Sta		Elev		Sta		Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-27.04	116.62	-25.39	116.61	-24.76	116.59	-23.95	116.58	-23.91	116.57		
-23.85	116.58	-22.79	116.56	-22.55	116.55	-22.54	116.56	-22.48	116.58		
-22.42	116.48	-22.4	116.45	-21.84	116.49	-21.8	116.49	-19.39	116.62		
-19.31	116.6	-18.97	116.57	-16.74	116.39	-16.39	116.34	-16.36	116.38		
-16.27	116.38	-16.2	116.47	-15.46	116.37	-15.2	116.35	-13.19	116.34		
-12.4	116.32	-12.21	116.31	-8.16	115.06	-7.62	114.86	-7.6	114.85		
-5.3	114.19	-5.25	114.17	-5.19	114.15	-5.05	114.11	-4	114.08		
-3.18	114.05	-3.14	114.05	-2.97	114.04	-2.39	114.02	-.54	113.95		
.03	113.93	.19	113.92	.27	113.92	.35	113.91	.4	113.91		
1.98	113.86	3.01	113.87	5.1	113.88	8.1	113.93	9.34	114.41		
9.35	114.41	9.43	114.44	9.5	114.47	10.09	114.72	10.13	114.74		
10.9	115.17	13.38	115.57	15.22	116.18	15.64	116.09	16.16	116.08		
18.24	116.16	18.86	116.19	19.7	116.18	23.76	116.04	23.82	116.12		
23.86	116.17	24.42	116.17	25.06	116.17	25.82	116.2	25.84	116.26		
26.08	116.26	29.6	116.4	29.82	116.41	30.65	116.43	31.34	116.45		
31.6	116.48	31.8	116.5								

Manning's n Values		num= 10		Sta		n Val		Sta		n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-27.04	.04	-23.85	.02	-16.39	.04	-12.21	.08	-7.6	.04		
10.09	.08	15.22	.04	16.16	.02	25.82	.04	30.65	.02		

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-12.21	13.38		30	31	32		.1	.3
Ineffective Flow			num=	5					
Sta L	Sta R	Elev	Permanent						
-27.04	-26.5	118	F						
-26.5	-19.39	116.62	F						
-17.9	-16.2	116.47	F						
15.22	24	116.19	F						
30	31.8	118	F						

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2207

INPUT  
 Description: 5m U/S of U/S End of Proposed Ret. Wall 105  
 102m upstream of  
 Plank Road bridge  
 Ineffective area at left end of the cross  
 section models the residences along Brookdale Drive, and at the  
 right end represents the structures along Harpers Ferry Road.

Station Elevation Data		num= 71		Sta		Elev		Sta		Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-42	116.26	-39.13	116.34	-36.91	116.28	-36.18	116.23	-32.82	116.12		
-32.14	116.12	-28.88	116.14	-26.62	116.14	-26.38	116.15	-25.66	116.17		
-25.64	116.14	-25.54	116.03	-23.84	116.07	-22.84	116.1	-19.76	116.16		
-19.45	116.17	-18.25	116.06	-16.66	115.9	-16.59	115.95	-16.51	116		
-16.06	116.01	-15.08	115.86	-11.14	115.25	-9.74	115.11	-9.62	115.04		
-9.44	114.93	-9.42	114.91	-9.38	114.88	-9.31	114.84	-8.45	114.26		
-7.62	113.69	-4.43	113.66	-2.3	113.64	-2.07	113.64	-.19	113.6		
0	113.61	.78	113.63	1.22	113.64	1.55	113.64	1.85	113.65		
4.3	113.72	5.07	113.74	6.31	114.36	6.45	114.42	6.56	114.48		
6.65	114.52	7.38	114.89	7.41	114.9	8.04	115.18	8.44	115.45		
8.51	115.48	8.6	115.53	8.75	115.6	8.79	115.61	9.95	115.7		
10.62	115.71	13.57	115.76	13.86	115.76	17.15	115.71	17.17	115.72		
17.75	115.86	18.14	115.86	19.49	115.89	19.73	115.93	19.89	115.96		
21.61	115.96	21.81	115.97	25.47	116.1	28.21	116.12	28.79	116.13		
30.98	116.29										

Manning's n Values		num= 7		Sta n Val		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-42	.04	-32.82	.02	-16.66	.04	-15.08	.08	-8.45	.04
6.31	.08	8.6	.02						

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-9.74	8.04		5	5	5		.1	.3
Ineffective Flow	num= 4								
Sta L	Sta R	Elev	Permanent						
-42	-31.14	118	F						
-31.14	-19.44	116.17	F						
-17.8	-16.05	116.01	F						
25.6	30.72	118	F						

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2202

INPUT  
 Description: 97m upstream of Plank Road bridge  
 U/S End Prop. Retaining Wall  
 No.105

Ineffective area at left end of the cross section models the residences along Brookdale Drive, and at the right end represents the structures along Harpers Ferry Road.

Beginning of ret. wall along Hartford Ferry Road. Thus, it is not effective in containing the flow at this location.

Station Elevation Data		num= 89		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-44.17	116.04	-42.98	116.07	-39.69	115.99	-38.59	115.93	-38.49	115.82		
-37.82	115.84	-37.13	115.88	-36.12	115.88	-35.62	115.89	-35.14	115.89		
-34.93	115.9	-34.54	115.9	-34.38	115.91	-34.24	115.92	-31.76	115.93		
-31.34	115.94	-30.92	115.94	-30.5	115.95	-30.09	115.96	-29.69	115.97		
-29.31	115.98	-28.93	115.98	-28.58	115.99	-28.24	116	-27.93	116		
-27.62	116.01	-27.35	116.02	-27.09	116.02	-26.62	116.03	-26.22	116.04		
-26.11	116.05	-25.88	116.05	-25.59	116.06	-22.93	116.1	-21.42	116.12		
-19.87	116.1	-19.57	116.09	-18.8	116.02	-16.53	115.82	-16.45	115.87		
-16.38	115.92	-15.34	116.12	-13.49	116.41	-12.89	116.48	-10.62	115.23		
-9.43	114.48	-7.89	113.68	-7.87	113.68	-4.49	113.64	-4.25	113.64		
-4.06	113.63	-.47	113.57	0	113.58	1.85	113.64	1.95	113.65		
2.07	113.65	2.23	113.66	3.64	113.7	4.9	113.73	4.93	113.74		
5.91	114.23	5.98	114.26	7.6	114.96	8.06	115.15	9.11	115.57		
9.14	115.93	9.59	115.94	9.6	115.89	9.61	115.64	10.19	115.65		
10.3	115.65	13.49	115.7	13.52	115.7	14.8	115.68	16.79	115.65		
16.8	115.65	17.39	115.79	17.57	115.79	18.53	115.81	19.07	115.83		
19.26	115.86	19.86	115.95	20.22	115.95	21.09	115.97	22.1	115.97		
24.88	116.05	25.55	116.08	26.13	116.1	28.45	116.1				

Manning's n Values		num= 7		Sta n Val		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-44.17	.02	-16.53	.04	-13.49	.08	-9.43	.04	5.91	.08
9.11	.02	19.07	.04						

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-12.89	9.11		33	34	35		.1	.3
Ineffective Flow	num= 3								
Sta L	Sta R	Elev	Permanent						
-44.17	-31.5	118	F						
-31.5	-12.89	116.48	F						
22.1	28.45	118	F						
Blocked Obstructions	num= 1								
Sta L	Sta R	Elev							
26.01	28.45	118							

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2168

INPUT  
 Description: U/S Limit of Proposed Channelization-Full width; (Taper to EX to Sta 2+180)  
 Ineffective area at left end of the cross section models the residences along Brookdale Drive, and at the right end represents the structures along Harpers Ferry Road.

Station Elevation Data num= 66

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-59.1	115.37	-57.13	115.39	-49.96	115.47	-49.48	115.47	-44.05	115.48
-43.6	115.48	-39.68	115.55	-35.79	115.64	-32.67	115.75	-28.11	115.73
-27.82	115.72	-27.47	115.72	-27.04	115.71	-26.49	115.71	-25.73	115.7
-25.37	115.69	-25.36	115.69	-24.53	115.64	-23.84	115.6	-23.7	115.6
-22.42	115.46	-22.13	115.48	-19.83	115.61	-19.33	115.64	-19.26	115.63
-16	115.45	-15.86	115.59	-15.78	115.58	-11.98	115.39	-11.69	115.38
-10.24	115.01	-9.77	114.87	-8.53	114.26	-7	113.49	-6.5	113.24
-6	112.99	-2.16	113	0	113	6	113	7.26	113.63
7.34	113.67	7.373	114.871	7.39	115.49	7.85	115.51	8.78	115.4
9.49	115.33	9.64	115.33	10.08	115.22	10.24	115.19	10.91	115.2
11.11	115.2	13.95	115.25	14.41	115.25	17.63	115.2	17.71	115.2
18.31	115.34	19.96	115.34	21.47	115.47	21.61	115.48	21.63	115.49
21.95	115.65	22.55	115.67	24.09	115.71	24.52	115.72	24.71	115.72
24.78	115.71								

Manning's n Values num= 7

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-59.1	.04	-22.42	.02	-16	.04	-11.98	.08	-7	.04
7.26	.02	19.96	.04						

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 -9.77 7.373 35 37.8 40 .1 .3

Ineffective Flow num= 5

Sta L	Sta R	Elev	Permanent
-59.1	-32.9	117	F
-24.6	-19.33	115.64	F
-19.33	-15.86	115.59	F
7.82	24	115.51	F
24	24.78	117	F

Blocked Obstructions num= 2

Sta L	Sta R	Elev	Sta L	Sta R	Elev
-59.1	-55.8	118	-51.2	-35.9	118

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2130

INPUT  
 Description: 26m U/S Plank Road Bridge  
 Ineffective area at left end of the cross section models the residences along Brookdale Drive, and at the right end represents the structures along Harpers Ferry Road.

Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-127.89	115.63	-127.64	115.62	-116.09	115.66	-115.61	115.63	-112.11	115.55
-112.05	115.55	-109.68	115.45	-108.14	115.4	-107.64	115.37	-106.65	115.33
-103.41	115.26	-103.06	115.28	-98.8	115.2	-97.96	115.17	-95.85	115.11
-90.15	115.19	-87.83	115.17	-84.12	115.11	-81.73	114.99	-81.5	114.99
-79.47	114.97	-76.73	115	-73.05	115.06	-72.12	115.07	-71.82	115.08
-68.54	114.98	-68.26	114.99	-66.78	115.07	-55.64	115.07	-43.21	115.18
-43.04	115.17	-35.77	115.14	-34.11	115.18	-33.86	115.19	-30.57	115.23
-28.75	115.33	-28.47	115.35	-27.49	115.39	-24.43	115.38	-24.32	115.37
-22.79	115.4	-20.67	115.35	-20.49	115.34	-19.47	115.32	-18.93	115.31
-18.15	115.31	-13.96	115.3	-11.65	115.17	-11.42	115.16	-8.47	113.68
-7.13	113.01	-7	112.95	-6.97	112.94	-6	112.45	6	112.45
8.5	113.7	8.92	113.91	9.01	114.89	9.45	114.95	10.11	114.88
11.11	114.76	11.26	114.76	11.39	114.73	11.86	114.63	12.48	114.64
15	114.69	15.53	114.7	18.3	114.74	21.27	114.69	21.6	114.69
22.15	114.82	22.2	114.83	23.85	114.83	25.41	114.96	25.5	114.97
25.51	114.98	25.78	115.11	25.81	115.11	26	115.11	26.07	115.11
26.26	115.12	27.4	115.18	28.39	115.21	29.07	115.24	29.59	115.22
29.78	115.22	30.1	115.2	30.53	115.19	30.61	115.18	31.87	115.34
32.91	115.45	33.36	115.44	35.93	115.39	36.81	115.4	39.57	115.45

40.26	115.48	44.22	115.53	47.23	115.49	48.54	115.44	48.75	115.43
50.87	115.52								
Manning's n Values									
Sta n Val		Sta n Val		Sta n Val		Sta n Val		Sta n Val	
*****									
-127.89	.04	-98.8	.02	-97.96	.04	-13.96	.08	-8.47	.04
8.92	.02	26	.04						
Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.									
	-11.42	8.92		13.5	13.8	14		.1	.3
Ineffective Flow num= 4									
Sta L Sta R		Elev		Permanent					
-127.89	-22.1	117	F						
9.45	25.5	114.95	F						
29.07	30	115.24	F						
30	50.87	117	F						
Blocked Obstructions num= 8									
Sta L Sta R		Elev		Sta L Sta R		Elev		Sta L Sta R Elev	
*****									
-118.85	-110.85	118	-103.85	-96.85	118	-90.85	-81.85	118	
-73.85	-65.85	118	-58.85	-50.85	118	-42.85	-35.5	118	
-31.2	-24.2	118	30.59	43.69	117.5				

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2116

INPUT

Description: U/S of Plank Rd. Culvert No. 05668 (FEMA Sta 5141, Sec AK)

Ineffective area at left end of the cross section models the residences along Brookdale Drive, and the area at the right end represents the structures along Harpers Ferry Road.

Station Elevation Data num= 114									
Sta Elev		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
*****									
-137.36	116.05	-137.1	116.05	-136.77	116.03	-131.43	115.85	-130.09	115.86
-125.18	115.82	-124.83	115.82	-116.78	115.52	-116.51	115.52	-116.1	115.51
-115.77	115.5	-112.71	115.52	-112.07	115.5	-110.2	115.41	-107.28	115.48
-106.77	115.46	-106.31	115.44	-105.76	115.44	-104.71	115.41	-100.53	115.27
-98.31	115.25	-98.14	115.24	-97.87	115.21	-96.45	115	-94.64	115.14
-93.5	115.12	-86.89	115.15	-86.41	115.15	-83.89	115.12	-82.48	115.1
-76.28	115.01	-72.76	115.05	-71.54	115.06	-69.89	115.05	-68.75	115
-68.7	115	-67.43	114.98	-65.06	114.94	-63.76	114.92	-63.26	114.93
-62.27	114.93	-62.06	114.94	-62.04	114.96	-61.9	114.94	-61.86	114.95
-61.65	114.95	-61.35	114.94	-59.87	114.97	-57.46	115.03	-57.06	115.07
-56.98	115.08	-56.57	115.12	-56.05	115.12	-55.04	115.14	-49.91	114.95
-48.51	114.95	-46.38	115.03	-44.92	115.07	-40.5	115.08	-40.31	115.09
-38.21	115.05	-38.09	115.05	-35.87	115.14	-35.72	115.15	-35.68	115.14
-33.03	115.14	-25.94	115.3	-23.79	115.35	-23.7	115.34	-23.3	115.34
-22.28	115.32	-16.45	115.24	-12.69	115.13	-11.57	115.08	-11.04	114.82
-9.03	113.815	-7	112.8	-6.88	112.74	-6	112.3	0	112.3
6	112.3	6.65	112.62	8.88	113.74	8.97	114.91	9.42	114.91
10.65	114.83	13.18	114.67	13.33	114.67	13.83	114.56	13.93	114.54
16.59	114.59	17.23	114.6	19.78	114.64	20.53	114.65	22.98	114.61
23.83	114.6	26.08	114.75	26.53	114.78	27.98	114.87	28.12	114.87
29.27	114.89	29.29	114.89	30.98	114.93	32.9	114.93	36.44	114.97
43.73	115.05	47.06	115.11	47.25	115.13	50.37	115.27	53.46	115.38
54.37	115.4	60.63	115.5	60.73	115.51	64.25	115.51		

Manning's n Values									
Sta n Val		Sta n Val		Sta n Val		Sta n Val		Sta n Val	
*****									
-137.36	.04	-16.45	.08	-9.03	.04	8.88	.02	32.9	.04
47.25	.02								
Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.									
	-9.03	8.88		36	36.6	37		.3	.5
Ineffective Flow num= 3									
Sta L Sta R		Elev		Permanent					
-137.36	-20.1	117	F						
8.97	35.6	114.91	F						
35.6	64.25	117	F						
Blocked Obstructions num= 8									

Sta L	Sta R	Elev	Sta L	Sta R	Elev	Sta L	Sta R	Elev
-137.36	-132.9	118	-120.9	-112.9	118	-105.9	-98.9	118
-92.9	-83.9	118	-75.9	-67.9	118	-60.9	-52.9	118
-44.9	-35.9	118	-33.9	-23.9	118			

CULVERT

RIVER: Mad River  
 REACH: Reach 1 RS: 2098.5

INPUT

Description: Proposed Plank Road Culvert No. 05668  
 Roadway profile assumes flow through bridge parapets.  
 Three concrete box culverts with effective hydraulic openings of 4m span by 2.1m height  
 The inverts of the barrels will be backfilled with gravel streambed material to promote fish passage. The assumed roughness coefficient of the backfilled barrels is 0.036.  
 At the inlet, the top edge of the barrels will be beveled to improve hydraulic capacity.

Distance from Upstream XS = 11.84  
 Deck/Roadway Width = 14.035  
 Weir Coefficient = 1.45  
 Upstream Deck/Roadway Coordinates

num= 21								
Sta Hi	Cord	Lo Cord	Sta Hi	Cord	Lo Cord	Sta Hi	Cord	Lo Cord
-84.11	114.77	0	-64.11	114.69	0	-44.11	114.79	0
-24.11	114.89	0	-12.2	114.91	0	-12.2	115.62	0
-8.2	115.64	0	-8.2	115.9	0	-7.88	115.98	0
-6.6	115.98	0	-6.6	114.91	0	6.6	114.87	0
6.6	115.94	0	9.8	115.94	0	9.8	114.8	0
10.89	114.79	0	15.89	114.73	0	24.89	114.84	0
35.89	114.76	0	38.14	114.76	0	65.89	114.4	0

Upstream Bridge Cross Section Data

Station Elevation Data num= 14			
Sta	Elev	Sta	Elev
-20.1	114.95	-11.443	114.934
10.93	114.6	10.93	114.45
27.43	114.61	28.15	114.76
		30.08	114.81
		38	114.89

Manning's n Values num= 3		
Sta	n Val	Sta
-20.1	.04	8.13
		30.08

Bank Sta:	Left	Right	Coeff	Contr.	Expan.
	-11.443	8.13	.3	.5	

Ineffective Flow num= 3			
Sta L	Sta R	Elev	Permanent
-137.36	-20.1	117	F
8.97	35.6	114.91	F
35.6	64.25	117	F

Blocked Obstructions num= 8								
Sta L	Sta R	Elev	Sta L	Sta R	Elev	Sta L	Sta R	Elev
-137.36	-132.9	118	-120.9	-112.9	118	-105.9	-98.9	118
-92.9	-83.9	118	-75.9	-67.9	118	-60.9	-52.9	118
-44.9	-35.9	118	-33.9	-23.9	118			

Downstream Deck/Roadway Coordinates

num= 23								
Sta Hi	Cord	Lo Cord	Sta Hi	Cord	Lo Cord	Sta Hi	Cord	Lo Cord
-84.11	114.77	0	-64.11	114.69	0	-44.11	114.79	0
-24.11	114.89	0	-12.2	114.96	0	-12.2	115.67	0
-8.2	115.69	0	-8.2	115.96	0	-7.88	116.03	0
-6.6	116.03	0	-6.6	114.96	0	6.6	114.92	0





Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-143.2	116.22	-142.09	116.1	-138.89	115.82	-135.12	115.7	-132.72	115.7
-127.7	115.6	-124.84	115.53	-118.89	115.35	-117.08	115.35	-116.38	115.33
-115.83	115.28	-115.8	115.28	-114.16	115.23	-113.13	115.23	-111.58	115.24
-102.06	115.07	-100.55	115.09	-98.78	115.05	-96.96	115.01	-96.85	115.01
-94.09	114.84	-82.07	114.67	-80.12	114.56	-80.04	114.56	-79.83	114.57
-77.42	114.78	-75.35	114.77	-74.43	114.79	-67.76	114.66	-65.69	114.66
-62.76	114.65	-59.73	114.61	-58.14	114.61	-55.32	114.59	-53.2	114.57
-51.02	114.54	-47.17	114.58	-44.58	114.68	-42.33	114.61	-41.18	114.49
-40.82	114.49	-39.74	114.67	-31.64	114.51	-31.12	114.5	-31.06	114.5
-30.93	114.51	-25.29	114.59	-23.77	114.61	-21.84	114.74	-19.82	114.54
-19.55	114.59	-19.23	114.65	-13.96	114.3	-10.3	112.5	-6.02	111.9
0	111.9	2.01	111.89	6.02	111.89	6.07	111.92	6.18	111.97
6.24	112	10.13	113.94	11.26	114.5	11.52	114.63	12.04	114.89
13.49	114.98	14.14	115.02	14.29	115.02	15.02	114.96	15.51	114.93
17.2	114.97	18.61	115	22.8	115.1	24.71	115.14	25.8	115.16
26.45	115.17	28.8	115.14	32.07	115.04	32.08	115.23	33.57	115.25
36.18	115.04	39.55	114.93	40.55	114.89	40.98	114.88	41.04	114.96
41.08	115.01	43.41	114.91	43.87	114.87	45.53	114.79	46.19	114.81
46.5	114.85	46.96	114.87	47.74	114.85	50.47	114.9	53.53	114.91
58.87	114.95	60.19	114.95	63.62	114.97	63.68	114.98	64.49	114.98
64.92	114.97	65.32	114.97	66.03	114.96	66.26	114.96	66.34	114.95
67.18	114.83	67.54	114.83	67.67	114.84	68.86	114.86	69.55	114.87
70.18	114.88	70.6	114.89	71.51	114.9	72.17	114.91	72.85	114.91
73.11	114.9	74.2	114.89	74.82	114.89	75.55	114.88	75.88	114.88
76.9	114.87	77.12	114.87	77.52	114.93	78.01	115.01	78.32	115.01
79.64	115.03	80.46	115.05	80.59	115.03	81.01	114.99	81.19	114.97
81.31	114.96	81.79	114.98	81.91	114.99	81.96	114.99	82.06	115
84.35	115.15	86.03	115.24	86.96	115.32	87.26	115.3	87.64	115.31
88.12	115.46	95.36	115.57	101.32	115.45	110.34	115.53	113.75	115.56
116.24	115.59	124.94	115.59	125.74	115.58	126.55	115.58	126.81	115.95
127.23	116.52	129.56	116.54	130.52	116.6	133.31	117.73		

Manning's n Values		num= 7	
Sta	n Val	Sta	n Val
-143.2	.08	-127.7	.04
15.51	.02	81.31	.04

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-13.96	11.26		11	12	13		.3	.5

Ineffective Flow		num= 3	
Sta L	Sta R	Elev	Permanent
-140.44	-23	117	F
-23	-13.96	114.66	F
34.5	135	117	F

Blocked Obstructions		num= 2			
Sta L	Sta R	Elev	Sta L	Sta R	Elev
46.4	62.52	117.5	88.22	123.32	118

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2067

INPUT

Description: Upstream of Beaver Pond Brook confluence.  
 Left-most ineffective

flow area models limit of conveyance from eastern end of the residences along Brookdale Drive down to Proposed Bridge No. 06591 (WB Exit 24 On-Ramp).

Ineffective flow area left of channel models expected limit of conveyance for flows that do not overtop Plank Road.

Ineffective flow area right end of section models expected limit of conveyance due to Harpers Ferry Road profile.

Station Elevation Data		num= 84							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-140.9	116.25	-134.59	115.75	-134.36	115.74	-133.94	115.74	-127.95	115.72
-122.91	115.63	-121.22	115.55	-116.84	115.54	-115.34	115.5	-114.04	115.37
-112.35	115.52	-110.45	115.61	-108.62	115.56	-104.55	115.55	-104.36	115.59
-103.05	115.57	-101.56	115.52	-99.73	115.47	-98.9	115.41	-96.53	115.38
-94.79	115.34	-94.61	115.34	-94.55	115.34	-94.3	115.24	-92.29	114.84

-91.81	114.8	-86.65	114.02	-85.84	113.84	-84.88	113.55	-81.83	112.83
-81.29	112.73	-79.24	112.38	-75.14	112.33	-72.57	112.26	-62.29	112.1
-59.87	112.09	-51.85	111.91	-45.74	111.94	-39.37	111.98	-36.64	112.04
-33.73	112.1	-23.19	112.02	-21.93	112.02	-21.48	111.96	-18.24	111.88
-16.28	111.83	-15.43	111.88	-14.49	112.31	-12.37	112.43	-9.57	112.49
-9	112.76	-8	112.76	-6	111.76	0	111.76	6	111.76
6.21	111.83	6.56	112	9.43	113.42	11.89	114.63	12.13	114.75
12.35	114.86	13.14	115.25	13.97	115.59	14.23	115.57	15.68	115.47
15.84	115.47	17.04	115.38	17.18	115.38	19.55	115.45	20.74	115.49
21.98	115.52	24.39	115.59	24.57	115.6	31.95	115.67	32.03	115.67
33.28	115.61	33.43	115.78	34.12	115.79	36.45	115.93	36.69	115.95
37.04	116.12	37.21	116.21	37.58	116.21	40.44	116.13		

Manning's n Values num= 9

Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val
-140.9	.08	-94.3	.08	-23.19	.06	-21.48	.04	-9.57	.06
9.43	.08	13.97	.04	17.04	.02	36.69	.04		

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-8	6.56	44	46.7	50	.3	.5
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Ineffective Flow num= 4

Sta L	Sta R	Elev	Permanent
-140.9	-30.9	117	F
-30.9	-25.5	114	F
-25.5	-8	112.76	F
29	40.44	117	F

Blocked Obstructions num= 1

Sta L	Sta R	Elev
-120.6	-104	117

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2020

INPUT

Description: FEMA Station 5139, Cross Section A1  
 BLA surveyed cross section

Just downstream of Beaver Pond Brook  
 confluence.

"Natural" cross section  
 The left-most ineffective

flow area models the expected limit of conveyance from the eastern  
 end of the residences along Brookdale Drive down to Proposed Bridge  
 No. 06591.

The ineffective flow area left of the channel models  
 the expected limit of conveyance for flows that do not overtop  
 Plank Road.

Station Elevation Data num= 71

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-139.82	116.2	-137.88	116.06	-136.68	115.96	-131	115.78	-129.86	115.74
-129.64	115.73	-125.85	115.67	-121.81	115.46	-117.6	115.38	-115.65	115.33
-114.71	115.26	-113.79	115.2	-112.64	115.13	-110.78	115.02	-110.12	114.99
-109.98	114.98	-106.98	114.5	-106.31	114.35	-103.62	113.8	-100.54	112.61
-98.52	112.09	-98.13	112	-95.56	111.94	-87.75	111.86	-78.57	111.86
-76.15	111.88	-74.5	111.88	-63.05	111.88	-59.69	111.88	-50.83	111.88
-45.17	111.88	-42.47	111.88	-33.84	111.89	-33.45	111.9	-31.09	110.95
-30.89	110.85	-29.52	110.79	-28	110.74	-23.93	110.63	-22.49	110.53
-21.91	110.56	-21.34	110.58	-15.59	110.9	-14.57	110.89	-12.46	110.76
-11.95	110.78	-9	112.25	-8	112.25	-6	111.25	0	111.25
6	111.25	12.2	111.25	14.63	111.5	18.11	111.85	19.39	111.78
23.18	113.5	24.25	113.76	24.78	113.87	25.39	114	26.75	114.38
27.03	114.47	28.66	115	29.36	115.33	29.67	115.5	30.74	116.04
31.22	116.28	32.36	116.86	36.02	118.71	36.21	118.73	37.07	118.81
37.39	118.83								

Manning's n Values num= 5

Sta n Val	Sta n Val	Sta n Val	Sta n Val	Sta n Val					
-139.82	.08	-125.85	.04	-114.71	.08	-11.95	.04	23.18	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

```

      -8  18.11          17    17    17          .3    .5
Ineffective Flow num= 3
Sta L Sta R Elev Permanent
-139.82 -40.5 117 F
-40.5 -9 112.25 F
18.11 21 111.85 F
Blocked Obstructions num= 1
Sta L Sta R Elev
*****
-139.82 -9 110.65

```

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 2004

INPUT  
 Description: 12.8m D/S of the Beaver Pond Brook confluence.

```

Station Elevation Data num= 62
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
*****
-113.84 116.84 -112.58 116.51 -111.67 116.33 -107.38 115.43 -104.96 115.38
-104.49 115.36 -100.09 115.23 -94.17 115.29 -92.73 115.3 -90.72 115.25
-86.24 115.17 -84.63 115.15 -80.73 115.11 -79.43 114.99 -75.78 114.56
-71.5 112.72 -69.76 112.07 -68.54 111.88 -62.86 111.91 -59.15 111.9
-57.63 111.88 -54.81 111.86 -46.42 111.81 -46.36 111.81 -43.79 111.77
-41.3 111.77 -41.22 111.61 -39.85 110.76 -38.9 110.31 -30.15 110.02
-26.76 110.07 -25.6 110.05 -24.97 110 -22.52 109.94 -21.94 109.92
-18.35 110.58 -17 110.77 -11.4 110.87 -9 112.07 -8 112.07
-6 111.07 0 111.07 6 111.07 6.19 111.07 11.07 111.95
20.46 111.57 28.53 115 35.12 115.5 38.12 117 42.6 119.25
43.97 119.93 44.11 120 44.58 120.05 44.87 120.09 46.62 120.33
47.66 120.47 47.79 120.5 48.14 120.53 48.36 120.54 48.47 120.55
48.66 120.57 49.66 120.68

```

```

Manning's n Values num= 4
Sta n Val Sta n Val Sta n Val Sta n Val
*****
-113.84 .08 -11.4 .04 20.46 .08 42.6 .04

```

```

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
      -8 11.07 23 21.1 19 .3 .5

```

```

Ineffective Flow num= 4
Sta L Sta R Elev Permanent
-112.6 -40.8 116 F
-40.8 -8 112.07 F
11.07 22 111.95 F
22 52 115 F

```

```

Blocked Obstructions num= 1
Sta L Sta R Elev
*****
-113.84 -9 110.65

```

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1983

INPUT  
 Description: 37.9m U/S I-84 WB Exit 24 On-Ramp from Harpers Ferry Rd.

Existing: Upstream of Structure No. 05774, easterly crossing over the Mad River

```

Station Elevation Data num= 68
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
*****
-106.72 118.72 -103.91 118.44 -102.64 118.34 -100.88 118.22 -96.8 117.31
-96.61 117.27 -96.45 117.23 -91.27 115.93 -87.07 114.93 -86.93 114.9
-86.52 114.9 -80.76 114.81 -78.23 114.81 -72.84 114.69 -69.77 114.66
-66.35 114.63 -62.36 114.64 -59.22 114.63 -57.15 114.41 -54 114.12
-53.46 113.98 -50.4 112.67 -49.6 112.23 -49.03 112.19 -48.05 112.19
-42.87 112.09 -42.29 112.19 -35.34 112 -34.31 111.95 -32.86 111.89
-32.21 111.23 -31.83 110.92 -31.23 110.86 -30.78 110.91 -29.96 110.83
-28.26 110.21 -26.3 110.13 -24.42 110 -23.99 109.91 -23.67 109.83
-22.01 109.93 -20.85 110.08 -18.19 110.05 -14.42 110.23 -14.18 110.24

```

-13.81	110.33	-12.97	110.69	-12.74	110.76	-12.56	110.84	-10.59	111.05
-9	111.84	-8	111.84	-6	110.84	0	110.84	6	110.84
8	111.84	10.1	111.76	17.19	115	29.62	115.5	32.71	117
37.8	119.49	40.85	121	42.97	122.07	43.01	122.6	43.02	122.73
43.35	122.73	43.44	121.91	43.52	121.8				

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-106.72	.08	-42.87	.06	-10.59	.04	10.1	.08	37.8	.04
42.97	.02								

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-8	8	12	10.3	8.5	.3	.5
----	---	----	------	-----	----	----

Ineffective Flow num= 4

Sta L	Sta R	Elev	Permanent
-106.72	-41	120	F
-41	-33.9	116	F
-33.9	-8	111.84	F
8	11	111.84	F

Blocked Obstructions num= 1

Sta L	Sta R	Elev
-106.72	-9	110.65

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1972

INPUT  
 Description: 26.7m U/S I-84 WB Exit 24 On-Ramp from Harpers Ferry Rd.

Station Elevation Data num= 67

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-99.93	119.08	-97.55	119.17	-96.42	119.19	-94.47	119.05	-92.55	118.52
-88.66	117.62	-88.42	117.55	-87.26	117.14	-83.49	115.8	-83.1	115.68
-82.73	115.6	-81.2	115.28	-79.47	114.91	-78.38	114.86	-73.08	114.66
-71.66	114.58	-66.91	114.61	-65.16	114.64	-56.63	114.49	-56.36	114.49
-51.32	114.38	-46.6	114	-46.56	114	-45.21	113.89	-42.98	113
-40.09	112.47	-37.78	112.43	-32.71	112.36	-32.59	112.39	-31.52	112.63
-30.69	112.74	-26.22	112.28	-24.04	112.06	-23.77	112.07	-22.58	111.92
-21.65	110.71	-20.95	110.62	-19.87	110.5	-18.21	110.4	-17.74	110.37
-16.53	110.3	-15.97	110.25	-14.97	110.19	-12.17	110.31	-11.49	110.5
-9.48	111.5	-9	111.72	-8	111.72	-6	110.72	0	110.72
6	110.72	8	111.66	15.06	115	25.7	115.5	28.77	117
30.36	117.77	32.89	119	38.18	121.61	38.2	122.15	38.22	122.34
38.25	122.8	38.56	122.8	38.6	122.5	38.65	121.99	38.73	121.88
38.78	121.81	38.8	121.81						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-99.93	.08	-45.21	.06	-16.53	.04	30.36	.04	38.18	.02

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-8	8	10.3	10.3	10.3	.3	.5
----	---	------	------	------	----	----

Ineffective Flow num= 5

Sta L	Sta R	Elev	Permanent
-99.93	-39.1	120	F
-39.1	-23	116	F
-23	-8	111.72	F
15.9	23.61	115.54	F
23.61	38.25	122.8	F

Blocked Obstructions num= 1

Sta L	Sta R	Elev
-99.93	-9	110.65

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1962

INPUT

Description: U/S of I-84 WB Exit 24 On-Ramp (06591) from Harpers Ferry Rd.

Station Elevation Data		num= 49		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-61.09	116.26	-57.79	116.25	-51.65	116.16	-51.31	116.16	-51.23	116.16		
-43.23	116.13	-40.54	116.11	-32.65	116.12	-31.01	116.11	-27.34	116.06		
-24.69	116.02	-23.57	116.01	-23.17	116	-23.11	115.99	-22.54	115.86		
-22.24	115.8	-22.09	115.77	-21.19	115.51	-21.18	115.51	-21.15	115.5		
-20.16	115	-19.12	114.48	-18.16	114	-17.1	113.47	-16.16	113		
-15.21	112.53	-14.15	112	-13.15	111.5	-12.15	111	-11.75	110.95		
-6	110.65	0	110.65	6	110.65	6.74	111.02	7	111.15		
11.29	113.3	12.51	113.91	15.22	115.26	15.68	115.33	16.69	115.42		
17.56	115.5	26.38	119.91	28.03	120.7	28.38	120.9	28.39	122.2		
28.43	122.54	28.47	122.85	28.93	122.85	28.94	122.76				

Manning's n Values		num= 4		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-61.09	.08	-18.16	.04	11.29	.08	28.38	.02

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-22.09	15.22		50	61.9	80		.3	.5
Ineffective Flow	num= 2								
Sta L	Sta R	Elev	Permanent						
-85	-38.6	120	F						
17.6	29	122.85	F						

BRIDGE

RIVER: Mad River  
REACH: Reach 1 RS: 1938.5

INPUT  
Description: Proposed Bridge No. 06591  
I-84 Westbound Exit 24 On-Ramp from  
Harpers Ferry Road

Distance from Upstream XS = 17.4  
Deck/Roadway Width = 12.8  
Weir Coefficient = 1.45

Upstream Deck/Roadway Coordinates		num= 10		Sta Hi Cord Lo Cord		Sta Hi Cord Lo Cord		Sta Hi Cord Lo Cord	
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-40	120.7	0	-20	120.7	0	-20	120.7	0	
-19.11	120.7	0	-19.11	120.7	118.65	13.75	121.5	119.5	
13.75	121.5	0	20	121.5	0	20	121.5	0	
41	121.5	0							

Upstream Bridge Cross Section Data		num= 10		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-32.85	118.285	-32.85	116	-19.11	116	-16.93	116	-6	110.53		
0	110.53	6	110.53	12.84	114	13.75	114	13.75	119.5		

Manning's n Values		num= 2		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-32.85	.08	-16.93	.04				

Bank Sta:	Left	Right	Coeff	Contr.	Expan.
	-16.93	12.84		.3	.5

Ineffective Flow	num= 2								
Sta L	Sta R	Elev	Permanent						
-85	-38.6	120	F						
17.6	29	122.85	F						

Downstream Deck/Roadway Coordinates		num= 10		Sta Hi Cord Lo Cord		Sta Hi Cord Lo Cord		Sta Hi Cord Lo Cord	
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-40	120.7	0	-20	120.7	0	-20	120.7	0	
-13.57	120.7	0	-13.57	120.7	118.24	15.08	121.7	119.27	
15.08	121.7	0	20	121.7	0	20	121.7	0	
40	121.7	0							

Downstream Bridge Cross Section Data

Station Elevation Data		num= 13							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-29.43	117.874	-29.43	116	-16.93	116	-13.57	114.3	-6	110.48
0	110.48	6	110.48	8.07	111.5	9.44	112	15.08	114.8
16.5	115.5	28.98	116	44.17	123.5				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-29.43	.08	-16.93	.04	16.5	.08

Bank Sta: Left Right Coeff Contr. Expan.

-13.57	15.08	.3	.5
--------	-------	----	----

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
8.5	15	111.57	T
23.73	33.2	116.2	T

Upstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Downstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Maximum allowable submergence for weir flow = .95  
 Elevation at which weir flow begins =  
 Energy head used in spillway design =  
 Spillway height used in design =  
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data  
 Energy  
 Selected Low Flow Methods = Highest Energy Answer

High Flow Method  
 Energy Only

Additional Bridge Parameters  
 Add Friction component to Momentum  
 Do not add Weight component to Momentum  
 Class B flow critical depth computations use critical depth  
 inside the bridge at the upstream end  
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1900

INPUT  
 Description: Between I-84 (05774) and WB Exit 24 On-Ramp (06591)  
 EX: D/S of EX

I-84 EB Exit 24 Off-Ramp to Harpers Ferry Rd.

Station Elevation Data		num= 37							
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-14.64	120.56	-14.59	120.62	-14.52	120.74	-14.43	121.55	-14.15	121.55
-14.08	120.95	-14.07	117.83	-14.02	114.83	-14.01	114.32	-13.89	114.26
-12.01	113.32	-9.6	112.11	-8.51	111.57	-8.5	111.57	-6.77	110.7
-6	110.32	0	110.32	6	110.32	7.73	111.18	8.5	111.57
12.26	111.42	14.02	111.35	16.44	112.56	17.52	113.1	18.22	113.44
18.52	113.6	22.11	115.39	23.73	116.2	24.85	116.2	26.24	115.55
27	115.2	30.35	115.2	31.21	115.6	32.08	116	33.18	116.23
34.34	116.47	34.7	116.54						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-14.64	.02	-14.01	.08	-12.01	.04	8.5	.06	17.52	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-12.01	17.52	29.4	29.4	29.4	.3	.5
--------	-------	------	------	------	----	----

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
8.5	15	111.57	T
23.73	33.2	116.2	T

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1871

INPUT  
 Description: U/S of Prop I-84 Bridge 05774  
 Approach Sect to Prop I-84 Bridge  
 05774

Cross section within former Century Pond  
 aka Scovill Pond,  
 East Brass Mill Pond, City Mills Pond  
 Wall at right end of  
 section represents the existing sanitary sewer pump station.

Station Elevation Data num= 32									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-16.16	119.47	-16.08	119.58	-16.03	119.65	-15.98	120.16	-15.95	120.47
-15.65	120.47	-15.63	120.24	-15.59	119.82	-15.52	116.54	-15.48	114.91
-12.87	113.6	-12.01	113.17	-11.68	113.01	-8.51	111.42	-8.5	111.42
-6.01	110.18	-6	110.17	0	110.17	6	110.17	7.84	111.09
8.5	111.42	8.64	111.42	9.77	111.98	12.14	113.17	12.53	113.36
13.14	113.67	16.05	115.12	18.54	116.37	20.67	116.4	20.86	116.45
20.92	116.64	20.93	116.7						

Manning's n Values num= 5									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-16.16	.02	-15.48	.08	-12.01	.04	12.14	.08	20.86	.02

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-15.48	16.05		122.4	122.4	122.4		.3	.5
Ineffective Flow	num=	Sta L	Sta R	Elev	Permanent				
	2	-16.16	-14.2	120.47	F				
		16.1	20.93	116.12	F				

BRIDGE

RIVER: Mad River  
 REACH: Reach 1 RS: 1807.5

INPUT  
 Description: Proposed I-84 Bridge No. 05774  
 Proposed easterly I-84 bridge over  
 the Mad River  
 Distance from Upstream XS = 34.24  
 Deck/Roadway Width = 58.8  
 Weir Coefficient = 1.45  
 Upstream Deck/Roadway Coordinates

num= 6														
Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-59.999	115.82		0	-13.04	115.82		0	-13.04	115.82	114.01				
12.97	116.12	114.32		12.97	116.12		0	59.999	116.12					0

Upstream Bridge Cross Section Data									
Station Elevation Data num= 10									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-26.9	117.5	-17.59	113.5	-13.04	113.05	-12.01	113	-6	110.01
0	110.01	6	110.01	11.96	113	12.97	113	12.97	114.32

Manning's n Values num= 2									
Sta	n Val	Sta	n Val						
-26.9	.08	-12.01	.04						

Bank Sta:	Left	Right	Coeff	Contr.	Expan.
	-12.01	11.96		.3	.5
Ineffective Flow	num=	Sta L	Sta R	Elev	Permanent
	2	-26.9	-14.2	120.47	F
		16.1	12.97	116.12	F

Downstream Deck/Roadway Coordinates  
 num= 6  
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord  
 \*\*\*\*\*  
 -59.999 115.43 0 -12.5 115.43 0 -12.5 115.43 113.63  
 13.58 115.73 113.93 13.58 115.73 0 59.999 115.73 0

Downstream Bridge Cross Section Data  
 Station Elevation Data num= 13  
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
 \*\*\*\*\*  
 -12.51 113.63 -12.5 113 -11.54 112.5 -6 109.73 0 109.73  
 6 109.73 13.58 113.505 15.32 114.5 16.12 114.85 17.3 114.5  
 18.3 114 21.96 114 37.98 124

Manning's n Values num= 4  
 Sta n Val Sta n Val Sta n Val  
 \*\*\*\*\*  
 -12.51 .04 -6 .042 6 .04 13.58 .08

Bank Sta: Left Right Coeff Contr. Expan.  
 -12.5 13.58 .3 .5  
 Ineffective Flow num= 1  
 Sta L Sta R Elev Permanent  
 -12.51 -13 115.5 F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Downstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Maximum allowable submergence for weir flow = .95  
 Elevation at which weir flow begins =  
 Energy head used in spillway design =  
 Spillway height used in design =  
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data  
 Energy  
 Selected Low Flow Methods = Energy

High Flow Method  
 Energy Only

Additional Bridge Parameters  
 Add Friction component to Momentum  
 Do not add Weight component to Momentum  
 Class B flow critical depth computations use critical depth  
 inside the bridge at the upstream end  
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1748

INPUT  
 Description: Between Proposed Bridges 06284 & 05774  
 U/S of Proposed Bridge  
 06284, I-84 Eastbound Exit 24 Off-Ramp to Harpers Ferry Road  
 D/S

of Proposed I-84 Bridge 05774  
 Cross section within former Century  
 Pond  
 aka Scovill Pond, East Brass Mill Pond, City Mills Pond

Station Elevation Data num= 32  
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
 \*\*\*\*\*  
 -33.16 115.5 -31.22 115.48 -29.04 115.46 -27.78 115.45 -24.92 115.41  
 -21.52 115.3 -20.81 115.28 -19.64 115.21 -15.41 113.8 -13.3 113.14  
 -12.84 112.92 -12.3 112.64 -10.69 111.84 -8.8 110.89 -8.79 110.89  
 -7.6 110.3 -6.29 109.64 0 109.64 6.29 109.64 7.43 110.22  
 8.79 110.89 8.8 110.89 10.17 111.58 12.3 112.64 13.56 113.27  
 14.6 113.79 15.22 114.1 15.64 114.31 16.4 114.32 16.58 114.37  
 16.6 120.76 16.61 122.98



Manning's n Values num= 6  
 \*\*\*\*\*  
 Sta n Val Sta n Val Sta n Val Sta n Val Sta n Val  
 -33.16 .02 -20.81 .04 -19.64 .08 -10.69 .04 10.17 .08  
 16.58 .02

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 -13.3 13.56 56.8 59.5 62.6 .3 .5  
 Ineffective Flow num= 1  
 Sta L Sta R Elev Permanent  
 -33.16 -13 115.5 F

BRIDGE

RIVER: Mad River  
 REACH: Reach 1 RS: 1727.5

INPUT  
 Description: Proposed I-84 E24 Off-Ramp Bridge No.06284  
 Exit to Harpers Ferry  
 Road

Distance from Upstream XS = 9.4  
 Deck/Roadway Width = 19.7  
 Weir Coefficient = 1.45

Upstream Deck/Roadway Coordinates num= 7  
 \*\*\*\*\*  
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord  
 -25.39 123.65 100 -23.7 123.73 100 -21.79 123.86 100  
 -21.79 123.86 119.435 16.51 124.89 120.542 16.51 124.89 100  
 19.7 124.93 100

Upstream Bridge Cross Section Data  
 Station Elevation Data num= 10  
 \*\*\*\*\*  
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
 -25.39 115.2 -24.06 115.1 -19.07 112.88 -17.97 112.58 -11.69 112.18  
 -6.54 109.61 6.54 109.61 12.55 112.61 16.36 114.51 16.38 120.44

Manning's n Values num= 3  
 \*\*\*\*\*  
 Sta n Val Sta n Val Sta n Val  
 -25.39 .06 -11.69 .04 16.36 .02

Bank Sta: Left Right Coeff Contr. Expan.  
 -11.69 12.55 .3 .5  
 Ineffective Flow num= 1  
 Sta L Sta R Elev Permanent  
 -25.39 -13 115.5 F

Downstream Deck/Roadway Coordinates num= 8  
 \*\*\*\*\*  
 Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord Sta Hi Cord Lo Cord  
 -31.62 122 100 -14.67 122.88 100 -13.93 122.95 100  
 -13.93 122.95 118.696 16.67 124.59 120.336 16.67 124.59 100  
 18.17 124.63 100 35.62 125 100

Downstream Bridge Cross Section Data  
 Station Elevation Data num= 12  
 \*\*\*\*\*  
 Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
 -31.62 115.07 -30.35 114.97 -24.33 112.15 -12.35 112.26 -6.99 109.58  
 6.99 109.58 13 112.58 19.03 115.59 19.05 118.78 19.61 118.77  
 27.32 120 35.62 124.06

Manning's n Values num= 4  
 \*\*\*\*\*  
 Sta n Val Sta n Val Sta n Val Sta n Val  
 -31.62 .06 -12.35 .04 19.03 .02 19.61 .06

Bank Sta: Left Right Coeff Contr. Expan.  
 -12.35 13 .3 .5  
 Ineffective Flow num= 1  
 Sta L Sta R Elev Permanent  
 -31.62 -13.9 122.78 F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Downstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Maximum allowable submergence for weir flow = .95  
 Elevation at which weir flow begins =  
 Energy head used in spillway design =  
 Spillway height used in design =  
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

Energy  
 Selected Low Flow Methods = Highest Energy Answer

High Flow Method  
 Energy Only

Additional Bridge Parameters

Add Friction component to Momentum  
 Do not add Weight component to Momentum  
 Class B flow critical depth computations use critical depth  
 inside the bridge at the upstream end  
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1689

INPUT  
 Description: FEMA Station 5137, Cross Section AG  
 D/S of Proposed Bridge 06284,

I-84 Eastbound Exit 24, Off-Ramp to Harpers Ferry Road  
 Cross

section within former Century Pond  
 aka Scovill Pond, East Brass  
 Mill Pond, City Mills Pond.  
 Right side fill slope is from  
 construction of a pump station which will be completed before the  
 start of this project

Station Elevation Data		num= 77		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-49.05	115.11	-46.99	115.09	-45.39	115.06	-42.77	115.02	-41.13	114.99		
-40.98	114.99	-38.55	114.9	-37.63	114.86	-36.73	114.79	-36.42	114.76		
-34.99	114.65	-33.26	114.5	-32.79	114.5	-32.52	114.64	-32.41	114.69		
-31.99	114.76	-31.39	114.8	-30.53	114.98	-29.82	114.98	-29.79	122.39		
-29.78	122.5	-29.74	123.04	-29.43	123.04	-29.4	122.79	-29.34	122.23		
-29.3	122.14	-29.21	121.98	-28.28	122.02	-27.98	122.03	-27.69	122.02		
-26.34	121.99	-25.32	121.96	-24.29	121.94	-23.05	121.9	-21.25	121.86		
-20.85	121.85	-20.76	121.84	-20.59	121.84	-19.4	121.81	-18.75	121.79		
-18.07	121.78	-16.88	121.74	-16.71	121.74	-16.06	121.72	-15.65	121.71		
-15.59	121.82	-15.52	121.96	-15.48	122.29	-15.43	122.78	-15.12	122.78		
-15.11	122.61	-15.07	122.13	-15.05	118.2	-15.03	113.44	-14.57	113.21		
-14.09	112.97	-13.67	112.76	-13.09	112.47	-11.93	111.9	-9.73	110.8		
-9.72	110.8	-9.03	110.45	-7.06	109.47	-6.01	109.47	-1.21	109.48		
0	109.48	7.04	109.48	7.69	109.8	9.54	110.73	9.55	110.73		
10.75	111.33	12.23	112.07	14.56	113.3856	26.296	119.4816	33.3965	123.1392		
34.7397	123.2102	35.3412	123.2269								

Manning's n Values		num= 7		Sta n Val		Sta n Val		Sta n Val		Sta n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-49.05	.08	-29.82	.02	-15.03	.08	-9.73	.04	9.54	.08		
12.23	.04	34.7397	.02								

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 -11.93 12.23 68.7 69 70 .3 .5  
 Ineffective Flow num= 1  
 Sta L Sta R Elev Permanent  
 -49.05 -13.9 122.78 F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1620

INPUT  
 Description: Cross Section within Former Century Pond  
 55m upstream of breached dam

aka Scovill Pond, East Brass Mill Pond, City Mills Pond

Station Elevation Data num= 53									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-22.11	118.55	-22.01	118.75	-21.98	118.81	-21.96	118.98	-21.89	119.62
-21.59	119.62	-21.58	119.44	-21.54	118.97	-21.53	118.41	-21.44	111.5
-20.42	111.49	-17.62	111.32	-15.15	110.41	-13.77	109.9	-11.95	109.23
-11.44	109.02	-10.93	108.99	-9.96	108.92	-9.01	108.87	-3.2	108.71
-2.51	108.67	-1.86	108.72	-1.03	108.71	2.45	108.82	6.83	108.66
7.6	108.64	10.59	109.02	10.93	109.09	11.35	109.22	13.13	109.79
13.45	109.89	14.8	110.34	15.02	110.32	24.09	111.03	24.23	111.05
24.49	111.1	26.24	111.6	27.3	112.07	27.89	112.27	30.18	112.95
31.7	113.4	32.05	113.49	32.81	112.113.6286	34.00	113.9952	34.68	114.3388
36.04	114.4588	39.79	114.5551	41.04	114.4719	42.52	113.9952	45.31	113.4694
46.11	113.4748	49.37	113.9952	53.2	116.74				

Manning's n Values num= 8									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-22.11	.02	-21.44	.08	-17.62	.04	15.02	.08	32.81	.04
36.04	.02	39.79	.04	49.37	.06				

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 -17.62 15.02 48 47 46.5 .1 .3

Ineffective Flow num= 2  
 Sta L Sta R Elev Permanent  
 -22.11 -21.62 119.62 F  
 -13 -.73 109.2 T

Blocked Obstructions num= 1  
 Sta L Sta R Elev  
 -13 -3 109.2

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1573

INPUT  
 Description: Upstream Heel Breached Century Dam  
 aka Scovill Pond Dam, East Brass Mill Pond Dam, City Mills Pond Dam  
 CTDEP Dam No. 15103  
 Dam

breached 1998.  
 Blocked area on the right side represents a pump station which will be completed before the start of this project

Station Elevation Data num= 61									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.8	116.26	-28.75	116.33	-28.67	116.44	-28.64	116.74	-28.59	117.25
-28.28	117.25	-28.27	117.05	-28.23	116.6	-28.22	115.19	-28.21	111.71
-28.07	111.73	-26.31	112.06	-23.28	111.97	-23.18	112	-23.01	112
-18.07	110.86	-15.79	110.42	-15.45	110.19	-14.88	109.41	-14.82	109.41
-12.11	109.28	-11.9	109.27	-11.88	109.26	-9.19	108.38	-9.13	108.36
-9.11	108.35	-6.04	107.7	-4.1	107.55	-3.66	107.46	-1.83	107.43
-.59	107.41	7.43	108.03	8.37	108.3	8.51	108.39	9.35	108.91
13.21	111.24	13.81	111.54	14.15	111.68	14.29	111.72	14.7	111.79
17.05	112.2	18.39	112.34	19.92	112.42	22.41	112.77	22.82	112.82
23.13	112.86	25.29	113.39	27.41	114.23	28.2	114.23	28.72	114.24
29.7	114.25	32.97	114.1138	33.94	114.0174	37.55	113.9952	58.59	114.0562
60.22	113.9952	61.08	114.25	61.64	114.38	63.34	114.76	65.54	115.35
69.84	118								

Manning's n Values num= 7									
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-28.8	.02	-28.21	.08	-15.79	.04	13.21	.08	33.94	.02



1.07	107.66	2.55	107.79	3.56	107.86	4.81	108	6.37	108.17
12.66	108.5	13	109.438	13.17	109.48	16.02	110.6	17.47	111.13
20.5	112.07	22.87	112.7	23.44	112.8	26.23	112.86	27.7	112.91
29.84	112.98	31.62	113.35	33.28	113.43	34.02	113.48		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-36.01	.02	-35.38	.08	-23.73	.04	12.66	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-26.05	13	15.2	15.2	15.3	.3	.5
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Ineffective Flow num= 4

Sta L	Sta R	Elev	Permanent
-36.01	-20.1	114.5	F
-20.1	-9.3	108.5	F
9.7	12.2	108.5	F
12.2	34.02	114	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1536

INPUT  
 Description: Downstream Toe of Proposed Rock Ramp  
 Location of downstream toe  
 of rock ramp proposed to be constructed downstream of Century Dam  
 to promote fish passage.

Station Elevation Data num= 50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-41.96	115.75	-41.66	115.75	-41.61	115.09	-41.6	109.38	-38.81	109.3
-37.82	109.27	-34.09	109.15	-30.5	109.17	-28.89	109.18	-27.87	109.18
-24.56	109.12	-23.15	109.11	-22.98	109.15	-22.42	109.07	-20.89	109.07
-18.89	108.95	-17.23	108.39	-16.68	108.2	-15.06	107.76	-14.76	107.68
-13.91	107.5	-13.57	107.45	-12.83	107.35	-10.92	107.17	-9.94	107.09
-9.19	107	-8.88	106.99	-8.02	106.96	-6.81	106.94	-5.73	106.94
-4.9	106.95	-3.48	106.98	-2.55	107	-.43	107.28	0	107.36
.84	107.5	3.09	107.78	4.89	108	5.57	108.08	13.15	108.5
13.85	109.04	14.57	109.59	16.67	109.97	18.06	110.2	20.52	110.56
22.98	110.99	24.3	111.21	25.58	111.29	25.88	111.38	29.61	112.5

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-41.96	.02	-38.81	.08	-13.91	.04	.84	.06	14.57	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-20.89	13.85	19.4	17.6	17	.3	.5
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Ineffective Flow num= 4

Sta L	Sta R	Elev	Permanent
-41.96	-27.8	114	F
-27.8	-16.7	108.5	F
11.5	16.4	108.5	F
16.4	29.61	113.8	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1523

INPUT  
 Description: FEMA STATION 5136, CROSS SECTION AF  
 Ineffective flow area added  
 to model obstruction from northerly embankment of Century Dam.

Station Elevation Data num= 49

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-54.15	114.33	-53.47	114.33	-52.94	114.32	-52.2	114.29	-51.73	114.27
-51.729	114.35	-51.603	114.53	-51.517	115.34	-51.214	115.34	-51.164	114.69
-51.15	109.1	-49.91	109.03	-48.8	108.96	-47.5	108.91	-44.04	108.86
-42.99	108.82	-39.19	108.77	-39	108.78	-33.23	108.68	-32.16	108.61
-29.9	108.61	-24.31	108.58	-18.83	108.63	-17.1	108.62	-14.99	107.98
-12.68	107.22	-12.39	106.79	-9.25	106.68	-7.07	106.68	-5.77	106.62

-2.53	106.85	-2.3	106.89	-1.08	106.91	0	106.93	.06	106.93
.12	106.92	.7	107.06	1.47	107.43	2.26	107.71	6.1	107.67
8.47	107.71	14.06	109.2	14.12	109.2	14.13	109.21	18.74	109.91
19.7	110.04	24.01	111.02	24.93	111.27	28.19	112.3		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-54.15	.02	-51.15	.08	-12.68	.04	.7	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-17.1	14.06	25	32.7	37	.1	.3
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-54.15	-37.4	113.5	F
19.3	28.19	113.5	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1487

INPUT  
 Description: 73 m D/S of Century Dam

Station Elevation Data num= 62

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-61.79	113.95	-61.35	113.91	-61.1	113.9	-60.06	113.42	-59.32	113.08
-58.41	112.67	-58	112.48	-56.61	111.84	-56.52	111.8	-56.11	111.61
-55.58	111.47	-54.3	111.12	-53.5	110.9	-45.85	108.38	-45.55	108.28
-45.54	108.28	-39.81	108.31	-38.48	108.33	-35.61	108.34	-33.34	108.38
-31.28	108.44	-29.76	108.43	-28.32	108.46	-23.04	108.26	-20.34	108.2
-16.27	108.16	-15.16	108.01	-12.88	107.76	-10.91	107.48	-10.08	107.14
-8.41	106.35	-5.61	106.31	-2.48	106.13	.35	106.19	3.34	106.32
9.71	106.25	12.63	107.31	14.3	107.94	17.31	109.01	18.29	109.25
21.08	109.58	21.93	109.68	22.67	109.78	23.08	109.83	26.14	110.25
28.16	110.54	28.86	110.77	32.86	112	34.43	112.11	36.92	112.24
39.14	111.74	40.39	111.42	43.07	111.86	45.81	112.18	50.06	112.26
50.08	112.26	56.92	112.47	62.47	112.48	64.03	112.47	65.38	112.73
69.59	113.52	72.23	115.3						

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-61.79	.04	-56.61	.08	-10.91	.04	12.63	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-16.27	18.29	58	62.5	62	.1	.3
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-61.79	-28.32	108.46	F
36.92	72.23	112.24	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1425

INPUT  
 Description: 135 m D/S of Century Dam

Station Elevation Data num= 70

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-87.17	113.9	-86.85	113.89	-86.23	113.84	-85.62	113.79	-84.82	113.4
-83.92	112.96	-82.64	112.33	-81.47	111.76	-80.93	111.74	-77.78	111.63
-76.15	111.31	-72.06	110.28	-66.62	109.09	-64.79	108.7	-59.34	108.16
-59.12	108.14	-59.04	108.13	-53.33	107.8	-53.01	107.77	-51.04	107.72
-48.32	107.65	-47.81	107.67	-44.16	107.96	-42.3	107.93	-41.25	107.97
-37.8	108.15	-36.1	108.23	-33.52	108.26	-29.33	108.24	-27.22	108.26
-25.95	108.28	-23.67	108.33	-23.65	108.33	-23.56	108.32	-19.61	108.05
-19.16	108.01	-18.71	107.93	-16	107.49	-15.39	107.36	-12.77	106.84
-10.62	106.79	-10.06	106.78	-6.95	106.66	-5.26	106.31	-4.34	105.97
-1.65	105.71	.7	105.67	3.09	105.6	5.4	105.61	8.78	105.95
9.7	106.39	12.12	107.57	15	108.19	16.82	108.65	20.93	109.72
23.01	109.98	24.61	110.17	25.92	110.18	32.25	111.21	32.49	111.27

32.79	111.28	39.05	111.54	41.13	111.59	43.58	111.68	44.97	112.03
47.69	112.56	52.69	115.59	53.43	116.03	53.93	116.05	55.02	116.11

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
-87.17	.04	-81.47	.08	-5.26	.04	9.7	.08	53.93	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
-6.95 12.12 20 55.8 74 .1 .3

Ineffective Flow num= 1  
Sta L Sta R Elev Permanent  
-87.17 -23.67 108.33 F

CROSS SECTION

RIVER: Mad River  
REACH: Reach 1 RS: 1370

INPUT

Description: FEMA STATION 5135, CROSS SECTION AE

Station Elevation Data		num= 96		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
-104.5	113.87	-103.96	113.89	-103.64	113.89	-103.42	113.88	-102.37	113.84	-101.23	113.75
-101.23	113.75	-101.1	113.74	-101	113.69	-100.93	113.66	-100.87	113.63	-99.18	112.83
-99.18	112.83	-99.17	112.83	-97.88	112.22	-97.23	111.91	-95.93	111.29	-94.25	110.86
-94.25	110.86	-92.46	110.39	-91.57	110.15	-88.79	109.55	-85.15	108.77	-80.58	108.54
-80.58	108.54	-80.41	108.54	-80.36	108.53	-80.29	108.52	-76.5	108.11	-74.45	107.98
-74.45	107.98	-70.57	108	-68.35	107.83	-66.36	107.66	-64.51	107.52	-59.67	107.7
-59.67	107.7	-58.97	107.73	-58.86	107.75	-58.71	107.75	-52.36	107.88	-51.2	107.89
-51.2	107.89	-48.38	107.97	-47.05	107.97	-41.84	108.01	-39.63	107.95	-38.54	107.89
-38.54	107.89	-37.04	107.64	-34.26	107.11	-33.03	107.22	-31.22	107.39	-29.52	107.51
-29.52	107.51	-27.09	107.53	-25.97	107.52	-22.59	107.3	-20.66	107.19	-20.01	107.1
-20.01	107.1	-17.03	106.78	-16.9	106.78	-12.33	106.72	-9.56	106.62	-9.45	106.61
-9.45	106.61	-9.35	106.61	-3.92	106.37	-3.1	106.23	-1.98	106.04	-1.2	105.66
-1.2	105.66	1	105.27	3.67	104.75	7.31	105.32	9.69	105.77	11.61	106.76
11.61	106.76	13.47	107.67	14.65	107.65	17.34	107.62	19.87	107.61	21.78	107.62
21.78	107.62	26.82	107.55	29.8	108.61	31.31	109.25	34.27	109.57	37.92	110.72
37.92	110.72	38	110.75	38.2	110.73	47.65	109.78	50.9	110.71	53.65	111.2
53.65	111.2	61.98	113.58	64.99	114.37	66.91	114.79	79.34	113.9	92.12	115.28
92.12	115.28	94.22	115.26	97.1	115.48	98.86	115.55	103.3	115.75	104.09	115.8
104.09	115.8	104.72	115.85	108.55	116.18	112.66	116.43	113.12	116.46	113.4	116.46

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
-104.5	.02	-102.37	.04	-94.25	.08	-1.98	.04	9.69	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
-3.92 11.61 33.5 44 50 .1 .3

Ineffective Flow num= 6  
Sta L Sta R Elev Permanent  
-104.5 -84.7 113 F  
-84.7 -41.84 108.01 F  
-36.5 -27.09 107.53 F  
13.47 27.6 107.67 F  
37.92 52 110.72 F  
66.91 88 114.79 F

CROSS SECTION

RIVER: Mad River  
REACH: Reach 1 RS: 1330

INPUT

Description: 39m U/S Proposed Pedestrian Bridge

Station Elevation Data		num= 93		Sta Elev		Sta Elev		Sta Elev		Sta Elev	
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
-77.57	113.69	-77.19	113.66	-77.14	113.66	-71.14	110.66	-67.3	108.74	-66.76	108.66
-66.76	108.66	-65.88	108.53	-65.64	108.52	-62.86	108.51	-61.14	108.56	-59.27	108.41
-59.27	108.41	-55.29	108.16	-50.99	107.42	-50.56	107.36	-50.12	107.32	-45.44	106.97
-45.44	106.97	-40.44	107.09	-40.26	107.1	-40.19	107.11	-32.44	107.68		

-32.16	107.68	-25.52	107.46	-25.41	107.45	-22.08	107.35	-20.46	107
-16.77	106.04	-15.59	106.03	-8.5	106.35	-5.8	105.61	-4.5	104.92
-3.6	104.68	-2.7	104.53	-1.6	104.42	-.4	104.35	.2	104.36
1.5	104.46	2.9	104.68	.5	105.23	8.28	105.86	10	106.257
11.18	106.53	13.34	106.74	15.91	107.03	18.85	107.15	21.02	107.24
22.3	107.29	29.19	107.4	32.47	107.44	37.87	107.48	41.18	107.51
42.28	107.45	44.68	107.21	45.28	107.14	45.6	107.02	46.2	106.79
46.86	106.55	48.76	106.57	50.62	106.6	52.28	107.3	53.9	108
56.29	108.07	57.8	108.11	58.14	108.12	59.22	108.16	60.9	108.2
63.19	108.26	68.38	108.4	68.98	108.7	74.48	109.96	78.49	110.4
86.6	114.11	89.04	114.8	90.78	116.11	92.69	116.73	93.57	116.98
94.27	116.98	95.31	117.06	97.66	117.33	99.54	117.52	100.58	117.63
101.17	117.75	101.25	117.76	101.27	117.75	101.48	117.56	102.1	117.55
103.15	117.54	105.2	117.55	108.43	117.57	108.46	117.57	114.28	117.73
114.31	117.73	116.51	117.79	118.58	117.83				

Manning's n Values		num= 12		Sta n Val		Sta n Val		Sta n Val	
-77.57	.04	-71.14	.08	-5.8	.04	8.28	.08	44.68	.04
52.28	.06	57.8	.02	60.9	.04	63.19	.06	68.98	.08
94.27	.04	101.48	.02						

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-8.5	10		21	21	21		.1	.3
Ineffective Flow	num= 4								
Sta L	Sta R	Elev	Permanent						
-77.57	-62.3	113	F						
-62.3	-32.44	107.68	F						
-18.5	-8.5	106.35	F						
41.18	55	107.51	T						

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1309

INPUT

Description: U/S of Proposed Pedestrian Bridge

Station Elevation Data		num= 83		Sta Elev		Sta Elev		Sta Elev	
-59.35	113.57	-59.15	113.55	-55.95	111.96	-53.44	110.7	-50.46	109.21
-49.51	108.73	-47.13	107.55	-46.09	107.41	-45.96	107.4	-44.78	107.13
-42.51	106.96	-40.75	106.94	-37.49	106.82	-35.84	106.82	-34.66	106.88
-31.33	107.01	-28.06	107.16	-25.37	107.26	-22.62	107.43	-21.95	107.35
-19.91	107.11	-18.91	106.74	-15.61	105.78	-9.73	105.86	-8.84	105.87
-8.42	105.65	-6.39	105.26	-5.09	104.63	-4.37	104.44	-3.02	104.34
-1.55	104.13	-.28	104.12	-.06	104.13	1.51	104.28	2.8	104.41
4.32	104.74	5.8	105.19	7.5	105.827	8.71	106.28	11.78	106.81
13.75	107.01	15.97	107.03	16.64	107	16.74	106.98	18.93	106.51
21.16	106.01	22.38	105.73	23.15	105.74	25.25	105.79	28.03	105.85
29.43	106.26	30.32	106.53	33.51	107.52	34.51	107.83	35.08	108
38.3	108	40.86	107.5	49.82	107.4	51	107.5	52.12	107.59
55.27	107.86	56.94	108	59.04	108.5	61.18	108.8	61.46	108.817
64.37	108.931	72.57	109.302	79.65	109.329	81.48	109.464	87.01	111.692
88.39	112.296	94.11	114.779	98.11	117.144	98.48	117.159	98.72	117.185
102.02	117.467	108.87	117.554	111.72	117.59	113.25	117.663	114.42	117.662
116.9	117.742	118.53	117.84	119.94	117.872				

Manning's n Values		num= 11		Sta n Val		Sta n Val		Sta n Val	
-59.35	.04	-55.95	.08	-8.84	.04	7.5	.08	18.93	.04
30.32	.06	40.86	.04	52.12	.02	55.27	.04	61.18	.08
102.02	.02								

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	-8.84	7.5		32	32	32		.3	.5
Ineffective Flow	num= 6								
Sta L	Sta R	Elev	Permanent						
-59.35	-46.6	113	F						
-46.6	-22.62	107.43	F						
-22.62	-8.84	105.87	F						
15.97	34.47	107.03	T						
38.34	58.6	107.99	F						



```

58.6      91      113      F
Blocked Obstructions num=      1
Sta L Sta R Elev
*****
102 111.6 120

```

BRIDGE

```

RIVER: Mad River
REACH: Reach 1 RS: 1288.5

```

```

INPUT
Description: Proposed Pedestrian Bridge
Distance from Upstream XS = 19
Deck/Roadway Width = 3.5
Weir Coefficient = 1.45
Upstream Deck/Roadway Coordinates
num= 22

```

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-33.4	113	0	-21.56	107	0	-14.07	107	0						
-12.7	107	0	-10.9	107.08	0	-10.9	108.45	0						
-10.3	108.47	0	-10.3	108.47	106.54	0	108.67	106.74						
10.3	108.47	106.54	10.3	108.47	0	10.9	108.45	0						
10.9	107.08	0	12.41	107	0	19.3	106.89	0						
26.98	107	0	47.15	107.5	0	49.85	108	0						
58.77	108.5	0	60.1	109	0	64.32	109.5	0						
79.72	110	0												

Upstream Bridge Cross Section Data

```

Station Elevation Data num= 31
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
*****
-33.4 113 -21.56 107 -14.07 107 -12.7 107 -10.9 107.08
-10.3 105.29 -7.6 105 -5.5 104.45 -4.8 104.29 -3.3 104.23
-1.6 103.96 -.2 103.99 1.5 104.17 2.7 104.25 3.9 104.45
6.1 105.15 6.7 105.29 8.1 105.62 9.6 106 10.3 106.39
10.9 107.08 12.41 107 19.3 106.89 26.98 107 39.79 107.2
47.15 107.5 49.85 108 58.77 108.5 60.1 109 64.32 109.5
79.72 110

```

Manning's n Values

```

num= 6
Sta n Val Sta n Val Sta n Val Sta n Val Sta n Val
*****
-33.4 .08 -14.07 .02 -10.3 .04 6.7 .08 10.3 .02
39.79 .08

```

```

Bank Sta: Left Right Coeff Contr. Expan.
-10.3 10.3 .3 .5

```

```

Ineffective Flow num= 6
Sta L Sta R Elev Permanent
-59.35 -46.6 113 F
-46.6 -22.62 107.43 F
-22.62 -8.84 105.87 F
15.97 34.47 107.03 T
38.34 58.6 107.99 F
58.6 91 113 F

```

```

Blocked Obstructions num= 1
Sta L Sta R Elev
*****
102 111.6 120

```

Downstream Deck/Roadway Coordinates

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-32.36	113	0	-20.43	107	0	-17.99	107	0						
-12.75	107	0	-10.9	107.08	0	-10.9	108.45	0						
-10.3	108.47	0	-10.3	108.47	106.54	0	108.67	106.74						
10.3	108.47	106.54	10.3	108.47	0	10.9	108.45	0						
10.9	107.08	0	14.86	107	0	19.3	106.97	0						
23.64	107	0	45.49	107.5	0	46.61	108	0						
48.45	108.5	0	60.2	109	0	63.58	109.5	0						
79.45	110	0												

Downstream Bridge Cross Section Data

Station Elevation Data num= 31  
 \*\*\*\*\*  

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-32.36	113	-20.43	107	-17.99	107	-12.75	107	-10.9	107.08
-10.3	105.29	-7.6	105	-5.5	104.45	-4.8	104.29	-3.3	104.23
-1.6	103.96	-.2	103.99	1.5	104.17	2.7	104.25	3.9	104.45
6.1	105.15	6.7	105.29	8.1	105.62	9.6	106	10.3	106.39
10.9	107.08	14.86	107	19.3	106.97	23.64	107	30.87	107.1
45.49	107.5	46.61	108	48.45	108.5	60.2	109	63.58	109.5
79.45	110								

Manning's n Values num= 6  
 \*\*\*\*\*  

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-32.36	.08	-17.99	.02	-10.3	.04	6.7	.08	10.3	.02
30.87	.08								

Bank Sta: Left Right Coeff Contr. Expan.  
 -10.3 10.3 .3 .5

Ineffective Flow num= 2  

Sta L	Sta R	Elev	Permanent
13.4	40.6	106.7	F
40.6	84.01	113	T

Blocked Obstructions num= 1  

Sta L	Sta R	Elev
-32.36	-22	113.47

Upstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Downstream Embankment side slope = 0 horiz. to 1.0 vertical  
 Maximum allowable submergence for weir flow = .95  
 Elevation at which weir flow begins =  
 Energy head used in spillway design =  
 Spillway height used in design =  
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data  
 Energy  
 Selected Low Flow Methods = Energy

High Flow Method  
 Pressure and Weir flow  
 Submerged Inlet Cd =  
 Submerged Inlet + Outlet Cd = .8  
 Max Low Cord =

Additional Bridge Parameters  
 Add Friction component to Momentum  
 Do not add Weight component to Momentum  
 Class B flow critical depth computations use critical depth inside the bridge at the upstream end  
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1277

INPUT  
 Description: Between I-84 / Pedestrian bridges (FEMA Sta 5134, Sec AD)  
 U/S of

Proposed I-84 Bridge No. 01224  
 D/S of Proposed Pedestrian Bridge

Station Elevation Data num= 61  
 \*\*\*\*\*  

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-37	113.48	-35.05	113.48	-34.58	113.47	-32.4	112.52	-31.37	112
-30.95	111.69	-24.12	109	-19.7	107	-18.45	106.94	-15.45	106.85
-14.75	106.5	-12.75	105.5	-12.1	105.19	-9.4	104.95	-8.45	104.88
-6.33	104.42	-6.04	104.35	-5.97	104.33	-5.72	104.26	-2.62	103.81
-.95	104.07	2.89	103.99	3.74	104.32	4.47	104.97	4.49	104.97
4.55	104.98	4.62	104.99	8.99	105.72	10.61	105.98	12.39	106.15
13.18	106.27	14.09	106.29	18.64	106.32	19.5	106.4	22.2	106.53
23.41	106.54	27.99	106.49	28.22	106.5	28.96	106.52	33.28	106.69

35.31	106.73	37.77	106.88	39.43	107	39.87	107.2	43.89	109
47.58	109	49.05	108.5	50.97	108	52.84	107.8	55.32	108
58.28	108.3	59.38	108.5	61.36	109	67.46	109.5	69.38	109.76
70.08	109.78	70.42	109.76	76.3	109.73	78.3	109.92	83.2	110.11
84.01	110.12								

Manning's n Values num= 7

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-37	.04	-18.45	.02	-14.75	.08	-8.45	.04	4.47	.08
37.77	.04	67.46	.08						

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.  
 -15.45 10.61 114.6 114.6 114.6 .3 .5

Ineffective Flow num= 2  
 Sta L Sta R Elev Permanent  
 13.4 40.6 106.7 F  
 40.6 84.01 113 T

Blocked Obstructions num= 1  
 Sta L Sta R Elev  
 -37 -22 113.47

BRI DGE

RIVER: Mad River  
 REACH: Reach 1 RS: 1214.5

INPUT  
 Description: Proposed I-84 Bridge No. 01224  
 includes E23 On-Ramp and E24  
 Off-Ramp  
 Proposed westerly I-84 bridge over the Mad River  
 Distance from Upstream XS = 18.58  
 Deck/Roadway Width = 89.02  
 Weir Coefficient = 1.45

Upstream Deck/Roadway Coordinates num= 8

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-64.82	113.47	0	-55.98	113.47	-20.8	113.47	-20.8	113.47	0	-20.8	113.47	-19.8	107.47	0
-20.8	113.47	111.2	11.46	113.26	111	11.46	113.26	0						
58.82	113.26	0	64.4	113.26	0									

Upstream Bridge Cross Section Data  
 Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-64.82	113.47	-55.98	113.47	-20.8	113.47	-20.8	107.47	-19.8	107.47	-18.85	107
-18.85	107	-17.83	106.5	-17.08	106.13	-14.04	106.11	-12.72	106	-11.7	105.5
-11.7	105.5	-7.4	104.5	-2.9	103.792	.2	103.836	2.2	104.12	3.1	104.5
3.1	104.5	3.4	104.538	10.46	107	14.4	107	49.1	107	52.1	108.5
52.1	108.5	53.6	109	56	109.5						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-64.82	.02	-20.8	.04	-19.8	.02	-14.04	.04	10.46	.08

Bank Sta: Left Right Coeff Contr. Expan.  
 -12.72 10.46 .3 .5

Ineffective Flow num= 2  
 Sta L Sta R Elev Permanent  
 13.4 40.6 106.7 F  
 40.6 84.01 113 T

Blocked Obstructions num= 1  
 Sta L Sta R Elev  
 -64.82 -22 113.47

Downstream Deck/Roadway Coordinates num= 8

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
-73.1	111.47	0	-55.98	111.47	0	-16.73	111.47	0						
-16.73	111.47	109.21	12.45	111.21	108.95	12.45	111.21	0						

58.52 111.21 0 64.4 111.21 0

Downstream Bridge Cross Section Data  
Station Elevation Data num= 20  
\*\*\*\*\*  
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
-40 111.6 -27.46 111.5 -16.73 107.47 -15.73 107.47 -14.78 107  
-13.76 106.5 -12.9 106.07 -10.12 106.01 -6.1 104 -5.72 103.85  
-.25 103.53 5.66 103.6 6.13 104 9.25 106 11.25 107  
11.45 107.1 12.45 107.1 12.45 111.21 58.52 111.21 64.4 111.21

Manning's n Values num= 4  
\*\*\*\*\*  
Sta n Val Sta n Val Sta n Val Sta n Val  
-40 .08 -15.73 .02 -10.12 .04 12.45 .02

Bank Sta: Left Right Coeff Contr. Expan.  
-10.12 11.45 .3 .5

Ineffective Flow num= 3  
Sta L Sta R Elev Permanent  
-75 -32.8 111.59 T  
-22 -17 106.5 T  
-17 -12 110 T

Upstream Embankment side slope = 0 horiz. to 1.0 vertical  
Downstream Embankment side slope = 0 horiz. to 1.0 vertical  
Maximum allowable submergence for weir flow = .95  
Elevation at which weir flow begins =  
Energy head used in spillway design =  
Spillway height used in design =  
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data  
Energy  
Selected Low Flow Methods = Energy

High Flow Method  
Pressure and Weir flow  
Submerged Inlet Cd =  
Submerged Inlet + Outlet Cd = .8  
Max Low Cord =

Additional Bridge Parameters  
Add Friction component to Momentum  
Do not add Weight component to Momentum  
Class B flow critical depth computations use critical depth  
inside the bridge at the upstream end  
Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Mad River  
REACH: Reach 1 RS: 1162

INPUT  
Description: 7m D/S Proposed I-84 Bridge 01224  
Station Elevation Data num= 52  
\*\*\*\*\*  
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev  
-82.27 112.57 -82.18 112.59 -80.55 112.94 -77.67 112.95 -76.62 112.9  
-75.64 112.55 -69.5 110.88 -66.08 109.86 -65.61 109.62 -62.33 108.45  
-61.87 108.42 -61.49 108.42 -59.73 108.01 -59.53 108.03 -59.49 108.02  
-59.42 107.98 -59.3 107.88 -58.36 107.16 -57.71 107.22 -56.96 107.12  
-56.18 106.99 -54.24 106.97 -52.14 106.97 -49.85 106.89 -48.93 106.87  
-46.03 106.81 -45.5 106.81 -42.67 106.68 -40.89 106.66 -36.48 106.69  
-34.37 106.66 -28.69 106.57 -28.24 106.57 -27.8 106.56 -23.49 106.51  
-21.11 106.51 -18.3 106.28 -17.83 106.26 -17.21 106.24 -16.82 106.24  
-14.94 106.18 -12.55 106.08 -11.17 106.09 -10.39 105.71 -7.7 104.39  
-5.72 103.56 .36 103.32 5.33 103.45 6.84 104.76 10.2 107.2  
12.02 107.5 12.03 111.2

Manning's n Values num= 5  
\*\*\*\*\*  
Sta n Val Sta n Val Sta n Val Sta n Val

```

-82.27    .08  -59.73    .02  -28.69    .08  -10.39    .04  12.02    .02
Bank Sta: Left  Right  Lengths: Left Channel  Right  Coeff Contr.  Expan.
          -11.17  10.2    10    9.3    9
Ineffective Flow num= 3
Sta L Sta R Elev Permanent
   -75  -32.8  111.59  T
   -22   -17  106.5   T
   -17  -12   110    T

```

CROSS SECTION

RIVER: Mad River  
REACH: Reach 1 RS: 1153

INPUT  
Description: 15m downstream of Proposed I-84 Bridge No. 01224  
FEMA Station

5132, Cross Section AB  
Blocked obstruction models building in  
Hamilton Park  
Ineffective flow area represents expected limit of  
effective flow downstream of Structure No. 01224

```

Station Elevation Data num= 51
*****
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
*****
-85.16 107.46 -82.88 107.43 -82.61 107.42 -82.31 107.42 -81.39 107.32
-77.44 106.94 -75.5 106.89 -73.33 106.88 -71.41 106.8 -68.19 106.66
-63.58 106.43 -62.39 106.42 -60.67 106.45 -57.08 106.51 -56.07 106.51
-54.89 106.52 -53.82 106.54 -52.25 106.54 -51.1 106.53 -46.22 106.59
-46.13 106.59 -40.03 106.55 -35.37 106.4 -27.94 106.37 -26.19 106.37
-24.82 106.35 -23.36 106.31 -22.09 106.28 -19.46 106.21 -19.29 106.2
-18.47 106.17 -16.6 106.16 -14.14 106.16 -13.6 106.15 -13.34 106.13
-11.8 106.17 -9.93 106.14 -9.18 106.02 -8.07 105.37 -7.5 104.983
-5.61 103.7 -4.63 103.22 -.3 103.08 4.74 103.49 6.28 103.7
7.06 104.24 8.67 105.44 9.23 105.86 10.22 106.59 11 107
11.01 111.2

```

```

Manning's n Values num= 4
*****
Sta n Val Sta n Val Sta n Val Sta n Val
*****
-85.16 .02 -19.46 .08 -9.18 .04 11 .02

```

```

Bank Sta: Left  Right  Lengths: Left Channel  Right  Coeff Contr.  Expan.
          -9.18  9.23    52    45.8    41
Ineffective Flow num= 1
Sta L Sta R Elev Permanent
   -85.16  -43.2  112.2  F
Blocked Obstructions num= 1
Sta L Sta R Elev
*****
   -17.8  -10.5  110

```

CROSS SECTION

RIVER: Mad River  
REACH: Reach 1 RS: 1107

INPUT  
Description: 62 m downstream of Proposed I-84 Br 01224

```

Station Elevation Data num= 82
*****
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
*****
-185.59 114.76 -181.14 113.72 -179.25 113.27 -177.08 112.46 -172.21 109.71
-171.76 109.47 -170.41 109.49 -168.89 109.52 -167.89 109.53 -167.61 109.47
-166.68 109.17 -164.16 108.41 -158.19 106.79 -153.39 106.29 -149.23 105.81
-147.28 105.68 -145.79 105.55 -144.86 105.45 -144.55 105.37 -143.35 105.13
-141.3 105.17 -140.77 105.18 -140.72 105.23 -140.64 105.25 -140.5 105.37
-140.4 105.63 -139.01 105.78 -136.58 105.66 -132.42 105.36 -127.67 105.29
-117.8 105.18 -116.48 105.18 -109.97 105.23 -104.24 105.31 -101.48 105.33
-93.12 105.38 -90.06 105.4 -87.93 105.41 -78.56 105.45 -76.97 105.45
-68.08 105.59 -65.57 105.61 -60.58 105.56 -52.52 105.63 -49.71 105.65
-47.99 105.66 -40.88 105.68 -38.42 105.68 -33.57 105.67 -33.01 105.67
-27.45 105.63 -26.56 105.63 -22.95 105.59 -20.14 105.57 -18.66 105.56
-17.05 105.54 -15.62 105.53 -13.6 105.58 -13 105.347 -10.37 104.32

```

-8	103.39	-1	103.31	5.5	103.28	9.74	104.83	11.7	105.401
12.04	105.5	12.1	105.52	15.72	106.09	16.49	106.21	16.5	106.22
16.58	106.25	18.65	107.36	18.88	107.37	18.89	111.56	18.94	112.18
19.24	112.22	19.32	111.44	19.33	111.39	19.45	111.22	19.61	111.22
22.45	111.29	22.7	111.3						

Manning's n Values num= 8

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-185.59	.08	-145.79	.04	-140.4	.08	-136.58	.04	-17.05	.08
-13.6	.04	11.7	.08	18.65	.02				

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-13.6	12.04	97.4	103.7	107.2	.1	.3
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Ineffective Flow num= 3

Sta L	Sta R	Elev	Permanent
-178	-150.9	113	F
-150.9	-38.42	105.68	F
-22	-13.6	105.58	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 1003

INPUT  
 Description: 166 m downstream of Proposed I-84 Br 01224

Station Elevation Data num= 82

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-194.73	110.07	-187.2	108.1	-183.19	106.97	-182.3	106.69	-181.16	106.5
-175.83	105.51	-172.8	105.16	-171.13	105.11	-160.15	104.51	-155.95	104.42
-152.72	104.41	-145.07	104.71	-144.97	104.71	-144.85	104.71	-139.9	104.88
-139.46	104.87	-138.8	104.88	-137.66	104.89	-137.58	104.84	-136.91	104.32
-135.58	104.33	-133.84	104.35	-132.92	104.44	-131.3	104.49	-124.86	104.86
-123.21	104.8	-119.95	104.84	-114.95	104.87	-112.75	104.96	-106.62	104.98
-106.1	104.98	-105.61	104.98	-91.5	105.05	-90.06	105.06	-81.59	105.12
-77.61	105.14	-69.36	105.13	-64.33	105.17	-64.17	105.17	-63.33	105.16
-54.54	105.12	-46.23	105.08	-43.43	105.07	-37.58	105.02	-27.7	105.04
-18.37	104.9	-14.06	104.7	-13.96	104.7	-13.9	104.69	-12.9	104.65
-10.74	104.56	-10.5	104.44	-10.22	104.31	-6.58	102.55	-5	101.79
0	101.7	4.8	101.72	6.35	102.56	7.25	103.05	10.04	104.63
10.4	104.84	10.49	104.91	11.41	105.37	12.23	105.54	13.32	106.01
13.39	106.04	18	107.19	19.29	107.54	21.18	108.1	22.36	112.14
22.38	112.44	22.41	112.8	22.55	112.8	22.71	112.8	22.75	112.39
22.79	111.98	22.86	111.89	22.92	111.8	24.72	111.83	25.35	111.84
26.84	111.91	28.26	111.98						

Manning's n Values num= 7

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-194.73	.08	-139.9	.06	-124.86	.04	-18.37	.08	-10.74	.04
10.04	.08	21.18	.02						

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-10.22	10.04	96.2	114.3	124.2	.1	.3
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Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-194.73	-162.15	110	F
-162.15	-64.33	105.17	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 894

INPUT  
 Description: FEMA STATION 5131, CROSS SECTION AA

Station Elevation Data num= 66

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-151.8	109.07	-150.87	108.66	-148.27	107.79	-145.78	106.6	-144.73	106.08
-141.68	104.57	-141.32	104.53	-140.89	104.51	-137.16	104.42	-135.65	104.67
-133.15	104.85	-131.56	105	-130.54	105	-128.26	105	-125.68	104.95
-124.07	104.8	-120.11	104.75	-118.8	104.74	-109.6	104.63	-109.53	104.63

-109.42	104.61	-108.83	104.61	-96.33	104.61	-93	104.59	-88.24	104.45
-83.22	104.43	-74.16	104.45	-66.84	104.41	-66.83	104.41	-54.65	104.31
-53.22	104.3	-51.11	104.26	-45.49	104.19	-40.05	104.14	-31.28	104.06
-28.73	104.07	-27.59	104.1	-22.54	104.18	-17.45	104.19	-16.87	104.19
-11.11	103.51	-9.83	103.03	-7.79	102.5	-6.36	101.63	-5.11	101.37
-3.32	100.2	0	100.5	5	100.94	5.57	101.51	6.76	102.69
6.97	102.84	8.01	103.6	8.27	103.82	8.57	103.92	12.79	103.98
12.96	103.99	13.48	103.99	15.59	104	17.44	104	26.6	104.5
32.77	107.5	33.21	107.57	36.15	107.5	37.12	107.48	37.34	107.5
40.33	109								

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-151.8	.08	-16.87	.04	8.57	.08	13.48	.06	33.21	.04
37.34	.06								

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-11.11	8.01		85.6	80.3	74.4		.1	.3
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Ineffective Flow num= 4

Sta L	Sta R	Elev	Permanent
-145	-131.56	105	T
-44	-25	108	T
-25	-16.87	104.19	F
17.27	25	104.02	F

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 809

INPUT  
 Description: 360 m downstream of Proposed I-84 Br 01224  
 112 m upstream of the Private Bridge

Station Elevation Data num= 51

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-74.67	109.44	-70.34	107.32	-65.96	105.68	-65.41	105.48	-61.64	105.26
-57.11	105.04	-56.45	104.96	-50.45	104.72	-44.66	104.57	-44.44	104.56
-42.13	104.51	-40.74	104.48	-40.68	104.48	-40.51	104.48	-26.27	104.09
-23.7	104.07	-17.18	103.99	-11.47	103.9	-10.79	103.89	-10.46	103.88
-9.47	103.84	-8.32	103.05	-7.7	102.585	-4.73	100.36	-4	99.81
-1.23	99.48	3	99.8	4.8	100	7.2	100.58	7.44	100.8
8.1	102.52	8.88	103.08	10.31	103.11	11.29	103.21	14.45	103.22
16.23	103.29	20.41	103.39	24.35	103.62	25.41	103.55	28.5	103.28
32.14	103.23	36.22	103.24	37.41	103.29	41.35	103.31	45.1	103.27
47	103.28	49.91	103.34	51.79	103.37	52.45	103.35	53.9	103.3
67.3	110								

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-74.67	.08	-8.32	.04	8.88	.08	51.79	.06

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

-7.7	8.1		98.6	97.1	90.8		.1	.3
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Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
21.7	27.7	107	T

CROSS SECTION

RIVER: Mad River  
 REACH: Reach 1 RS: 714

INPUT  
 Description: FEMA STATION 5130, CROSS SECTION  
 Z

5130/Z/1

Station Elevation Data		num= 51		Sta		Elev		Sta		Elev	
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.94	107.83	-39.23	107.04	-37.5	106.52	-34.52	105.44	-33.39	105.21		
-31.72	104.65	-30.1	104.27	-28.87	103.95	-26.76	103	-26.32	102.79		
-25.46	102.82	-21.36	102.83	-19.84	102.77	-17.41	102.83	-16.98	102.84		
-16.01	102.88	-14.86	102.85	-13.91	102.85	-12.52	102.89	-10.9	102.85		
-10.87	102.83	-9.93	102.23	-9.06	101.66	-5.44	99.44	-5.22	99.36		
-5.19	99.33	-5.17	99.29	-4.17	99.07	-3.12	98.92	-2.23	98.89		
-.5	99.06	.69	99.04	1.78	98.97	2.89	99.17	4.33	99.29		
4.69	99.45	5.12	99.56	5.37	99.66	6.12	100.19	7.36	100.92		
9.58	102.22	10.02	102.35	11.53	102.35	16.94	102.31	20.04	102.25		
21.02	102.21	22.79	102.12	23.46	102.03	24.67	102.01	25	102		
37	108										

Manning's n Values		num= 7		Sta		n Val		Sta		n Val	
Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-40.94	.08	-16.98	.04	-16.01	.02	-12.52	.04	-10.87	.08		
-9.06	.04	9.58	.06								

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	-9.93	9.58		16.4	16.4		.3	.5
Ineffective Flow			num= 2					
Sta L	Sta R	Elev	Permanent					
-40.94	-10.9	102.85	F					
11.53	37	102.4	F					

SUMMARY OF MANNING'S N VALUES

River: Mad River

Reach	River Sta.	n1	n2	n3	n4	n5
*Reach 1	* 2409	* .02*	* .04*	* .08*	* .04*	* .08*
*Reach 1	* 2337	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2280	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2238	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2207	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2202	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2168	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2130	* .04*	* .02*	* .04*	* .08*	* .04*
*Reach 1	* 2116	* .04*	* .08*	* .04*	* .02*	* .04*
*Reach 1	* 2098.5	* Culvert	* *	* *	* *	* *
*Reach 1	* 2079	* .08*	* .04*	* .08*	* .04*	* .08*
*Reach 1	* 2067	* .08*	* .08*	* .06*	* .04*	* .06*
*Reach 1	* 2020	* .08*	* .04*	* .08*	* .04*	* .08*
*Reach 1	* 2004	* .08*	* .04*	* .08*	* .04*	* *
*Reach 1	* 1983	* .08*	* .06*	* .04*	* .08*	* .04*



*Reach 1	*	1972	*	.08*	.06*	.04*	.04*	.02*
*Reach 1	*	1962	*	.08*	.04*	.08*	.02*	*
*Reach 1	*	1938.5	*	*Bri dge	*	*	*	*
*Reach 1	*	1900	*	.02*	.08*	.04*	.06*	.08*
*Reach 1	*	1871	*	.02*	.08*	.04*	.08*	.02*
*Reach 1	*	1807.5	*	*Bri dge	*	*	*	*
*Reach 1	*	1748	*	.02*	.04*	.08*	.04*	.08*
*Reach 1	*	1727.5	*	*Bri dge	*	*	*	*
*Reach 1	*	1689	*	.08*	.02*	.08*	.04*	.08*
*Reach 1	*	1620	*	.02*	.08*	.04*	.08*	.04*
*Reach 1	*	1573	*	.02*	.08*	.04*	.08*	.02*
*Reach 1	*	1561.5	*	*Inl Struct*	*	*	*	*
*Reach 1	*	1550	*	.02*	.08*	.04*	.08*	*
*Reach 1	*	1536	*	.02*	.08*	.04*	.06*	.08*
*Reach 1	*	1523	*	.02*	.08*	.04*	.08*	*
*Reach 1	*	1487	*	.04*	.08*	.04*	.08*	*
*Reach 1	*	1425	*	.04*	.08*	.04*	.08*	.04*
*Reach 1	*	1370	*	.02*	.04*	.08*	.04*	.08*
*Reach 1	*	1330	*	.04*	.08*	.04*	.08*	.04*
*Reach 1	*	1309	*	.08*	.04*	.08*	.08*	.04*
*Reach 1	*	1288.5	*	*Bri dge	*	*	*	*
*Reach 1	*	1277	*	.04*	.02*	.08*	.04*	.08*
*Reach 1	*	1214.5	*	*Bri dge	*	*	*	*
*Reach 1	*	1162	*	.08*	.02*	.08*	.04*	.02*
*Reach 1	*	1153	*	.02*	.08*	.04*	.02*	*
*Reach 1	*	1107	*	.08*	.04*	.08*	.04*	.08*
*Reach 1	*	1003	*	.08*	.06*	.04*	.08*	.04*
*Reach 1	*	894	*	.08*	.04*	.08*	.06*	.04*
*Reach 1	*	809	*	.08*	.04*	.08*	.06*	*
*Reach 1	*	714	*	.08*	.04*	.02*	.04*	.08*

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SUMMARY OF REACH LENGTHS

River: Mad River

* Reach	* River Sta.	* Left	* Channel	* Right
*Reach 1	2409	75.2*	71.8*	69.4*
*Reach 1	2337	58.8*	56.9*	54.2*
*Reach 1	2280	42*	42.3*	43*
*Reach 1	2238	30*	31*	32*
*Reach 1	2207	5*	5*	5*
*Reach 1	2202	33*	34*	35*

*Reach 1	*	2168	*	35*	37.8*	40*
*Reach 1	*	2130	*	13.5*	13.8*	14*
*Reach 1	*	2116	*	36*	36.6*	37*
*Reach 1	*	2098.5	*Cul vert	*	*	*
*Reach 1	*	2079	*	11*	12*	13*
*Reach 1	*	2067	*	44*	46.7*	50*
*Reach 1	*	2020	*	17*	17*	17*
*Reach 1	*	2004	*	23*	21.1*	19*
*Reach 1	*	1983	*	12*	10.3*	8.5*
*Reach 1	*	1972	*	10.3*	10.3*	10.3*
*Reach 1	*	1962	*	50*	61.9*	80*
*Reach 1	*	1938.5	*Bri dge	*	*	*
*Reach 1	*	1900	*	29.4*	29.4*	29.4*
*Reach 1	*	1871	*	122.4*	122.4*	122.4*
*Reach 1	*	1807.5	*Bri dge	*	*	*
*Reach 1	*	1748	*	56.8*	59.5*	62.6*
*Reach 1	*	1727.5	*Bri dge	*	*	*
*Reach 1	*	1689	*	68.7*	69*	70*
*Reach 1	*	1620	*	48*	47*	46.5*
*Reach 1	*	1573	*	25*	23.1*	21.5*
*Reach 1	*	1561.5	*Inl Struct*	*	*	*
*Reach 1	*	1550	*	15.2*	15.2*	15.3*
*Reach 1	*	1536	*	19.4*	17.6*	17*
*Reach 1	*	1523	*	25*	32.7*	37*
*Reach 1	*	1487	*	58*	62.5*	62*
*Reach 1	*	1425	*	20*	55.8*	74*
*Reach 1	*	1370	*	33.5*	44*	50*
*Reach 1	*	1330	*	21*	21*	21*
*Reach 1	*	1309	*	32*	32*	32*
*Reach 1	*	1288.5	*Bri dge	*	*	*
*Reach 1	*	1277	*	114.6*	114.6*	114.6*
*Reach 1	*	1214.5	*Bri dge	*	*	*
*Reach 1	*	1162	*	10*	9.3*	9*
*Reach 1	*	1153	*	52*	45.8*	41*
*Reach 1	*	1107	*	97.4*	103.7*	107.2*
*Reach 1	*	1003	*	96.2*	114.3*	124.2*
*Reach 1	*	894	*	85.6*	80.3*	74.4*
*Reach 1	*	809	*	98.6*	97.1*	90.8*
*Reach 1	*	714	*	16.4*	16.4*	16.4*

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SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS  
River: Mad River

* Reach	* River Sta.	* Contr.	* Expan.
*Reach 1	2409	.3*	.5*
*Reach 1	2337	.1*	.3*
*Reach 1	2280	.1*	.3*
*Reach 1	2238	.1*	.3*
*Reach 1	2207	.1*	.3*
*Reach 1	2202	.1*	.3*
*Reach 1	2168	.1*	.3*
*Reach 1	2130	.1*	.3*
*Reach 1	2116	.3*	.5*
*Reach 1	2098.5	*Cul vert	*
*Reach 1	2079	.3*	.5*
*Reach 1	2067	.3*	.5*
*Reach 1	2020	.3*	.5*
*Reach 1	2004	.3*	.5*
*Reach 1	1983	.3*	.5*
*Reach 1	1972	.3*	.5*
*Reach 1	1962	.3*	.5*
*Reach 1	1938.5	*Bri dge	*
*Reach 1	1900	.3*	.5*
*Reach 1	1871	.3*	.5*
*Reach 1	1807.5	*Bri dge	*
*Reach 1	1748	.3*	.5*
*Reach 1	1727.5	*Bri dge	*
*Reach 1	1689	.3*	.5*
*Reach 1	1620	.1*	.3*
*Reach 1	1573	.3*	.5*
*Reach 1	1561.5	*Inl Struct*	*
*Reach 1	1550	.3*	.5*

*Reach 1	*	1536	*	.3*	.5*
*Reach 1	*	1523	*	.1*	.3*
*Reach 1	*	1487	*	.1*	.3*
*Reach 1	*	1425	*	.1*	.3*
*Reach 1	*	1370	*	.1*	.3*
*Reach 1	*	1330	*	.1*	.3*
*Reach 1	*	1309	*	.3*	.5*
*Reach 1	*	1288.5	*Bri dge	*	*
*Reach 1	*	1277	*	.3*	.5*
*Reach 1	*	1214.5	*Bri dge	*	*
*Reach 1	*	1162	*	.3*	.5*
*Reach 1	*	1153	*	.1*	.3*
*Reach 1	*	1107	*	.1*	.3*
*Reach 1	*	1003	*	.1*	.3*
*Reach 1	*	894	*	.1*	.3*
*Reach 1	*	809	*	.1*	.3*
*Reach 1	*	714	*	.3*	.5*

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## APPENDIX B. HEC-RAS Output

### Part 1. Output Tables

● Proposed Condition ("Standard 1" output) .....	1
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● Proposed Condition ("Culvert Only" output) .....	11
● Existing Condition ("Standard 1" output) .....	12
● Existing Condition ("Six XS Bridge" output) .....	19
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● Natural Condition 2 - partially using Proposed geometry ("Standard 1" output) .....	24

### Part 2. Cross-Section And Water Surface Profile Plots

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● Water Surface Profile Plots Plots (Proposed Condition 10, 50, 100 & 500-YR) .....	42
● Water Surface Profile Plots Plots (Existing Condition 10, 50, 100 & 500-YR) .....	43

**MAD RIVER - PROPOSED CONDITION, DESIGN DISCHARGE**  
**HEC-RAS 4.1.0 - "Standard Table 1" Output**

HEC-RAS Plan: PR DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2409	Fish Low Pass.	0.1	116.37	116.47	116.45	116.48	0.0111	0.41	0.25	4.1	0.53
Reach 1	2409	Fish High Pass.	2.75	116.37	116.75	116.71	116.81	0.014401	1.06	2.6	12.32	0.74
Reach 1	2409	2 Year	21.8	116.37	117.22	117.22	117.54	0.019212	2.5	8.72	13.72	1
Reach 1	2409	3 Year	28.6	116.37	117.35	117.35	117.72	0.018378	2.72	10.51	13.99	1
Reach 1	2409	5 Year	35	116.37	117.46	117.46	117.89	0.017736	2.89	12.09	14.17	1
Reach 1	2409	10 Year	46.72	116.37	117.64	117.64	118.16	0.017107	3.17	14.72	14.45	1
Reach 1	2409	25 Year	70.79	116.37	117.98	117.98	118.64	0.016352	3.6	19.67	14.88	1
Reach 1	2409	50 Year	96.28	116.37	118.29	118.29	119.09	0.016577	3.97	24.25	15.11	1
Reach 1	2409	100 Year	124.59	116.37	118.59	118.59	119.54	0.016878	4.31	28.94	15.33	1
Reach 1	2409	500 Year	188.31	116.37	119.22	119.22	120.42	0.016435	4.87	39.09	20.6	0.99
Reach 1	2337	Fish Low Pass.	0.1	114.97	115.07	115.07	115.09	0.041942	0.67	0.15	3.25	0.98
Reach 1	2337	Fish High Pass.	2.75	114.97	115.32	115.32	115.41	0.027068	1.34	2.06	11.08	0.99
Reach 1	2337	2 Year	21.8	114.97	115.85	115.85	116.16	0.018611	2.46	8.86	14.17	0.99
Reach 1	2337	3 Year	28.6	114.97	115.96	115.98	116.35	0.020013	2.76	10.37	14.71	1.05
Reach 1	2337	5 Year	35	114.97	116.05	116.1	116.5	0.020749	2.98	11.74	15.18	1.08
Reach 1	2337	10 Year	46.72	114.97	116.2	116.3	116.76	0.021823	3.31	14.12	16.19	1.13
Reach 1	2337	25 Year	70.79	114.97	116.45	116.62	117.2	0.024203	3.85	18.69	23	1.22
Reach 1	2337	50 Year	96.28	114.97	116.63	116.88	117.59	0.025067	4.38	23.11	25.08	1.28
Reach 1	2337	100 Year	124.59	114.97	116.8	117.14	117.98	0.025904	4.87	27.66	27.06	1.33
Reach 1	2337	500 Year	188.31	114.97	117.12	117.7	118.77	0.028254	5.84	36.67	30.65	1.44
Reach 1	2280	Fish Low Pass.	0.1	114.06	114.17	114.13	114.17	0.003455	0.25	0.42	6.1	0.3
Reach 1	2280	Fish High Pass.	2.75	114.06	114.48	114.36	114.52	0.00584	0.87	3.16	10.09	0.5
Reach 1	2280	2 Year	21.8	114.06	115.09	114.96	115.34	0.01108	2.21	9.87	12.88	0.81
Reach 1	2280	3 Year	28.6	114.06	115.24	115.13	115.54	0.011333	2.43	11.78	13.61	0.83
Reach 1	2280	5 Year	35	114.06	115.37	115.25	115.7	0.011236	2.58	13.61	14.63	0.83
Reach 1	2280	10 Year	46.72	114.06	115.61	115.45	115.99	0.010145	2.73	17.45	16.6	0.8
Reach 1	2280	25 Year	70.79	114.06	115.98	115.8	116.47	0.009691	3.12	24.48	22.9	0.8
Reach 1	2280	50 Year	96.28	114.06	116.28	116.14	116.87	0.009568	3.46	32.35	29.26	0.82
Reach 1	2280	100 Year	124.59	114.06	116.48	116.47	117.23	0.01093	3.96	38.63	33.04	0.88
Reach 1	2280	500 Year	188.31	114.06	117.19	117.26	117.86	0.007402	3.94	68.83	60.14	0.76
Reach 1	2238	Fish Low Pass.	0.1	113.86	113.93	113.91	113.93	0.011073	0.31	0.33	8.05	0.49
Reach 1	2238	Fish High Pass.	2.75	113.86	114.17	114.1	114.21	0.009749	0.9	3.07	13.96	0.61
Reach 1	2238	2 Year	21.8	113.86	114.79	114.58	114.93	0.007334	1.7	12.82	17.59	0.64
Reach 1	2238	3 Year	28.6	113.86	114.95	114.7	115.12	0.007148	1.8	15.87	18.39	0.62
Reach 1	2238	5 Year	35	113.86	115.1	114.79	115.28	0.007153	1.88	18.65	19.08	0.61
Reach 1	2238	10 Year	46.72	113.86	115.37	114.96	115.56	0.007727	1.95	24	21.3	0.59
Reach 1	2238	25 Year	70.79	113.86	115.8	115.27	116.02	0.007744	2.09	33.89	24.62	0.56
Reach 1	2238	50 Year	96.28	113.86	116.15	115.55	116.41	0.007497	2.26	43.01	32.85	0.55
Reach 1	2238	100 Year	124.59	113.86	116.48	115.79	116.74	0.006332	2.28	56.94	49.96	0.52
Reach 1	2238	500 Year	188.31	113.86	116.82	116.48	117.15	0.006637	2.6	75.56	58.84	0.54
Reach 1	2207	Fish Low Pass.	0.1	113.6	113.69	113.67	113.7	0.005659	0.23	0.46	10.96	0.35
Reach 1	2207	Fish High Pass.	2.75	113.6	113.92	113.83	113.95	0.007124	0.83	3.32	13.37	0.53
Reach 1	2207	2 Year	21.8	113.6	114.48	114.32	114.67	0.009911	1.91	11.42	15.34	0.71
Reach 1	2207	3 Year	28.6	113.6	114.62	114.44	114.84	0.01085	2.11	13.55	15.82	0.73
Reach 1	2207	5 Year	35	113.6	114.73	114.55	115	0.011617	2.27	15.4	16.22	0.74
Reach 1	2207	10 Year	46.72	113.6	114.93	114.73	115.25	0.012681	2.51	18.61	16.91	0.76
Reach 1	2207	25 Year	70.79	113.6	115.26	115.05	115.69	0.013732	2.9	24.56	19.36	0.79
Reach 1	2207	50 Year	96.28	113.6	115.55	115.34	116.08	0.01339	3.24	30.43	21.69	0.8
Reach 1	2207	100 Year	124.59	113.6	115.91	115.62	116.46	0.010872	3.33	40.43	35.08	0.75
Reach 1	2207	500 Year	188.31	113.6	116.7	116.39	116.99	0.003754	2.44	81.89	72.98	0.46
Reach 1	2202	Fish Low Pass.	0.1	113.57	113.66	113.63	113.66	0.008661	0.29	0.36	8.15	0.44
Reach 1	2202	Fish High Pass.	2.75	113.57	113.85	113.81	113.9	0.013363	1	2.74	13.37	0.71
Reach 1	2202	2 Year	21.8	113.57	114.3	114.29	114.59	0.018968	2.39	9.11	15.15	0.98
Reach 1	2202	3 Year	28.6	113.57	114.43	114.42	114.77	0.018216	2.55	11.2	15.72	0.97
Reach 1	2202	5 Year	35	113.57	114.56	114.52	114.92	0.017388	2.64	13.24	16.23	0.93
Reach 1	2202	10 Year	46.72	113.57	114.75	114.7	115.16	0.017988	2.86	16.35	16.96	0.93
Reach 1	2202	25 Year	70.79	113.57	115.1	115.01	115.6	0.018367	3.15	22.5	18.34	0.91
Reach 1	2202	50 Year	96.28	113.57	115.46	115.3	116	0.017562	3.27	29.41	19.86	0.86
Reach 1	2202	100 Year	124.59	113.57	115.86	115.58	116.39	0.014156	3.24	39.19	32.16	0.77
Reach 1	2202	500 Year	188.31	113.57	116.2	116.2	116.91	0.016337	3.76	50.52	67.74	0.83
Reach 1	2168	Fish Low Pass.	0.1	112.99	113.02	113.02	113.03	0.064514	0.45	0.23	12.09	1.05
Reach 1	2168	Fish High Pass.	2.75	112.99	113.17	113.17	113.26	0.02863	1.28	2.14	12.71	1
Reach 1	2168	2 Year	21.8	112.99	113.7	113.66	113.97	0.016924	2.3	9.47	14.77	0.92
Reach 1	2168	3 Year	28.6	112.99	113.82	113.79	114.15	0.017859	2.56	11.18	15	0.95

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2168	5 Year	35	112.99	113.92	113.9	114.31	0.018334	2.75	12.72	15.2	0.96
Reach 1	2168	10 Year	46.72	112.99	114.13	114.08	114.57	0.017004	2.93	15.96	15.63	0.92
Reach 1	2168	25 Year	70.79	112.99	114.59	114.4	115.06	0.013579	3.04	23.27	16.56	0.82
Reach 1	2168	50 Year	96.28	112.99	114.94	114.7	115.49	0.012993	3.28	29.35	17.39	0.8
Reach 1	2168	100 Year	124.59	112.99	115.19	114.99	115.89	0.013965	3.72	33.68	18.32	0.85
Reach 1	2168	500 Year	188.31	112.99	115.72	115.89	116.45	0.011229	3.92	52.61	59.68	0.79
Reach 1	2130	Fish Low Pass.	0.1	112.45	112.49	112.47	112.49	0.004822	0.21	0.5	12.16	0.33
Reach 1	2130	Fish High Pass.	2.75	112.45	112.71	112.62	112.75	0.007498	0.85	3.23	13.03	0.54
Reach 1	2130	2 Year	21.8	112.45	113.24	113.12	113.45	0.010801	2.03	10.74	15.17	0.77
Reach 1	2130	3 Year	28.6	112.45	113.42	113.25	113.65	0.009313	2.12	13.48	15.88	0.74
Reach 1	2130	5 Year	35	112.45	113.58	113.35	113.82	0.008057	2.16	16.17	16.54	0.7
Reach 1	2130	10 Year	46.72	112.45	113.88	113.53	114.13	0.006762	2.2	21.25	17.73	0.64
Reach 1	2130	25 Year	70.79	112.45	114.43	113.86	114.69	0.005345	2.26	31.31	18.93	0.56
Reach 1	2130	50 Year	96.28	112.45	114.79	114.13	115.11	0.005759	2.52	38.27	30.82	0.58
Reach 1	2130	100 Year	124.59	112.45	115.23	114.41	115.49	0.004238	2.33	55.09	75.83	0.49
Reach 1	2130	500 Year	188.31	112.45	116	115.19	116.22	0.002111	2	94.6	111.31	0.36
Reach 1	2116	Fish Low Pass.	0.1	112.3	112.32	112.32	112.33	0.058192	0.44	0.24	12.08	1
Reach 1	2116	Fish High Pass.	2.75	112.3	112.47	112.47	112.56	0.028957	1.29	2.13	12.7	1
Reach 1	2116	2 Year	21.8	112.3	113.1	112.97	113.3	0.010565	2.02	10.81	15.19	0.76
Reach 1	2116	3 Year	28.6	112.3	113.32	113.09	113.52	0.007818	2	14.28	16.07	0.68
Reach 1	2116	5 Year	35	112.3	113.51	113.2	113.71	0.006478	2.01	17.4	16.83	0.63
Reach 1	2116	10 Year	46.72	112.3	113.82	113.39	114.04	0.005021	2.04	22.94	17.93	0.57
Reach 1	2116	25 Year	70.79	112.3	114.39	113.71	114.62	0.0034	2.14	33.4	19.11	0.5
Reach 1	2116	50 Year	96.28	112.3	114.74	113.98	115.04	0.003487	2.43	40.3	33.81	0.52
Reach 1	2116	100 Year	124.59	112.3	115.2	114.25	115.44	0.002307	2.25	62.03	94.11	0.44
Reach 1	2116	500 Year	188.31	112.3	116.01	115.14	116.19	0.001192	1.93	106.41	138.15	0.33
Reach 1	2098.5	Culvert										
Reach 1	2079	Fish Low Pass.	0.1	111.89	111.93	111.91	111.93	0.015166	0.29	0.36	12.28	0.54
Reach 1	2079	Fish High Pass.	2.75	111.89	112.16	112.07	112.19	0.006872	0.8	3.45	14.41	0.52
Reach 1	2079	2 Year	21.8	111.89	112.8	112.53	112.92	0.005322	1.51	14.42	18.76	0.55
Reach 1	2079	3 Year	28.6	111.89	112.98	112.64	113.11	0.004811	1.61	17.77	19.47	0.54
Reach 1	2079	5 Year	35	111.89	113.12	112.74	113.27	0.004613	1.7	20.58	20.05	0.54
Reach 1	2079	10 Year	46.72	111.89	112.9	112.9	113.32	0.017109	2.89	16.18	19.14	1
Reach 1	2079	25 Year	70.79	111.89	113.35	113.18	113.75	0.010098	2.8	25.32	20.98	0.81
Reach 1	2079	50 Year	96.28	111.89	113.87	113.44	114.22	0.006224	2.62	36.68	23.06	0.66
Reach 1	2079	100 Year	124.59	111.89	114.34	113.7	114.68	0.005117	2.59	48.1	25.54	0.59
Reach 1	2079	500 Year	188.31	111.89	115.39	114.2	115.66	0.002521	2.38	89.76	192.02	0.44
Reach 1	2067	Fish Low Pass.	0.1	111.76	111.81	111.78	111.81	0.007366	0.18	0.56	12.23	0.27
Reach 1	2067	Fish High Pass.	2.75	111.76	111.97	111.93	112.03	0.032727	1.04	2.64	33.17	0.74
Reach 1	2067	2 Year	21.8	111.76	112.45	112.43	112.74	0.035995	2.36	9.35	83.29	0.93
Reach 1	2067	3 Year	28.6	111.76	112.55	112.55	112.91	0.038965	2.67	10.85	86.09	0.99
Reach 1	2067	5 Year	35	111.76	112.66	112.66	113.07	0.037341	2.84	12.55	87.41	0.99
Reach 1	2067	10 Year	46.72	111.76	112.85	112.76	113	0.00987	1.65	27.77	90.2	0.52
Reach 1	2067	25 Year	70.79	111.76	113.42	112.8	113.54	0.004061	1.43	47.26	93.75	0.36
Reach 1	2067	50 Year	96.28	111.76	113.94	112.97	114.05	0.002573	1.37	65.72	96.77	0.3
Reach 1	2067	100 Year	124.59	111.76	114.44	113.15	114.53	0.001619	1.25	96.77	100.92	0.25
Reach 1	2067	500 Year	188.31	111.76	115.46	113.52	115.56	0.00111	1.29	141.34	117.14	0.22
Reach 1	2020	Fish Low Pass.	0.13	111.25	111.27	111.27	111.28	0.017553	0.28	0.45	39.43	0.57
Reach 1	2020	Fish High Pass.	3.66	111.25	111.5	111.41	111.53	0.005822	0.73	5.02	43.16	0.48
Reach 1	2020	2 Year	31.15	111.25	112.22	111.88	112.31	0.00364	1.36	23.26	118.26	0.47
Reach 1	2020	3 Year	40.7	111.25	112.3	111.98	112.33	0.001277	0.86	62.87	119.9	0.28
Reach 1	2020	5 Year	49.9	111.25	112.51	112.08	112.53	0.001047	0.88	75.2	121.12	0.26
Reach 1	2020	10 Year	66.54	111.25	112.83	112.22	112.86	0.000831	0.93	95.54	122.83	0.24
Reach 1	2020	25 Year	100.52	111.25	113.41	112.25	113.44	0.000651	1.02	131.58	125.58	0.23
Reach 1	2020	50 Year	137.34	111.25	113.93	112.25	113.98	0.000567	1.11	165.42	129.34	0.22
Reach 1	2020	100 Year	176.98	111.25	114.42	112.27	114.47	0.000525	1.2	197.89	133.5	0.22
Reach 1	2020	500 Year	269.01	111.25	115.45	112.61	115.51	0.000455	1.35	268.56	150.71	0.21
Reach 1	2004	Fish Low Pass.	0.13	111.07	111.11	111.09	111.12	0.006148	0.24	0.53	42.02	0.37
Reach 1	2004	Fish High Pass.	3.66	111.07	111.34	111.28	111.4	0.010172	1.01	3.63	44.6	0.64
Reach 1	2004	2 Year	31.15	111.07	111.99	111.87	112.19	0.009699	2.03	16.69	89.34	0.74
Reach 1	2004	3 Year	40.7	111.07	112.29	112.03	112.31	0.000803	0.73	74.79	92.51	0.23
Reach 1	2004	5 Year	49.9	111.07	112.49	112.07	112.51	0.000709	0.77	87.57	93.53	0.22
Reach 1	2004	10 Year	66.54	111.07	112.83	112.07	112.85	0.00061	0.83	108.36	95.16	0.21
Reach 1	2004	25 Year	100.52	111.07	113.4	112.07	113.43	0.00052	0.94	144.51	97.85	0.2
Reach 1	2004	50 Year	137.34	111.07	113.93	112.07	113.96	0.00048	1.05	177.54	100.32	0.2
Reach 1	2004	100 Year	176.98	111.07	114.42	112.07	114.46	0.000463	1.15	208.21	102.6	0.21

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2004	500 Year	269.01	111.07	115.44	112.37	115.5	0.000418	1.32	286.08	141.84	0.2
Reach 1	1983	Fish Low Pass.	0.13	110.84	110.87	110.86	110.87	0.027109	0.38	0.33	30.3	0.72
Reach 1	1983	Fish High Pass.	3.66	110.84	111.11	111.05	111.17	0.010981	1.07	3.43	34.7	0.66
Reach 1	1983	2 Year	31.15	110.84	112.03	111.68	112.05	0.000967	0.79	47.56	46.98	0.25
Reach 1	1983	3 Year	40.7	110.84	112.26	111.84	112.29	0.000868	0.86	58.02	60.85	0.24
Reach 1	1983	5 Year	49.9	110.84	112.46	111.84	112.49	0.000808	0.91	67.24	61.66	0.24
Reach 1	1983	10 Year	66.54	110.84	112.79	111.84	112.83	0.000744	1	82.37	63.05	0.24
Reach 1	1983	25 Year	100.52	110.84	113.36	111.84	113.41	0.000684	1.15	109.16	65.63	0.24
Reach 1	1983	50 Year	137.34	110.84	113.89	111.9	113.94	0.000659	1.29	134.21	67.99	0.24
Reach 1	1983	100 Year	176.98	110.84	114.37	112.16	114.44	0.000652	1.42	157.94	72.5	0.25
Reach 1	1983	500 Year	269.01	110.84	115.38	112.56	115.48	0.00063	1.66	210.91	115.54	0.25
Reach 1	1972	Fish Low Pass.	0.13	110.72	110.77	110.74	110.77	0.005246	0.23	0.55	22.92	0.34
Reach 1	1972	Fish High Pass.	3.66	110.72	111.03	110.93	111.07	0.007339	0.94	3.9	24.74	0.55
Reach 1	1972	2 Year	31.15	110.72	111.99	111.56	112.03	0.001304	0.97	35.18	31.84	0.29
Reach 1	1972	3 Year	40.7	110.72	112.22	111.72	112.27	0.001195	1.05	42.54	34.82	0.29
Reach 1	1972	5 Year	49.9	110.72	112.42	111.72	112.48	0.001132	1.12	49.02	41.88	0.28
Reach 1	1972	10 Year	66.54	110.72	112.74	111.72	112.81	0.001064	1.23	59.68	51.88	0.28
Reach 1	1972	25 Year	100.52	110.72	113.3	111.89	113.39	0.001003	1.42	78.63	55.22	0.29
Reach 1	1972	50 Year	137.34	110.72	113.81	112.14	113.92	0.000978	1.59	96.43	57.56	0.29
Reach 1	1972	100 Year	176.98	110.72	114.28	112.38	114.41	0.000976	1.75	113.35	63.64	0.3
Reach 1	1972	500 Year	269.01	110.72	115.27	112.86	115.44	0.000931	2.02	150.64	101.96	0.31
Reach 1	1962	Fish Low Pass.	0.13	110.65	110.69	110.67	110.69	0.011662	0.29	0.44	12.75	0.49
Reach 1	1962	Fish High Pass.	3.66	110.65	110.98	110.85	111	0.004822	0.72	5.05	18.62	0.44
Reach 1	1962	2 Year	31.15	110.65	111.92	111.36	112	0.002381	1.27	24.51	22.53	0.39
Reach 1	1962	3 Year	40.7	110.65	112.14	111.49	112.24	0.002288	1.37	29.62	23.41	0.39
Reach 1	1962	5 Year	49.9	110.65	112.34	111.6	112.44	0.002227	1.46	34.23	24.19	0.39
Reach 1	1962	10 Year	66.54	110.65	112.65	111.78	112.78	0.002152	1.58	42	25.44	0.39
Reach 1	1962	25 Year	100.52	110.65	113.19	112.11	113.35	0.002066	1.78	56.43	27.62	0.4
Reach 1	1962	50 Year	137.34	110.65	113.69	112.41	113.88	0.002155	1.94	70.63	29.61	0.4
Reach 1	1962	100 Year	176.98	110.65	114.15	112.7	114.37	0.002329	2.09	84.65	31.45	0.41
Reach 1	1962	500 Year	269.01	110.65	115.13	113.29	115.4	0.002647	2.29	117.61	35.39	0.4
Reach 1	1938.5	Bridge										
Reach 1	1900	Fish Low Pass.	0.13	110.32	110.36		110.37	0.006572	0.25	0.51	12.17	0.38
Reach 1	1900	Fish High Pass.	3.66	110.32	110.67		110.7	0.005023	0.83	4.38	13.39	0.47
Reach 1	1900	2 Year	31.15	110.32	111.55		111.71	0.004742	1.74	17.86	22.45	0.54
Reach 1	1900	3 Year	40.7	110.32	111.78		111.94	0.004285	1.77	23.02	23.81	0.57
Reach 1	1900	5 Year	49.9	110.32	111.98		112.14	0.003933	1.8	27.77	24.6	0.54
Reach 1	1900	10 Year	66.54	110.32	112.29		112.46	0.003556	1.87	35.63	25.84	0.51
Reach 1	1900	25 Year	100.52	110.32	112.82		113.03	0.003169	2.01	50.04	27.98	0.48
Reach 1	1900	50 Year	137.34	110.32	113.3		113.54	0.002966	2.15	63.98	29.92	0.47
Reach 1	1900	100 Year	176.98	110.32	113.74		114.01	0.002742	2.3	77.56	31.67	0.45
Reach 1	1900	500 Year	269.01	110.32	114.75		115.06	0.002198	2.5	111.08	34.84	0.42
Reach 1	1871	Fish Low Pass.	0.13	110.17	110.22	110.19	110.22	0.003595	0.2	0.62	12.19	0.29
Reach 1	1871	Fish High Pass.	3.66	110.17	110.52	110.38	110.56	0.004681	0.82	4.48	13.4	0.45
Reach 1	1871	2 Year	31.15	110.17	111.42	111.01	111.57	0.004559	1.72	18.1	17	0.53
Reach 1	1871	3 Year	40.7	110.17	111.62	111.17	111.8	0.004624	1.88	21.66	17.96	0.55
Reach 1	1871	5 Year	49.9	110.17	111.8	111.3	112	0.004639	2.01	24.86	18.66	0.56
Reach 1	1871	10 Year	66.54	110.17	112.08	111.52	112.32	0.004646	2.2	30.29	19.79	0.57
Reach 1	1871	25 Year	100.52	110.17	112.57	111.91	112.88	0.004617	2.48	40.46	21.74	0.58
Reach 1	1871	50 Year	137.34	110.17	113.01	112.27	113.39	0.004606	2.72	50.47	23.5	0.59
Reach 1	1871	100 Year	176.98	110.17	113.42	112.6	113.85	0.005118	2.93	60.31	25.14	0.6
Reach 1	1871	500 Year	269.01	110.17	114.45	113.26	114.92	0.005258	3.04	88.36	29.26	0.56
Reach 1	1807.5	Bridge										
Reach 1	1748	Fish Low Pass.	0.13	109.64	109.69	109.66	109.69	0.003189	0.19	0.65	12.78	0.27
Reach 1	1748	Fish High Pass.	3.66	109.64	110.02	109.84	110.05	0.003253	0.72	5.1	14.09	0.38
Reach 1	1748	2 Year	31.15	109.64	110.84	110.46	111	0.004746	1.73	18.04	17.4	0.54
Reach 1	1748	3 Year	40.7	109.64	111.02	110.61	111.21	0.004999	1.92	21.23	18.13	0.57
Reach 1	1748	5 Year	49.9	109.64	111.18	110.74	111.4	0.005174	2.07	24.08	18.75	0.58
Reach 1	1748	10 Year	66.54	109.64	111.44	110.96	111.71	0.00526	2.28	29.16	19.8	0.6
Reach 1	1748	25 Year	100.52	109.64	111.93	111.34	112.26	0.005645	2.56	39.21	21.73	0.61
Reach 1	1748	50 Year	137.34	109.64	112.35	111.69	112.75	0.006647	2.82	48.71	23.42	0.62
Reach 1	1748	100 Year	176.98	109.64	112.72	112.02	113.2	0.007587	3.06	57.82	24.93	0.64
Reach 1	1748	500 Year	269.01	109.64	113.45	112.68	114.07	0.00825	3.51	76.66	28.19	0.66
Reach 1	1727.5	Bridge										

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 1	1689	Fish Low Pass.	0.13	109.47	109.52	109.5	109.52	0.004861	0.21	0.6	14.28	0.33
Reach 1	1689	Fish High Pass.	3.66	109.47	109.79	109.66	109.82	0.005332	0.81	4.54	15.36	0.47
Reach 1	1689	2 Year	31.15	109.47	110.46	110.24	110.66	0.007677	1.97	15.8	18.05	0.67
Reach 1	1689	3 Year	40.7	109.47	110.59	110.38	110.84	0.008608	2.24	18.15	18.56	0.72
Reach 1	1689	5 Year	49.9	109.47	110.7	110.51	111.01	0.009341	2.47	20.21	19	0.76
Reach 1	1689	10 Year	66.54	109.47	110.81	110.71	111.26	0.012481	2.96	22.45	19.48	0.88
Reach 1	1689	25 Year	100.52	109.47	111.08	111.07	111.75	0.017224	3.63	27.72	20.53	1
Reach 1	1689	50 Year	137.34	109.47	111.41	111.41	112.21	0.018854	3.96	34.7	21.85	1
Reach 1	1689	100 Year	176.98	109.47	111.73	111.73	112.64	0.019907	4.22	41.98	23.14	1
Reach 1	1689	500 Year	269.01	109.47	112.34	112.34	113.49	0.01937	4.76	56.77	25.53	0.99
Reach 1	1620	Fish Low Pass.	0.13	108.64	108.74	108.74	108.76	0.04395	0.66	0.19	6.46	1
Reach 1	1620	Fish High Pass.	3.66	108.64	108.98	108.98	109.1	0.026398	1.49	2.46	13.29	1.01
Reach 1	1620	2 Year	31.15	108.64	109.55	109.55	109.82	0.020294	2.31	13.5	25.21	1.01
Reach 1	1620	3 Year	40.7	108.64	109.66	109.66	109.98	0.018997	2.49	16.34	25.86	1
Reach 1	1620	5 Year	49.9	108.64	109.76	109.76	110.12	0.018324	2.65	18.83	26.42	1
Reach 1	1620	10 Year	66.54	108.64	110.02	109.92	110.35	0.012176	2.57	25.88	27.92	0.85
Reach 1	1620	25 Year	100.52	108.64	110.47	110.2	110.8	0.007941	2.58	39.1	32.19	0.73
Reach 1	1620	50 Year	137.34	108.64	110.88	110.46	111.23	0.005998	2.64	53.71	38.58	0.66
Reach 1	1620	100 Year	176.98	108.64	111.25	110.72	111.62	0.005128	2.74	68.78	42.43	0.63
Reach 1	1620	500 Year	269.01	108.64	112.07	111.24	112.46	0.003436	2.83	107.54	48.76	0.54
Reach 1	1573	Fish Low Pass.	0.13	107.41	108.25	107.49	108.25	0.000002	0.02	5.74	16.82	0.01
Reach 1	1573	Fish High Pass.	3.66	107.41	108.61	107.88	108.62	0.000325	0.32	11.42	18.78	0.13
Reach 1	1573	2 Year	31.15	107.41	109.39	108.66	109.46	0.001809	1.13	27.6	24.62	0.34
Reach 1	1573	3 Year	40.7	107.41	109.57	108.8	109.65	0.001995	1.27	31.92	25.43	0.36
Reach 1	1573	5 Year	49.9	107.41	109.71	108.91	109.81	0.002106	1.4	35.75	25.79	0.38
Reach 1	1573	10 Year	66.54	107.41	109.96	109.11	110.08	0.00226	1.58	42.07	26.36	0.4
Reach 1	1573	25 Year	100.52	107.41	110.39	109.48	110.57	0.00246	1.87	53.65	27.54	0.43
Reach 1	1573	50 Year	137.34	107.41	110.79	109.75	111.02	0.00252	2.11	65.24	30.18	0.44
Reach 1	1573	100 Year	176.98	107.41	111.14	110.02	111.43	0.002665	2.36	75.66	32.35	0.47
Reach 1	1573	500 Year	269.01	107.41	111.95	110.58	112.32	0.002504	2.72	100.46	39.67	0.47
Reach 1	1561.5		Inl Struct									
Reach 1	1550	Fish Low Pass.	0.13	107.55	107.61	107.61	107.63	0.047753	0.63	0.2	5.1	1.02
Reach 1	1550	Fish High Pass.	3.66	107.55	107.87	107.87	107.98	0.026082	1.45	2.53	11.76	1
Reach 1	1550	2 Year	31.15	107.55	108.5	108.5	108.71	0.017579	2.02	15.41	36.39	0.93
Reach 1	1550	3 Year	40.7	107.55	108.57	108.57	108.84	0.019575	2.32	17.52	36.54	1.01
Reach 1	1550	5 Year	49.9	107.55	108.65	108.65	108.96	0.018418	2.47	20.16	36.73	1
Reach 1	1550	10 Year	66.54	107.55	108.82	108.78	109.16	0.014738	2.6	25.62	37.12	0.93
Reach 1	1550	25 Year	100.52	107.55	109.15	109.02	109.54	0.010523	2.77	36.31	37.89	0.83
Reach 1	1550	50 Year	137.34	107.55	109.38	109.24	109.88	0.010458	3.13	43.87	38.43	0.86
Reach 1	1550	100 Year	176.98	107.55	109.56	109.48	110.21	0.011497	3.57	49.64	39.17	0.92
Reach 1	1550	500 Year	269.01	107.55	109.94	109.94	110.9	0.012609	4.33	62.08	41.23	1
Reach 1	1536	Fish Low Pass.	0.13	106.94	107.02	106.99	107.02	0.008255	0.33	0.38	6.94	0.45
Reach 1	1536	Fish High Pass.	3.66	106.94	107.2	107.25	107.39	0.057108	1.94	1.88	10.13	1.44
Reach 1	1536	2 Year	31.15	106.94	108.16	107.89	108.31	0.010876	1.72	18.11	23.5	0.63
Reach 1	1536	3 Year	40.7	106.94	108.36	108.03	108.52	0.010301	1.74	23.39	27.87	0.6
Reach 1	1536	5 Year	49.9	106.94	108.49	108.16	108.67	0.010102	1.85	26.96	30.54	0.6
Reach 1	1536	10 Year	66.54	106.94	108.69	108.35	108.9	0.010979	1.99	33.45	31.54	0.62
Reach 1	1536	25 Year	100.52	106.94	109.05	108.64	109.3	0.011375	2.24	44.94	34.39	0.62
Reach 1	1536	50 Year	137.34	106.94	109.29	108.89	109.63	0.012085	2.56	54.7	52.79	0.66
Reach 1	1536	100 Year	176.98	106.94	109.48	109.15	109.91	0.013557	2.92	62.49	56.03	0.71
Reach 1	1536	500 Year	269.01	106.94	109.9	109.62	110.51	0.01458	3.51	80.62	57.89	0.76
Reach 1	1523	Fish Low Pass.	0.13	106.62	106.71	106.71	106.73	0.049555	0.62	0.2	5.53	1.02
Reach 1	1523	Fish High Pass.	3.66	106.62	106.96	106.96	107.06	0.025836	1.39	2.63	12.8	0.98
Reach 1	1523	2 Year	31.15	106.62	107.6	107.6	107.96	0.025346	2.69	11.58	15.76	1
Reach 1	1523	3 Year	40.7	106.62	107.81	107.81	108.15	0.039567	2.58	15.8	23.3	1
Reach 1	1523	5 Year	49.9	106.62	107.91	107.91	108.29	0.039101	2.73	18.27	24.01	1
Reach 1	1523	10 Year	66.54	106.62	108.15	108.09	108.54	0.031375	2.75	24.18	25.67	0.91
Reach 1	1523	25 Year	100.52	106.62	108.59	108.39	108.98	0.023597	2.79	36.1	31.06	0.79
Reach 1	1523	50 Year	137.34	106.62	108.93	108.74	109.34	0.01974	2.87	52.27	61.06	0.74
Reach 1	1523	100 Year	176.98	106.62	109.21	109.01	109.63	0.018195	2.99	66.34	65.28	0.72
Reach 1	1523	500 Year	269.01	106.62	109.66	109.41	110.19	0.017157	3.39	90.6	68.27	0.73
Reach 1	1487	Fish Low Pass.	0.13	106.13	106.25	106.21	106.25	0.00573	0.31	0.41	6.22	0.38
Reach 1	1487	Fish High Pass.	3.66	106.13	106.5	106.42	106.53	0.007689	0.83	4.43	19.1	0.55
Reach 1	1487	2 Year	31.15	106.13	107.29	106.91	107.4	0.003959	1.47	21.18	23.03	0.49
Reach 1	1487	3 Year	40.7	106.13	107.49	107.03	107.62	0.00389	1.57	25.95	24.12	0.48



HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	1487	5 Year	49.9	106.13	107.69	107.14	107.82	0.00427	1.62	30.78	25.99	0.48
Reach 1	1487	10 Year	66.54	106.13	107.98	107.32	108.13	0.004949	1.71	39.02	29.35	0.47
Reach 1	1487	25 Year	100.52	106.13	108.42	107.65	108.61	0.005169	1.9	54.48	57.1	0.47
Reach 1	1487	50 Year	137.34	106.13	108.81	107.96	109	0.004671	1.99	79.77	63.88	0.45
Reach 1	1487	100 Year	176.98	106.13	109.08	108.24	109.3	0.004942	2.17	97.26	65.54	0.47
Reach 1	1487	500 Year	269.01	106.13	109.54	108.84	109.83	0.005533	2.55	128.85	70.15	0.5
Reach 1	1425	Fish Low Pass.	0.13	105.6	105.68	105.66	105.69	0.016444	0.44	0.29	5.77	0.62
Reach 1	1425	Fish High Pass.	3.66	105.6	106.02	105.91	106.06	0.007336	0.94	3.9	13.38	0.56
Reach 1	1425	2 Year	31.15	105.6	106.99	106.55	107.11	0.005277	1.58	20.8	24.45	0.48
Reach 1	1425	3 Year	40.7	105.6	107.19	106.7	107.34	0.005209	1.7	25.96	25.9	0.48
Reach 1	1425	5 Year	49.9	105.6	107.36	106.85	107.52	0.005271	1.81	30.42	27.1	0.49
Reach 1	1425	10 Year	66.54	105.6	107.61	107.06	107.8	0.005597	2.01	37.24	29.01	0.5
Reach 1	1425	25 Year	100.52	105.6	107.98	107.4	108.25	0.006059	2.4	48.79	48.34	0.54
Reach 1	1425	50 Year	137.34	105.6	108.25	107.7	108.62	0.007204	2.85	58.26	65.72	0.61
Reach 1	1425	100 Year	176.98	105.6	108.55	108	108.93	0.00662	2.97	89.51	79.73	0.59
Reach 1	1425	500 Year	269.01	105.6	108.95	108.74	109.42	0.007513	3.49	122.22	83.94	0.65
Reach 1	1370	Fish Low Pass.	0.13	104.75	104.95	104.91	104.97	0.010475	0.55	0.23	2.31	0.55
Reach 1	1370	Fish High Pass.	3.66	104.75	105.43	105.36	105.53	0.012604	1.36	2.69	7.83	0.74
Reach 1	1370	2 Year	31.15	104.75	106.42	106.19	106.66	0.013258	2.19	14.27	15.97	0.71
Reach 1	1370	3 Year	40.7	104.75	106.64	106.37	106.91	0.012016	2.3	18.39	21.48	0.68
Reach 1	1370	5 Year	49.9	104.75	106.82	106.52	107.11	0.011122	2.39	23	29.16	0.67
Reach 1	1370	10 Year	66.54	104.75	107.01	106.84	107.36	0.01182	2.7	28.73	31.31	0.7
Reach 1	1370	25 Year	100.52	104.75	107.43	107.19	107.83	0.010329	2.97	42.99	42.85	0.68
Reach 1	1370	50 Year	137.34	104.75	107.8	107.5	108.21	0.009012	3.12	64.64	77.3	0.66
Reach 1	1370	100 Year	176.98	104.75	108.06	107.89	108.53	0.009525	3.44	88.92	103.88	0.69
Reach 1	1370	500 Year	269.01	104.75	108.83	108.41	109.09	0.004686	2.88	174.18	115.78	0.5
Reach 1	1330	Fish Low Pass.	0.13	104.35	104.47	104.44	104.48	0.011389	0.47	0.27	3.7	0.55
Reach 1	1330	Fish High Pass.	3.66	104.35	104.86	104.8	104.96	0.013158	1.38	2.65	7.88	0.76
Reach 1	1330	2 Year	31.15	104.35	105.82	105.66	106.1	0.011999	2.36	13.19	14.63	0.79
Reach 1	1330	3 Year	40.7	104.35	106.04	105.85	106.34	0.01343	2.45	16.58	17.51	0.78
Reach 1	1330	5 Year	49.9	104.35	106.21	106	106.54	0.014687	2.55	19.56	23.68	0.78
Reach 1	1330	10 Year	66.54	104.35	106.5	106.24	106.83	0.012303	2.6	28.09	29.58	0.72
Reach 1	1330	25 Year	100.52	104.35	107.21	106.65	107.46	0.005721	2.35	52.66	58.89	0.52
Reach 1	1330	50 Year	137.34	104.35	107.55	106.95	107.87	0.006056	2.68	71.3	98.65	0.55
Reach 1	1330	100 Year	176.98	104.35	107.98	107.24	108.2	0.004019	2.44	122.43	108.08	0.46
Reach 1	1330	500 Year	269.01	104.35	108.79	107.97	108.93	0.002187	2.13	222.31	136.76	0.36
Reach 1	1309	Fish Low Pass.	0.13	104.12	104.24	104.2	104.25	0.010909	0.48	0.26	3.34	0.54
Reach 1	1309	Fish High Pass.	3.66	104.12	104.68	104.56	104.74	0.00744	1.09	3.36	9.26	0.58
Reach 1	1309	2 Year	31.15	104.12	105.7	105.36	105.9	0.006296	1.96	15.88	15.69	0.62
Reach 1	1309	3 Year	40.7	104.12	105.92	105.55	106.14	0.005901	2.1	19.95	30.49	0.62
Reach 1	1309	5 Year	49.9	104.12	106.1	105.7	106.34	0.005355	2.2	24.41	33.04	0.6
Reach 1	1309	10 Year	66.54	104.12	106.39	105.96	106.66	0.004801	2.37	31.85	37.38	0.59
Reach 1	1309	25 Year	100.52	104.12	107.13	106.34	107.38	0.002787	2.32	56.53	68.46	0.48
Reach 1	1309	50 Year	137.34	104.12	107.5	106.68	107.8	0.002715	2.52	87.55	90.46	0.48
Reach 1	1309	100 Year	176.98	104.12	107.89	107	108.2	0.002279	2.52	118.99	99.38	0.45
Reach 1	1309	500 Year	269.01	104.12	108.73	107.78	108.95	0.001321	2.24	212.06	110.21	0.36
Reach 1	1288.5		Bridge									
Reach 1	1277	Fish Low Pass.	0.13	103.81	104.01	103.96	104.02	0.011137	0.47	0.27	3.51	0.54
Reach 1	1277	Fish High Pass.	3.66	103.81	104.5	104.28	104.53	0.003151	0.79	4.61	10.65	0.38
Reach 1	1277	2 Year	31.15	103.81	105.59	105.06	105.7	0.006803	1.44	21.63	21.15	0.45
Reach 1	1277	3 Year	40.7	103.81	105.82	105.23	105.94	0.006987	1.53	26.59	22.97	0.45
Reach 1	1277	5 Year	49.9	103.81	106.01	105.36	106.14	0.006988	1.6	31.2	24.69	0.45
Reach 1	1277	10 Year	66.54	103.81	106.31	105.57	106.46	0.006366	1.72	39.21	31.96	0.44
Reach 1	1277	25 Year	100.52	103.81	106.97	105.92	107.11	0.003969	1.69	69.16	58.11	0.37
Reach 1	1277	50 Year	137.34	103.81	107.31	106.23	107.46	0.003911	1.85	89.22	60.49	0.38
Reach 1	1277	100 Year	176.98	103.81	107.74	106.52	107.89	0.003114	1.84	116.03	62.43	0.34
Reach 1	1277	500 Year	269.01	103.81	108.67	107.2	108.82	0.002089	1.81	174.06	76.68	0.3
Reach 1	1214.5		Bridge									
Reach 1	1162	Fish Low Pass.	0.13	103.32	103.4	103.4	103.42	0.046728	0.63	0.2	5.04	1.01
Reach 1	1162	Fish High Pass.	3.66	103.32	103.8		103.84	0.004209	0.82	4.44	12.04	0.43
Reach 1	1162	2 Year	31.15	103.32	104.69		104.87	0.005455	1.9	16.42	15.06	0.58
Reach 1	1162	3 Year	40.7	103.32	104.87		105.1	0.005864	2.12	19.19	15.66	0.61
Reach 1	1162	5 Year	49.9	103.32	105.02		105.29	0.006228	2.31	21.61	16.18	0.64
Reach 1	1162	10 Year	66.54	103.32	105.25		105.6	0.00684	2.61	25.51	16.98	0.68
Reach 1	1162	25 Year	100.52	103.32	105.64		106.13	0.007901	3.11	32.33	18.3	0.75

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	1162	50 Year	137.34	103.32	106.1		106.67	0.008163	3.34	41.18	21.8	0.74
Reach 1	1162	100 Year	176.98	103.32	106.66	106.02	107.23	0.006318	3.36	54.85	44.37	0.67
Reach 1	1162	500 Year	269.01	103.32	106.95	106.96	107.94	0.009908	4.46	65.75	61.51	0.85
Reach 1	1153	Fish Low Pass.	0.13	103.08	103.36	103.17	103.36	0.000123	0.09	1.44	8.11	0.07
Reach 1	1153	Fish High Pass.	3.66	103.08	103.79	103.47	103.81	0.001617	0.62	5.93	12.15	0.28
Reach 1	1153	2 Year	31.15	103.08	104.65	104.19	104.81	0.004258	1.78	17.51	14.63	0.52
Reach 1	1153	3 Year	40.7	103.08	104.83	104.35	105.04	0.004818	2.02	20.11	15.12	0.56
Reach 1	1153	5 Year	49.9	103.08	104.97	104.5	105.23	0.005307	2.23	22.36	15.53	0.59
Reach 1	1153	10 Year	66.54	103.08	105.2	104.74	105.53	0.006123	2.57	25.93	16.17	0.65
Reach 1	1153	25 Year	100.52	103.08	105.53	105.17	106.05	0.008094	3.21	31.35	17.12	0.76
Reach 1	1153	50 Year	137.34	103.08	105.8	105.57	106.53	0.01012	3.8	36.1	17.94	0.86
Reach 1	1153	100 Year	176.98	103.08	105.95	105.95	107.01	0.013524	4.56	38.85	18.41	1
Reach 1	1153	500 Year	269.01	103.08	106.69	106.99	107.81	0.010235	4.82	61.27	71.88	0.91
Reach 1	1107	Fish Low Pass.	0.13	103.28	103.33	103.33	103.34	0.055619	0.55	0.23	8.19	1.04
Reach 1	1107	Fish High Pass.	3.66	103.28	103.52	103.52	103.61	0.02736	1.35	2.71	14.47	1
Reach 1	1107	2 Year	31.15	103.28	104.1	104.1	104.44	0.018232	2.59	12.01	17.54	1
Reach 1	1107	3 Year	40.7	103.28	104.24	104.24	104.64	0.01737	2.8	14.56	18.29	1
Reach 1	1107	5 Year	49.9	103.28	104.36	104.36	104.81	0.016788	2.96	16.87	18.95	1
Reach 1	1107	10 Year	66.54	103.28	104.57	104.57	105.09	0.016055	3.2	20.79	20.02	1
Reach 1	1107	25 Year	100.52	103.28	104.97	104.93	105.57	0.013608	3.44	29.23	22.23	0.96
Reach 1	1107	50 Year	137.34	103.28	105.35	105.25	106.01	0.01182	3.59	38.3	62.93	0.92
Reach 1	1107	100 Year	176.98	103.28	105.62	105.83	106.4	0.012583	3.93	45.56	126.28	0.95
Reach 1	1107	500 Year	269.01	103.28	106.04	106.04	106.38	0.005814	3.08	132.74	166.58	0.67
Reach 1	1003	Fish Low Pass.	0.13	101.7	101.78	101.74	101.78	0.005847	0.27	0.47	9.07	0.37
Reach 1	1003	Fish High Pass.	3.66	101.7	102.1	101.97	102.15	0.005849	0.94	3.9	11.15	0.51
Reach 1	1003	2 Year	31.15	101.7	102.98	102.68	103.2	0.006611	2.04	15.28	14.61	0.64
Reach 1	1003	3 Year	40.7	101.7	103.18	102.85	103.43	0.006776	2.24	18.19	15.36	0.66
Reach 1	1003	5 Year	49.9	101.7	103.35	103	103.64	0.006866	2.39	20.85	16.01	0.67
Reach 1	1003	10 Year	66.54	101.7	103.63	103.24	103.97	0.006907	2.62	25.42	17.07	0.68
Reach 1	1003	25 Year	100.52	101.7	104.12	103.66	104.56	0.006731	2.93	34.32	18.96	0.69
Reach 1	1003	50 Year	137.34	101.7	104.53	104.05	105.07	0.006718	3.24	42.5	38.17	0.71
Reach 1	1003	100 Year	176.98	101.7	104.89	104.41	105.53	0.006663	3.55	51.15	80.8	0.72
Reach 1	1003	500 Year	269.01	101.7	105.67	105.47	105.91	0.002501	2.62	182.13	189.22	0.47
Reach 1	894	Fish Low Pass.	0.13	100.2	100.35	100.35	100.39	0.038546	0.87	0.15	1.92	1
Reach 1	894	Fish High Pass.	3.66	100.2	100.79	100.79	100.93	0.024491	1.69	2.17	7.45	1
Reach 1	894	2 Year	31.15	100.2	101.65	101.62	102.06	0.015813	2.84	10.98	12.11	0.95
Reach 1	894	3 Year	40.7	100.2	101.86	101.8	102.32	0.014568	3.02	13.49	12.65	0.93
Reach 1	894	5 Year	49.9	100.2	102.03	101.96	102.54	0.013714	3.16	15.8	13.12	0.92
Reach 1	894	10 Year	66.54	100.2	102.32	102.22	102.9	0.012742	3.38	19.71	13.89	0.9
Reach 1	894	25 Year	100.52	100.2	102.84	102.69	103.53	0.011945	3.68	27.35	16.06	0.9
Reach 1	894	50 Year	137.34	100.2	103.32	103.13	104.08	0.010993	3.86	35.59	18.22	0.88
Reach 1	894	100 Year	176.98	100.2	103.72	103.52	104.57	0.010232	4.1	43.37	21.04	0.87
Reach 1	894	500 Year	269.01	100.2	104.58	104.58	105.41	0.006964	4.19	85.59	124.93	0.76
Reach 1	809	Fish Low Pass.	0.13	99.48	99.68	99.6	99.69	0.00267	0.28	0.45	4.4	0.28
Reach 1	809	Fish High Pass.	3.66	99.48	100.16	99.95	100.2	0.003804	0.86	4.24	9.93	0.42
Reach 1	809	2 Year	31.15	99.48	101.15		101.34	0.005027	1.93	16.15	13.35	0.56
Reach 1	809	3 Year	40.7	99.48	101.36		101.59	0.005201	2.13	19.08	13.72	0.58
Reach 1	809	5 Year	49.9	99.48	101.54		101.81	0.005427	2.31	21.57	14.03	0.6
Reach 1	809	10 Year	66.54	99.48	101.74		102.12	0.006748	2.73	24.34	14.37	0.67
Reach 1	809	25 Year	100.52	99.48	102.21		102.74	0.00736	3.21	31.35	15.18	0.71
Reach 1	809	50 Year	137.34	99.48	102.71		103.34	0.007073	3.51	39.13	16.23	0.71
Reach 1	809	100 Year	176.98	99.48	103.06	102.56	103.86	0.007558	3.96	44.93	17.18	0.75
Reach 1	809	500 Year	269.01	99.48	103.66	103.77	104.77	0.008462	4.77	70.33	63.82	0.82
Reach 1	714	Fish Low Pass.	0.13	98.89	99	99	99.03	0.04116	0.73	0.17	3.13	1
Reach 1	714	Fish High Pass.	3.66	98.89	99.3	99.3	99.43	0.025209	1.55	2.35	9.53	1
Reach 1	714	2 Year	31.15	98.89	100.06	100.06	100.49	0.017308	2.91	10.7	12.37	1
Reach 1	714	3 Year	40.7	98.89	100.23	100.23	100.74	0.016664	3.14	12.97	12.93	1
Reach 1	714	5 Year	49.9	98.89	100.41	100.39	100.95	0.015635	3.28	15.23	13.5	0.98
Reach 1	714	10 Year	66.54	98.89	100.91	100.65	101.36	0.009042	2.96	22.46	15.18	0.78
Reach 1	714	25 Year	100.52	98.89	101.51	101.1	102.01	0.007423	3.12	32.23	17.19	0.73
Reach 1	714	50 Year	137.34	98.89	102.13	101.51	102.64	0.006638	3.17	43.39	21.79	0.67
Reach 1	714	100 Year	176.98	98.89	102.39	101.89	103.07	0.007909	3.65	48.67	35.97	0.74
Reach 1	714	500 Year	269.01	98.89	102.91	102.79	103.84	0.008791	4.36	71.21	53.39	0.8

**MAD RIVER - PROPOSED CONDITION, DESIGN DISCHARGE**  
**HEC-RAS 4.1.0 - "Six XS Bridge" Output**

HEC-RAS Plan: PR DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	1972	Fish Low Pass.	110.77	110.77	110.74	0.08	0	22.92		0.13		0.23
Reach 1	1972	Fish High Pass.	111.07	111.03	110.93	0.06	0.01	24.74		3.66		0.94
Reach 1	1972	2 Year	112.03	111.99	111.56	0.02	0.01	31.84	13.23	17.89	0.03	0.97
Reach 1	1972	3 Year	112.27	112.22	111.72	0.02	0.01	34.82	17.37	23.22	0.12	1.05
Reach 1	1972	5 Year	112.48	112.42	111.72	0.02	0.02	41.88	21.33	28.31	0.25	1.12
Reach 1	1972	10 Year	112.81	112.74	111.72	0.02	0.02	51.88	28.46	37.45	0.63	1.23
Reach 1	1972	25 Year	113.39	113.3	111.89	0.01	0.02	55.22	42.83	55.84	1.85	1.42
Reach 1	1972	50 Year	113.92	113.81	112.14	0.01	0.03	57.56	58.16	75.42	3.76	1.59
Reach 1	1972	100 Year	114.41	114.28	112.38	0.01	0.03	63.64	74.44	96.19	6.35	1.75
Reach 1	1972	500 Year	115.44	115.27	112.86	0.02	0.03	101.96	111.3	143.13	14.56	2.02
Reach 1	1962	Fish Low Pass.	110.69	110.69	110.67	0.11	0	12.75		0.13		0.29
Reach 1	1962	Fish High Pass.	111	110.98	110.85	0.08	0	18.62		3.66		0.72
Reach 1	1962	2 Year	112	111.92	111.36	0.06	0.02	22.53		31.15		1.27
Reach 1	1962	3 Year	112.24	112.14	111.49	0.06	0.03	23.41		40.7		1.37
Reach 1	1962	5 Year	112.44	112.34	111.6	0.05	0.03	24.19		49.9		1.46
Reach 1	1962	10 Year	112.78	112.65	111.78	0.05	0.04	25.44		66.54		1.58
Reach 1	1962	25 Year	113.35	113.19	112.11	0.05	0.05	27.62		100.52		1.78
Reach 1	1962	50 Year	113.88	113.69	112.41	0.05	0.05	29.61		137.34		1.94
Reach 1	1962	100 Year	114.37	114.15	112.7	0.05	0.06	31.45		176.98		2.09
Reach 1	1962	500 Year	115.4	115.13	113.29	0.05	0.07	35.39		269.01		2.29
Reach 1	1938.5 BR U	Fish Low Pass.	110.58	110.58	110.55	0.05	0	12.2		0.13		0.21
Reach 1	1938.5 BR U	Fish High Pass.	110.92	110.89	110.74	0.06	0	13.42		3.66		0.8
Reach 1	1938.5 BR U	2 Year	111.92	111.77	111.37	0.06	0	16.93		31.15		1.74
Reach 1	1938.5 BR U	3 Year	112.16	111.97	111.53	0.06	0	17.73		40.7		1.9
Reach 1	1938.5 BR U	5 Year	112.36	112.15	111.66	0.06	0	18.44		49.9		2.02
Reach 1	1938.5 BR U	10 Year	112.69	112.44	111.88	0.06	0	19.58		66.54		2.21
Reach 1	1938.5 BR U	25 Year	113.26	112.94	112.27	0.06	0	21.58		100.52		2.48
Reach 1	1938.5 BR U	50 Year	113.78	113.4	112.63	0.06	0	23.41		137.34		2.7
Reach 1	1938.5 BR U	100 Year	114.26	113.83	112.97	0.06	0.01	25.1		176.98		2.89
Reach 1	1938.5 BR U	500 Year	115.28	114.79	113.64	0.05	0.01	28.27		268.4	0.61	3.1
Reach 1	1938.5 BR D	Fish Low Pass.	110.53	110.53	110.5	0.16	0	12.2		0.13		0.21
Reach 1	1938.5 BR D	Fish High Pass.	110.86	110.82	110.69	0.16	0	13.38		3.66		0.84
Reach 1	1938.5 BR D	2 Year	111.86	111.71	111.32	0.15	0	17.06		31.15		1.76
Reach 1	1938.5 BR D	3 Year	112.1	111.91	111.47	0.14	0.01	18.03		40.7		1.91
Reach 1	1938.5 BR D	5 Year	112.3	112.09	111.61	0.14	0.02	18.81		49.9		2.02
Reach 1	1938.5 BR D	10 Year	112.63	112.38	111.83	0.13	0.03	19.98		66.54		2.2
Reach 1	1938.5 BR D	25 Year	113.2	112.89	112.22	0.12	0.05	22.01		100.52		2.45
Reach 1	1938.5 BR D	50 Year	113.71	113.35	112.57	0.11	0.06	23.86		137.34		2.66
Reach 1	1938.5 BR D	100 Year	114.19	113.78	112.91	0.11	0.07	25.56		176.98		2.85
Reach 1	1938.5 BR D	500 Year	115.22	114.76	113.56	0.09	0.08	28.56		269.01		3.03
Reach 1	1900	Fish Low Pass.	110.37	110.36		0.14	0	12.17		0.13		0.25
Reach 1	1900	Fish High Pass.	110.7	110.67		0.14	0	13.39		3.66		0.83
Reach 1	1900	2 Year	111.71	111.55		0.14	0	22.45		31.15		1.74
Reach 1	1900	3 Year	111.94	111.78		0.13	0.01	23.81		40.7		1.77
Reach 1	1900	5 Year	112.14	111.98		0.13	0.01	24.6		49.9		1.8
Reach 1	1900	10 Year	112.46	112.29		0.12	0.02	25.84		66.54		1.87
Reach 1	1900	25 Year	113.03	112.82		0.11	0.03	27.98		100.52		2.01
Reach 1	1900	50 Year	113.54	113.3		0.11	0.04	29.92		137.33	0.01	2.15
Reach 1	1900	100 Year	114.01	113.74		0.11	0.05	31.67	0.04	176.82	0.12	2.3
Reach 1	1900	500 Year	115.06	114.75		0.1	0.05	34.84	0.96	266.76	1.3	2.5
Reach 1	1871	Fish Low Pass.	110.22	110.22	110.19	0.17	0	12.19		0.13		0.2
Reach 1	1871	Fish High Pass.	110.56	110.52	110.38	0.16	0	13.4		3.66		0.82
Reach 1	1871	2 Year	111.57	111.42	111.01	0.15	0	17		31.15		1.72
Reach 1	1871	3 Year	111.8	111.62	111.17	0.16	0	17.96		40.7		1.88
Reach 1	1871	5 Year	112	111.8	111.3	0.16	0	18.66		49.9		2.01
Reach 1	1871	10 Year	112.32	112.08	111.52	0.16	0	19.79		66.54		2.2
Reach 1	1871	25 Year	112.88	112.57	111.91	0.16	0	21.74		100.52		2.48
Reach 1	1871	50 Year	113.39	113.01	112.27	0.16	0	23.5		137.34		2.72
Reach 1	1871	100 Year	113.85	113.42	112.6	0.17	0	25.14		176.98		2.93
Reach 1	1871	500 Year	114.92	114.45	113.26	0.19	0.02	29.26		269.01		3.04
Reach 1	1807.5 BR U	Fish Low Pass.	110.05	110.05	110.03	0.27	0	12.17		0.13		0.25
Reach 1	1807.5 BR U	Fish High Pass.	110.39	110.36	110.22	0.24	0	13.4		3.66		0.82
Reach 1	1807.5 BR U	2 Year	111.41	111.26	110.85	0.27	0	17.02		31.15		1.71
Reach 1	1807.5 BR U	3 Year	111.64	111.46	111	0.28	0	17.82		40.7		1.88

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	1807.5 BR U	5 Year	111.84	111.64	111.14	0.29	0	18.52		49.9		2.01
Reach 1	1807.5 BR U	10 Year	112.16	111.92	111.36	0.3	0	19.63		66.54		2.21
Reach 1	1807.5 BR U	25 Year	112.72	112.4	111.75	0.29	0	21.58		100.52		2.5
Reach 1	1807.5 BR U	50 Year	113.23	112.84	112.11	0.29	0	23.34		137.34		2.74
Reach 1	1807.5 BR U	100 Year	113.69	113.24	112.44	0.29	0	26.01	0.07	176.78	0.13	2.97
Reach 1	1807.5 BR U	500 Year	114.7	114.15	113.11	0.38	0.01	14.42	0.48	267.05	1.48	3.31
Reach 1	1807.5 BR D	Fish Low Pass.	109.79	109.78	109.75	0.09	0	12.22		0.13		0.19
Reach 1	1807.5 BR D	Fish High Pass.	110.15	110.12	109.94	0.1	0	13.57		3.66		0.73
Reach 1	1807.5 BR D	2 Year	111.14	110.99	110.57	0.14	0	17.06		31.15		1.7
Reach 1	1807.5 BR D	3 Year	111.36	111.18	110.72	0.15	0	17.81		40.7		1.88
Reach 1	1807.5 BR D	5 Year	111.55	111.34	110.86	0.15	0	18.47		49.9		2.03
Reach 1	1807.5 BR D	10 Year	111.87	111.61	111.08	0.16	0	19.53		66.54		2.24
Reach 1	1807.5 BR D	25 Year	112.42	112.1	111.47	0.16	0	21.49		100.52		2.54
Reach 1	1807.5 BR D	50 Year	112.93	112.54	111.83	0.17	0	23.25		137.34		2.77
Reach 1	1807.5 BR D	100 Year	113.39	112.94	112.16	0.19	0.01	24.82		176.98		3
Reach 1	1807.5 BR D	500 Year	114.31	113.71	112.83	0.22	0.01	19.09		269.01		3.42
Reach 1	1748	Fish Low Pass.	109.69	109.69	109.66	0.02	0	12.78		0.13		0.19
Reach 1	1748	Fish High Pass.	110.05	110.02	109.84	0.03	0	14.09		3.66		0.72
Reach 1	1748	2 Year	111	110.84	110.46	0.04	0	17.4		31.15		1.73
Reach 1	1748	3 Year	111.21	111.02	110.61	0.05	0	18.13		40.7		1.92
Reach 1	1748	5 Year	111.4	111.18	110.74	0.05	0	18.75		49.9		2.07
Reach 1	1748	10 Year	111.71	111.44	110.96	0.05	0.01	19.8		66.54		2.28
Reach 1	1748	25 Year	112.26	111.93	111.34	0.05	0.01	21.73		100.52		2.56
Reach 1	1748	50 Year	112.75	112.35	111.69	0.05	0.01	23.42		137.34		2.82
Reach 1	1748	100 Year	113.2	112.72	112.02	0.06	0.01	24.93		176.98		3.06
Reach 1	1748	500 Year	114.07	113.45	112.68	0.06	0	28.19		269	0.01	3.51
Reach 1	1727.5 BR U	Fish Low Pass.	109.67	109.67	109.63	0.04	0	13.32		0.13		0.16
Reach 1	1727.5 BR U	Fish High Pass.	110.02	109.99	109.81	0.06	0	14.62		3.66		0.69
Reach 1	1727.5 BR U	2 Year	110.95	110.8	110.41	0.09	0	17.87		31.15		1.69
Reach 1	1727.5 BR U	3 Year	111.16	110.98	110.56	0.1	0	18.58		40.7		1.87
Reach 1	1727.5 BR U	5 Year	111.35	111.14	110.69	0.1	0	19.2		49.9		2.03
Reach 1	1727.5 BR U	10 Year	111.65	111.4	110.9	0.1	0	20.25		66.54		2.23
Reach 1	1727.5 BR U	25 Year	112.2	111.88	111.27	0.09	0.01	22.19		100.52		2.51
Reach 1	1727.5 BR U	50 Year	112.69	112.3	111.62	0.09	0.01	25.54	0.02	137.32		2.76
Reach 1	1727.5 BR U	100 Year	113.14	112.68	111.95	0.09	0.01	31.01	0.41	176.57	0	3.01
Reach 1	1727.5 BR U	500 Year	114.01	113.39	112.59	0.09	0.02	34.34	1.92	266.57	0.52	3.5
Reach 1	1727.5 BR D	Fish Low Pass.	109.63	109.63	109.6	0.11	0	14.18		0.13		0.18
Reach 1	1727.5 BR D	Fish High Pass.	109.95	109.93	109.77	0.13	0	15.37		3.66		0.72
Reach 1	1727.5 BR D	2 Year	110.86	110.71	110.35	0.18	0.02	18.5		31.15		1.7
Reach 1	1727.5 BR D	3 Year	111.06	110.88	110.49	0.2	0.02	19.2		40.7		1.88
Reach 1	1727.5 BR D	5 Year	111.25	111.04	110.62	0.21	0.03	19.81		49.9		2.03
Reach 1	1727.5 BR D	10 Year	111.55	111.3	110.82	0.23	0.06	20.87		66.54		2.22
Reach 1	1727.5 BR D	25 Year	112.1	111.79	111.18	0.25	0.11	22.85		100.52		2.46
Reach 1	1727.5 BR D	50 Year	112.59	112.22	111.52	0.26	0.13	24.53		137.34		2.71
Reach 1	1727.5 BR D	100 Year	113.03	112.6	111.85	0.26	0.14	26.96	0.3	176.68	0	2.93
Reach 1	1727.5 BR D	500 Year	113.91	113.33	112.48	0.24	0.17	28.42	1.91	266.66	0.44	3.39
Reach 1	1689	Fish Low Pass.	109.52	109.52	109.5	0.76	0.01	14.28		0.13		0.21
Reach 1	1689	Fish High Pass.	109.82	109.79	109.66	0.7	0.02	15.36		3.66		0.81
Reach 1	1689	2 Year	110.66	110.46	110.24	0.81	0.02	18.05		31.15		1.97
Reach 1	1689	3 Year	110.84	110.59	110.38	0.85	0.02	18.56		40.7		2.24
Reach 1	1689	5 Year	111.01	110.7	110.51	0.88	0.01	19		49.9		2.47
Reach 1	1689	10 Year	111.26	110.81	110.71	0.85	0.06	19.48		66.54		2.96
Reach 1	1689	25 Year	111.75	111.08	111.07	0.78	0.17	20.53		100.52		3.63
Reach 1	1689	50 Year	112.21	111.41	111.41	0.68	0.22	21.85		137.34		3.96
Reach 1	1689	100 Year	112.64	111.73	111.73	0.62	0.26	23.14		176.98		4.22
Reach 1	1689	500 Year	113.49	112.34	112.34	0.47	0.38	25.53	0.11	268.84	0.05	4.76
Reach 1	1620	Fish Low Pass.	108.76	108.74	108.74	0	0.01	6.46		0.13		0.66
Reach 1	1620	Fish High Pass.	109.1	108.98	108.98	0.05	0.03	13.29		3.66		1.49
Reach 1	1620	2 Year	109.82	109.55	109.55	0.2	0.06	25.21		31.15		2.31
Reach 1	1620	3 Year	109.98	109.66	109.66	0.21	0.07	25.86		40.7		2.49
Reach 1	1620	5 Year	110.12	109.76	109.76	0.22	0.08	26.42		49.9		2.65
Reach 1	1620	10 Year	110.35	110.02	109.92	0.21	0.06	27.92		66.54		2.57
Reach 1	1620	25 Year	110.8	110.47	110.2	0.19	0.05	32.19		100.49	0.03	2.58
Reach 1	1620	50 Year	111.23	110.88	110.46	0.17	0.04	38.58		136.52	0.82	2.64
Reach 1	1620	100 Year	111.62	111.25	110.72	0.17	0.03	42.43		173.88	3.1	2.74
Reach 1	1620	500 Year	112.46	112.07	111.24	0.14	0	48.76	1.35	255.78	11.89	2.83

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	1330	Fish Low Pass.	104.48	104.47	104.44	0.23	0	3.7		0.13		0.47
Reach 1	1330	Fish High Pass.	104.96	104.86	104.8	0.2	0.01	7.88		3.66		1.38
Reach 1	1330	2 Year	106.1	105.82	105.66	0.18	0.03	14.63		31.15		2.36
Reach 1	1330	3 Year	106.34	106.04	105.85	0.18	0.02	17.51		40.7		2.45
Reach 1	1330	5 Year	106.54	106.21	106	0.17	0.03	23.68		49.9		2.55
Reach 1	1330	10 Year	106.83	106.5	106.24	0.15	0.02	29.58	2	64.5	0.04	2.6
Reach 1	1330	25 Year	107.46	107.21	106.65	0.08	0	58.89	9.63	89.34	1.55	2.35
Reach 1	1330	50 Year	107.87	107.55	106.95	0.08	0.02	98.65	14.13	118.76	4.45	2.68
Reach 1	1330	100 Year	108.2	107.98	107.24	0.06	0	108.08	30.35	127.18	19.44	2.44
Reach 1	1330	500 Year	108.93	108.79	107.97	0.04	0	136.76	63.13	142.94	62.94	2.13
Reach 1	1309	Fish Low Pass.	104.25	104.24	104.2	0.12	0	3.34		0.13		0.48
Reach 1	1309	Fish High Pass.	104.74	104.68	104.56	0.12	0.01	9.26		3.66		1.09
Reach 1	1309	2 Year	105.9	105.7	105.36	0.09	0.03	15.69		31.15		1.96
Reach 1	1309	3 Year	106.14	105.92	105.55	0.09	0.03	30.49	0.12	40.58	0	2.1
Reach 1	1309	5 Year	106.34	106.1	105.7	0.08	0.04	33.04	0.74	49.13	0.02	2.2
Reach 1	1309	10 Year	106.66	106.39	105.96	0.08	0.04	37.38	2.4	64	0.14	2.37
Reach 1	1309	25 Year	107.38	107.13	106.34			68.46	8.08	90.73	1.71	2.32
Reach 1	1309	50 Year	107.8	107.5	106.68			90.46	14.36	113.91	9.07	2.52
Reach 1	1309	100 Year	108.2	107.89	107			99.38	26.91	129.97	20.09	2.52
Reach 1	1309	500 Year	108.95	108.73	107.78			110.21	52.15	146.48	70.38	2.24
Reach 1	1288.5 BR U	Fish Low Pass.	104.13	104.12	104.05	0.02	0	3.66		0.13		0.34
Reach 1	1288.5 BR U	Fish High Pass.	104.62	104.57	104.41	0.02	0	10.23		3.66		0.96
Reach 1	1288.5 BR U	2 Year	105.78	105.64	105.18	0.01	0	18.47		31.15		1.66
Reach 1	1288.5 BR U	3 Year	106.02	105.85	105.34	0.01	0.01	19.33		40.7		1.8
Reach 1	1288.5 BR U	5 Year	106.22	106.05	105.47	0.01	0	20		49.9		1.82
Reach 1	1288.5 BR U	10 Year	106.55	106.35	105.7	0.01	0	20.52		66.54		2
Reach 1	1288.5 BR U	25 Year	107.38	107.13	106.05			32.31	3.63	89.7	7.03	2.28
Reach 1	1288.5 BR U	50 Year	107.77	107.5	106.38			47.93	10.95	98.47	23.67	2.5
Reach 1	1288.5 BR U	100 Year	108.14	107.89	106.57			50.8	20.01	94.16	53.32	2.39
Reach 1	1288.5 BR U	500 Year	108.89	108.73	107.55			84.37	41.64	79.42	124.54	1.73
Reach 1	1288.5 BR D	Fish Low Pass.	104.11	104.1	104.05	0.09	0	3.27		0.13		0.44
Reach 1	1288.5 BR D	Fish High Pass.	104.59	104.53	104.41	0.04	0.01	9.97		3.66		1.06
Reach 1	1288.5 BR D	2 Year	105.76	105.63	105.19	0.05	0.01	18.42		31.15		1.62
Reach 1	1288.5 BR D	3 Year	106	105.85	105.35	0.05	0.02	19.29		40.7		1.74
Reach 1	1288.5 BR D	5 Year	106.21	106.04	105.48	0.05	0.02	19.96		49.9		1.84
Reach 1	1288.5 BR D	10 Year	106.54	106.33	105.69	0.04	0.03	20.49		66.54		2.02
Reach 1	1288.5 BR D	25 Year	107.37	107.13	106.05			28.29	3.63	89.7	7.03	2.28
Reach 1	1288.5 BR D	50 Year	107.73	107.5	106.38			45.13	10.95	98.47	23.67	2.5
Reach 1	1288.5 BR D	100 Year	108.14	107.79	106.57			46.33	20.01	94.16	53.32	2.39
Reach 1	1288.5 BR D	500 Year	108.89	108.67	107.66			74.5	41.64	79.42	124.54	1.73
Reach 1	1277	Fish Low Pass.	104.02	104.01	103.96	0.06	0	3.51		0.13		0.47
Reach 1	1277	Fish High Pass.	104.53	104.5	104.28			10.65		3.66		0.79
Reach 1	1277	2 Year	105.7	105.59	105.06	0.11	0.02	21.15		31.15		1.44
Reach 1	1277	3 Year	105.94	105.82	105.23	0.11	0.02	22.97		40.7		1.53
Reach 1	1277	5 Year	106.14	106.01	105.36	0.11	0.02	24.69		49.9	0	1.6
Reach 1	1277	10 Year	106.46	106.31	105.57	0.1	0.03	31.96		66.36	0.18	1.72
Reach 1	1277	25 Year	107.11	106.97	105.92			58.11	0.13	93.85	6.54	1.69
Reach 1	1277	50 Year	107.46	107.31	106.23	0.07	0.04	60.49	2.47	118.91	15.96	1.85
Reach 1	1277	100 Year	107.89	107.74	106.52	0.06	0.06	62.43	7.78	139.25	29.95	1.84
Reach 1	1277	500 Year	108.82	108.67	107.2	0.04	0.08	76.68	23.63	181.12	64.26	1.81
Reach 1	1214.5 BR U	Fish Low Pass.	103.95	103.95	103.87	0.33	0	4.92		0.13		0.23
Reach 1	1214.5 BR U	Fish High Pass.	104.34	104.21	104.21			7.93		3.66		1.65
Reach 1	1214.5 BR U	2 Year	105.58	105.42	105	0.59	0.03	17.28		31.15		1.75
Reach 1	1214.5 BR U	3 Year	105.81	105.63	105.18	0.58	0.04	18.48		40.7		1.89
Reach 1	1214.5 BR U	5 Year	106.01	105.81	105.32	0.58	0.05	19.37		49.9		2
Reach 1	1214.5 BR U	10 Year	106.34	106.1	105.55	0.57	0.06	21.77	0.01	66.53		2.16
Reach 1	1214.5 BR U	25 Year	107.06	106.86	105.93			28.63	6.12	94.4		1.99
Reach 1	1214.5 BR U	50 Year	107.35	107.05	106.35	0.47	0.11	30.41	10.62	126.71	0	2.45
Reach 1	1214.5 BR U	100 Year	107.78	107.43	106.64	0.39	0.08	31.19	18.77	158.03	0.17	2.61
Reach 1	1214.5 BR U	500 Year	108.7	108.3	107.19	0.4	0.22	32.26	45.26	222.8	0.95	2.77
Reach 1	1214.5 BR D	Fish Low Pass.	103.62	103.61	103.6	0.19	0	7.26		0.13		0.41
Reach 1	1214.5 BR D	Fish High Pass.	103.95	103.84	103.84			11.53		3.66		1.46
Reach 1	1214.5 BR D	2 Year	104.96	104.7	104.52	0.05	0.04	14.71		31.15		2.26
Reach 1	1214.5 BR D	3 Year	105.19	104.88	104.68	0.05	0.04	15.35		40.7		2.47
Reach 1	1214.5 BR D	5 Year	105.39	105.03	104.83	0.05	0.04	15.89		49.9		2.65
Reach 1	1214.5 BR D	10 Year	105.7	105.27	105.06	0.06	0.05	16.73		66.54		2.93

HEC-RAS Plan: PR_DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	1214.5 BR D	25 Year	106.22	105.47	105.47			17.46		100.52		3.84
Reach 1	1214.5 BR D	50 Year	106.77	106.12	105.85	0.06	0.04	22.49	0.16	137.18		3.58
Reach 1	1214.5 BR D	100 Year	107.3	106.69	106.25	0.05	0.02	24.76	3.78	173.2		3.48
Reach 1	1214.5 BR D	500 Year	108.08	106.95	106.88	0.07	0.07	25.83	8.53	260.48		4.71
Reach 1	1162	Fish Low Pass.	103.42	103.4	103.4	0	0.01	5.04		0.13		0.63
Reach 1	1162	Fish High Pass.	103.84	103.8		0.02	0.01	12.04		3.66		0.82
Reach 1	1162	2 Year	104.87	104.69		0.04	0.01	15.06		31.15		1.9
Reach 1	1162	3 Year	105.1	104.87		0.05	0.01	15.66		40.7		2.12
Reach 1	1162	5 Year	105.29	105.02		0.05	0.01	16.18		49.9		2.31
Reach 1	1162	10 Year	105.6	105.25		0.06	0.01	16.98		66.54		2.61
Reach 1	1162	25 Year	106.13	105.64		0.07	0.01	18.3		100.52		3.11
Reach 1	1162	50 Year	106.67	106.1		0.08	0.05	21.8	0	137.34		3.34
Reach 1	1162	100 Year	107.23	106.66	106.02	0.08	0.15	44.37	0.8	176.18		3.36
Reach 1	1162	500 Year	107.94	106.95	106.96			61.51	7.85	261.16		4.46
Reach 1	1153	Fish Low Pass.	103.36	103.36	103.17	0.02	0	8.11		0.13		0.09
Reach 1	1153	Fish High Pass.	103.81	103.79	103.47	0.19	0.01	12.15		3.66		0.62
Reach 1	1153	2 Year	104.81	104.65	104.19	0.35	0.02	14.63		31.15		1.78
Reach 1	1153	3 Year	105.04	104.83	104.35	0.38	0.02	15.12		40.7		2.02
Reach 1	1153	5 Year	105.23	104.97	104.5	0.4	0.02	15.53		49.9		2.23
Reach 1	1153	10 Year	105.53	105.2	104.74	0.43	0.02	16.17		66.54		2.57
Reach 1	1153	25 Year	106.05	105.53	105.17	0.47	0.01	17.12		100.52		3.21
Reach 1	1153	50 Year	106.53	105.8	105.57	0.5	0.02	17.94		137.34		3.8
Reach 1	1153	100 Year	107.01	105.95	105.95	0.33	0.24	18.41		176.98	0	4.56
Reach 1	1153	500 Year	107.81	106.69	106.99	0.09	0.04	71.88	15.97	252.49	0.55	4.82

**MAD RIVER - PROPOSED CONDITION, DESIGN DISCHARGE**  
**HEC-RAS 4.1.0 - "Culvert Only" Output**

Reach	River Sta	Profile	E.G. US. (m)	W.S. US. (m)	E.G. IC (m)	E.G. OC (m)	Min El Weir Flow (m)	Q Culv Group (m3/s)	Q Weir (m3/s)	Delta WS (m)	Culv Vel US (m/s)	Culv Vel DS (m/s)
Reach 1	2098.5	Box Culvert Fish Low Pass.	112.22	112.32	112.22	112.22	114.9	0.1		0.39	0.34	0.44
Reach 1	2098.5	Box Culvert Fish High Pass.	112.47	112.47	112.46	112.47	114.9	2.75		0.32	1.24	1.31
Reach 1	2098.5	Box Culvert 2 Year	113.3	113.1	113.27	113.3	114.9	21.8		0.29	2.61	2.29
Reach 1	2098.5	Box Culvert 3 Year	113.52	113.32	113.48	113.52	114.9	28.6		0.34	2.85	2.46
Reach 1	2098.5	Box Culvert 5 Year	113.71	113.51	113.66	113.71	114.9	35		0.39	3.02	2.63
Reach 1	2098.5	Box Culvert 10 Year	114.04	113.82	113.98	114.04	114.9	46.72		0.93	3.31	3.37
Reach 1	2098.5	Box Culvert 25 Year	114.62	114.39	114.55	114.62	114.9	70.79		1.04	3.72	3.87
Reach 1	2098.5	Box Culvert 50 Year	115.05	114.74	115.01	115.05	114.9	90.11	6.17	0.88	3.98	4.04
Reach 1	2098.5	Box Culvert 100 Year	115.44	115.2	115.31	115.44	114.9	93.68	30.91	0.86	3.72	3.72
Reach 1	2098.5	Box Culvert 500 Year	116.19	116.01	115.83	116.19	114.9	79.89	108.42	0.62	3.17	3.17

**Culvert Output**

File Type Options Help

River: Mad River Profile: 100 Year Culv Group: Box Culvert

Reach: Reach 1 RS: 2098.5 Plan: PR\_DOT

Plan: PR\_DOT Mad River Reach 1 RS: 2098.5 Culv Group: Box Culvert Profile: 100 Year

Q Culv Group (m3/s)	93.68	Culv Full Len (m)	14.04
# Barrels	3	Culv Vel US (m/s)	3.72
Q Barrel (m3/s)	31.23	Culv Vel DS (m/s)	3.72
E.G. US. (m)	115.44	Culv Inv El Up (m)	111.59
W.S. US. (m)	115.20	Culv Inv El Dn (m)	111.41
E.G. DS (m)	114.68	Culv Frctn Ls (m)	0.25
W.S. DS (m)	114.34	Culv Exit Loss (m)	0.36
Delta EG (m)	0.75	Culv Entr Loss (m)	0.14
Delta WS (m)	0.86	Q Weir (m3/s)	30.91
E.G. IC (m)	115.31	Weir Sta Lft (m)	-20.10
E.G. OC (m)	115.44	Weir Sta Rgt (m)	35.60
Culvert Control	Outlet	Weir Submerg	0.00
Culv WS Inlet (m)	114.29	Weir Max Depth (m)	0.71
Culv WS Outlet (m)	114.11	Weir Avg Depth (m)	0.59
Culv Nml Depth (m)		Weir Flow Area (m2)	27.62
Culv Crt Depth (m)	2.44	Min El Weir Flow (m)	114.90

Errors, Warnings and Notes

Select Profile

**Culvert Output**

File Type Options Help

River: Mad River Profile: 500 Year Culv Group: Box Culvert

Reach: Reach 1 RS: 2098.5 Plan: PR\_DOT

Plan: PR\_DOT Mad River Reach 1 RS: 2098.5 Culv Group: Box Culvert Profile: 500 Year

Q Culv Group (m3/s)	79.89	Culv Full Len (m)	14.04
# Barrels	3	Culv Vel US (m/s)	3.17
Q Barrel (m3/s)	26.63	Culv Vel DS (m/s)	3.17
E.G. US. (m)	116.19	Culv Inv El Up (m)	111.59
W.S. US. (m)	116.01	Culv Inv El Dn (m)	111.41
E.G. DS (m)	115.66	Culv Frctn Ls (m)	0.18
W.S. DS (m)	115.39	Culv Exit Loss (m)	0.24
Delta EG (m)	0.52	Culv Entr Loss (m)	0.10
Delta WS (m)	0.62	Q Weir (m3/s)	108.42
E.G. IC (m)	115.83	Weir Sta Lft (m)	-20.10
E.G. OC (m)	116.19	Weir Sta Rgt (m)	35.60
Culvert Control	Outlet	Weir Submerg	0.39
Culv WS Inlet (m)	114.29	Weir Max Depth (m)	1.45
Culv WS Outlet (m)	114.11	Weir Avg Depth (m)	1.18
Culv Nml Depth (m)		Weir Flow Area (m2)	66.00
Culv Crt Depth (m)	2.25	Min El Weir Flow (m)	114.90

Errors, Warnings and Notes

Select Profile

**MAD RIVER - EXISTING CONDITION, DESIGN DISCHARGE**  
**HEC-RAS 4.1.0 - "Standard Table 1" Output**

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2409	Fish Low Pass.	0.1	116.37	116.47	116.45	116.48	0.011967	0.42	0.25	4.07	0.55
Reach 1	2409	Fish High Pass.	2.75	116.37	116.75	116.71	116.81	0.013721	1.04	2.64	12.33	0.72
Reach 1	2409	2 Year	21.8	116.37	117.22	117.22	117.54	0.019185	2.5	8.72	13.73	1
Reach 1	2409	3 Year	28.6	116.37	117.35	117.35	117.72	0.018331	2.72	10.52	13.99	1
Reach 1	2409	5 Year	35	116.37	117.46	117.46	117.89	0.017371	2.88	12.17	14.17	0.99
Reach 1	2409	10 Year	46.72	116.37	117.65	117.65	118.16	0.016984	3.17	14.76	14.45	1
Reach 1	2409	25 Year	70.79	116.37	117.98	117.98	118.64	0.016227	3.59	19.72	14.89	1
Reach 1	2409	50 Year	96.28	116.37	118.29	118.29	119.09	0.016573	3.97	24.25	15.11	1
Reach 1	2409	100 Year	124.59	116.37	118.59	118.59	119.54	0.016952	4.31	28.89	15.33	1
Reach 1	2409	500 Year	188.31	116.37	119.22	119.22	120.42	0.016396	4.86	39.12	20.62	0.99
Reach 1	2337	Fish Low Pass.	0.1	114.97	115.07	115.07	115.09	0.036521	0.63	0.16	3.34	0.92
Reach 1	2337	Fish High Pass.	2.75	114.97	115.32	115.32	115.41	0.028849	1.37	2.01	10.99	1.02
Reach 1	2337	2 Year	21.8	114.97	115.86	115.85	116.16	0.017991	2.43	8.96	14.21	0.98
Reach 1	2337	3 Year	28.6	114.97	115.96	115.98	116.35	0.02006	2.76	10.36	14.7	1.05
Reach 1	2337	5 Year	35	114.97	116.05	116.09	116.5	0.021099	3	11.67	15.16	1.09
Reach 1	2337	10 Year	46.72	114.97	116.2	116.3	116.76	0.022096	3.33	14.05	16.14	1.14
Reach 1	2337	25 Year	70.79	114.97	116.44	116.62	117.2	0.024337	3.85	18.66	22.98	1.22
Reach 1	2337	50 Year	96.28	114.97	116.63	116.89	117.59	0.024998	4.37	23.13	25.1	1.28
Reach 1	2337	100 Year	124.59	114.97	116.8	117.14	117.98	0.02585	4.87	27.68	27.07	1.33
Reach 1	2337	500 Year	188.31	114.97	117.12	117.7	118.77	0.028283	5.84	36.65	30.64	1.44
Reach 1	2280	Fish Low Pass.	0.1	114.06	114.17	114.13	114.17	0.003381	0.24	0.42	6.11	0.3
Reach 1	2280	Fish High Pass.	2.75	114.06	114.48	114.37	114.52	0.005817	0.87	3.17	10.09	0.49
Reach 1	2280	2 Year	21.8	114.06	115.09	114.96	115.34	0.011301	2.22	9.8	12.86	0.81
Reach 1	2280	3 Year	28.6	114.06	115.23	115.12	115.53	0.011587	2.45	11.69	13.57	0.84
Reach 1	2280	5 Year	35	114.06	115.37	115.25	115.7	0.011227	2.58	13.61	14.63	0.83
Reach 1	2280	10 Year	46.72	114.06	115.67	115.45	116.01	0.008867	2.61	18.36	17.03	0.75
Reach 1	2280	25 Year	70.79	114.06	116.06	115.8	116.49	0.00811	2.95	26.42	24.67	0.74
Reach 1	2280	50 Year	96.28	114.06	116.32	116.14	116.88	0.00887	3.38	33.49	29.98	0.79
Reach 1	2280	100 Year	124.59	114.06	116.47	116.47	117.23	0.011093	3.97	38.36	32.88	0.89
Reach 1	2280	500 Year	188.31	114.06	117.19	117.26	117.86	0.0074	3.94	68.84	60.15	0.76
Reach 1	2238	Fish Low Pass.	0.1	113.86	113.93	113.91	113.93	0.012829	0.33	0.31	7.89	0.53
Reach 1	2238	Fish High Pass.	2.75	113.86	114.17	114.11	114.21	0.009988	0.9	3.04	13.95	0.62
Reach 1	2238	2 Year	21.8	113.86	114.81	114.58	114.95	0.006519	1.65	13.25	17.71	0.61
Reach 1	2238	3 Year	28.6	113.86	115	114.69	115.15	0.005873	1.71	16.69	18.59	0.58
Reach 1	2238	5 Year	35	113.86	115.17	114.8	115.33	0.005477	1.75	19.99	19.44	0.55
Reach 1	2238	10 Year	46.72	113.86	115.5	114.96	115.66	0.005762	1.74	26.89	22.55	0.51
Reach 1	2238	25 Year	70.79	113.86	115.96	115.26	116.14	0.005301	1.87	38.06	25.65	0.48
Reach 1	2238	50 Year	96.28	113.86	116.24	115.55	116.47	0.005977	2.12	46.66	37.83	0.51
Reach 1	2238	100 Year	124.59	113.86	116.48	115.79	116.74	0.006099	2.3	56.54	49.75	0.52
Reach 1	2238	500 Year	188.31	113.86	116.85	116.46	117.17	0.005943	2.55	77.15	58.84	0.53
Reach 1	2207	Fish Low Pass.	0.1	113.6	113.69	113.67	113.7	0.004956	0.22	0.48	11.01	0.33
Reach 1	2207	Fish High Pass.	2.75	113.6	113.92	113.83	113.95	0.006794	0.82	3.37	13.38	0.52
Reach 1	2207	2 Year	21.8	113.6	114.61	114.31	114.75	0.006383	1.62	13.48	15.8	0.56
Reach 1	2207	3 Year	28.6	113.6	114.81	114.44	114.96	0.006305	1.72	16.67	16.49	0.54
Reach 1	2207	5 Year	35	113.6	114.98	114.54	115.15	0.006254	1.79	19.6	17.13	0.53
Reach 1	2207	10 Year	46.72	113.6	115.3	114.73	115.48	0.005685	1.85	25.37	19.83	0.5
Reach 1	2207	25 Year	70.79	113.6	115.74	115.05	115.96	0.005966	2.09	35.13	25.4	0.51
Reach 1	2207	50 Year	96.28	113.6	115.97	115.35	116.26	0.006959	2.45	42.12	38.31	0.56
Reach 1	2207	100 Year	124.59	113.6	116.16	115.65	116.51	0.007596	2.73	50.31	62.5	0.59
Reach 1	2207	500 Year	188.31	113.6	116.73	116.39	117.01	0.004068	2.33	83.07	72.72	0.45
Reach 1	2202	Fish Low Pass.	0.1	113.57	113.63	113.63	113.65	0.042152	0.53	0.19	5.79	0.93
Reach 1	2202	Fish High Pass.	2.75	113.57	113.87	113.81	113.91	0.010518	0.93	2.95	13.43	0.63
Reach 1	2202	2 Year	21.8	113.57	114.58	114.29	114.71	0.006327	1.61	13.57	16.31	0.56
Reach 1	2202	3 Year	28.6	113.57	114.78	114.42	114.93	0.006181	1.69	16.91	17.09	0.54
Reach 1	2202	5 Year	35	113.57	114.96	114.52	115.11	0.006054	1.75	19.98	17.78	0.53
Reach 1	2202	10 Year	46.72	113.57	115.28	114.7	115.44	0.005663	1.8	25.89	19.11	0.49
Reach 1	2202	25 Year	70.79	113.57	115.72	115.01	115.93	0.006167	2.04	34.86	23.12	0.5
Reach 1	2202	50 Year	96.28	113.57	115.94	115.3	116.23	0.007662	2.4	40.78	38.43	0.56
Reach 1	2202	100 Year	124.59	113.57	116.1	115.58	116.48	0.009279	2.75	46.39	64.23	0.62
Reach 1	2202	500 Year	188.31	113.57	116.68	116.24	116.98	0.005041	2.32	78.19	70.18	0.47
Reach 1	2168	Fish Low Pass.	0.1	113.02	113.14	113.1	113.14	0.007442	0.33	0.31	5.15	0.43
Reach 1	2168	Fish High Pass.	2.75	113.02	113.43	113.37	113.51	0.012994	1.24	2.22	7.64	0.73
Reach 1	2168	2 Year	21.8	113.02	114.28	114.05	114.45	0.009614	1.81	12.07	15.28	0.65
Reach 1	2168	3 Year	28.6	113.02	114.5	114.19	114.67	0.009035	1.84	15.57	16.56	0.6



HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2168	5 Year	35	113.02	114.69	114.31	114.87	0.008548	1.85	18.87	17.68	0.57
Reach 1	2168	10 Year	46.72	113.02	115.05	114.49	115.22	0.007419	1.82	25.68	19.96	0.51
Reach 1	2168	25 Year	70.79	113.02	115.5	114.82	115.7	0.007155	1.99	36.24	41.14	0.5
Reach 1	2168	50 Year	96.28	113.02	115.73	115.11	115.96	0.007156	2.17	46.45	59.95	0.51
Reach 1	2168	100 Year	124.59	113.02	115.91	115.57	116.17	0.007016	2.29	56.89	65.28	0.51
Reach 1	2168	500 Year	188.31	113.02	116.62	115.97	116.83	0.002878	1.8	97.38	65.28	0.35
Reach 1	2130	Fish Low Pass.	0.1	112.43	112.54	112.54	112.56	0.045383	0.75	0.14	2.58	1.04
Reach 1	2130	Fish High Pass.	2.75	112.43	112.87	112.82	112.95	0.016678	1.31	2.11	7.51	0.79
Reach 1	2130	2 Year	21.8	112.43	113.64	113.52	113.94	0.017984	2.44	8.95	10.19	0.83
Reach 1	2130	3 Year	28.6	112.43	113.83	113.69	114.18	0.018115	2.61	10.94	10.83	0.83
Reach 1	2130	5 Year	35	112.43	114.02	113.84	114.39	0.01871	2.67	13.13	11.96	0.81
Reach 1	2130	10 Year	46.72	112.43	114.59	114.1	114.83	0.01437	2.2	21.25	17.01	0.63
Reach 1	2130	25 Year	70.79	112.43	115.04	114.53	115.32	0.013853	2.35	30.72	38.67	0.61
Reach 1	2130	50 Year	96.28	112.43	115.47	114.86	115.67	0.007135	1.99	49.73	92.27	0.46
Reach 1	2130	100 Year	124.59	112.43	115.67	115.37	115.9	0.006705	2.05	59.75	106.67	0.45
Reach 1	2130	500 Year	188.31	112.43	116.54	115.62	116.73	0.002146	1.46	105.54	106.67	0.27
Reach 1	2116	Fish Low Pass.	0.1	112.21	112.4	112.33	112.41	0.002865	0.28	0.37	3.77	0.29
Reach 1	2116	Fish High Pass.	2.75	112.21	112.78	112.64	112.83	0.005536	0.92	2.99	8.41	0.49
Reach 1	2116	2 Year	21.8	112.21	113.44	113.31	113.73	0.014258	2.39	9.13	10.32	0.81
Reach 1	2116	3 Year	28.6	112.21	113.58	113.48	113.95	0.016606	2.7	10.59	10.74	0.87
Reach 1	2116	5 Year	35	112.21	113.7	113.62	114.14	0.018311	2.94	11.9	11.09	0.91
Reach 1	2116	10 Year	46.72	112.21	114.48	113.86	114.72	0.005528	2.2	22.36	17.3	0.53
Reach 1	2116	25 Year	70.79	112.21	114.82	114.27	115.19	0.006751	2.74	28.99	21.4	0.6
Reach 1	2116	50 Year	96.28	112.21	114.84	114.66	115.51	0.012061	3.68	29.44	22.81	0.8
Reach 1	2116	100 Year	124.59	112.21	115.55	115.36	115.83	0.004118	2.6	62.16	124.78	0.49
Reach 1	2116	500 Year	188.31	112.21	116.55	115.65	116.69	0.001388	1.84	115.81	136.78	0.3
Reach 1	2095.5	Bridge										
Reach 1	2079	Fish Low Pass.	0.1	111.29	111.43	111.4	111.45	0.015513	0.58	0.18	1.82	0.59
Reach 1	2079	Fish High Pass.	2.75	111.29	111.95	111.85	112.04	0.017203	1.38	2	5.13	0.7
Reach 1	2079	2 Year	21.8	111.29	112.84	112.65	113.06	0.013222	2.07	10.51	12.14	0.71
Reach 1	2079	3 Year	28.6	111.29	113.08	112.8	113.31	0.010764	2.1	13.6	12.82	0.65
Reach 1	2079	5 Year	35	111.29	113.26	112.92	113.51	0.01033	2.2	15.88	13.3	0.64
Reach 1	2079	10 Year	46.72	111.29	113.19	113.13	113.69	0.021609	3.11	15.01	13.12	0.93
Reach 1	2079	25 Year	70.79	111.29	113.51	113.51	114.19	0.024512	3.68	19.24	13.98	1
Reach 1	2079	50 Year	96.28	111.29	113.89	113.85	114.66	0.022601	3.88	24.8	15.04	0.97
Reach 1	2079	100 Year	124.59	111.29	115.07	114.18	115.38	0.005086	2.61	63.72	151.88	0.5
Reach 1	2079	500 Year	188.31	111.29	116.5	115.06	116.63	0.001542	1.89	143.79	222.74	0.29
Reach 1	2067	Fish Low Pass.	0.1	111.17	111.37	111.3	111.37	0.003752	0.33	0.31	3.02	0.33
Reach 1	2067	Fish High Pass.	2.75	111.17	111.88	111.68	111.93	0.005415	1.01	2.71	9.12	0.5
Reach 1	2067	2 Year	21.8	111.17	112.72	112.5	112.95	0.006807	2.21	11.41	92.89	0.65
Reach 1	2067	3 Year	28.6	111.17	112.67	112.67	113.12	0.013778	3.05	10.73	90.8	0.92
Reach 1	2067	5 Year	35	111.17	112.81	112.81	113.31	0.013496	3.26	12.59	96.09	0.93
Reach 1	2067	10 Year	46.72	111.17	113.1	113.1	113.49	0.008985	3.07	21.88	101.19	0.79
Reach 1	2067	25 Year	70.79	111.17	113.41	113.37	113.86	0.008816	3.43	30.24	102.69	0.8
Reach 1	2067	50 Year	96.28	111.17	114.2	113.6	114.27	0.001221	1.62	98.49	107.92	0.32
Reach 1	2067	100 Year	124.59	111.17	115.19	113.83	115.24	0.000548	1.34	149.78	115.99	0.22
Reach 1	2067	500 Year	188.31	111.17	116.53	114	116.58	0.00036	1.34	226.21	164.74	0.19
Reach 1	2020	Fish Low Pass.	0.13	110.75	110.82	110.82	110.86	0.042387	0.8	0.16	22.05	1.03
Reach 1	2020	Fish High Pass.	3.66	110.75	111.2	111.2	111.33	0.025705	1.62	2.26	36.08	1.02
Reach 1	2020	2 Year	31.15	110.75	111.95	111.95	112.34	0.017921	2.75	11.32	108.86	1.01
Reach 1	2020	3 Year	40.7	110.75	112.35	112.11	112.37	0.000466	0.56	65.42	118.37	0.17
Reach 1	2020	5 Year	49.9	110.75	112.57	112.11	112.59	0.000407	0.58	77.18	119.66	0.16
Reach 1	2020	10 Year	66.54	110.75	112.94	112.11	112.96	0.000346	0.64	96.66	121.95	0.16
Reach 1	2020	25 Year	100.52	110.75	113.59	112.11	113.62	0.000287	0.72	132.9	128.61	0.15
Reach 1	2020	50 Year	137.34	110.75	114.2	112.11	114.23	0.000233	0.76	186.38	134.47	0.14
Reach 1	2020	100 Year	176.98	110.75	115.19	112.15	115.21	0.000148	0.74	256.48	145.44	0.12
Reach 1	2020	500 Year	269.01	110.75	116.53	112.5	116.56	0.000127	0.84	356.51	175.92	0.12
Reach 1	2004	Fish Low Pass.	0.13	109.92	110.33	110.01	110.33	0.000009	0.03	4.53	19.24	0.02
Reach 1	2004	Fish High Pass.	3.66	109.92	110.93	110.24	110.94	0.0001	0.21	18.15	30.61	0.08
Reach 1	2004	2 Year	31.15	109.92	112.09	110.74	112.1	0.000167	0.5	67.66	78.3	0.11
Reach 1	2004	3 Year	40.7	109.92	112.35	110.88	112.36	0.000167	0.54	80.98	90.93	0.12
Reach 1	2004	5 Year	49.9	109.92	112.57	111	112.58	0.000164	0.57	95.67	94.42	0.12
Reach 1	2004	10 Year	66.54	109.92	112.94	111.15	112.95	0.00016	0.62	118.73	95.68	0.12
Reach 1	2004	25 Year	100.52	109.92	113.59	111.47	113.61	0.000152	0.7	159.62	99.29	0.12
Reach 1	2004	50 Year	137.34	109.92	114.2	111.66	114.22	0.000147	0.76	198.15	103.55	0.12
Reach 1	2004	100 Year	176.98	109.92	115.19	111.84	115.21	0.000104	0.74	260.5	122.07	0.11

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2004	500 Year	269.01	109.92	116.53	112.2	116.56	0.000098	0.84	345.01	164.66	0.11
Reach 1	1983	Fish Low Pass.	0.13	110.09	110.33	110.16	110.33	0.000113	0.08	1.57	9.35	0.06
Reach 1	1983	Fish High Pass.	3.66	110.09	110.92	110.42	110.93	0.000508	0.4	9.2	15.22	0.16
Reach 1	1983	2 Year	31.15	110.09	112.04	111.09	112.08	0.000862	0.97	34.74	33.07	0.25
Reach 1	1983	3 Year	40.7	110.09	112.29	111.23	112.34	0.000778	1.02	46.5	57.08	0.24
Reach 1	1983	5 Year	49.9	110.09	112.53	111.35	112.57	0.000629	0.99	58.6	69.05	0.22
Reach 1	1983	10 Year	66.54	110.09	112.9	111.6	112.94	0.000479	0.97	78.02	75.85	0.2
Reach 1	1983	25 Year	100.52	110.09	113.55	111.95	113.6	0.000347	0.96	111.99	78.53	0.18
Reach 1	1983	50 Year	137.34	110.09	114.16	112.37	114.21	0.000286	0.99	143.78	84.09	0.16
Reach 1	1983	100 Year	176.98	110.09	115.16	112.55	115.2	0.000171	0.9	195.59	122.7	0.13
Reach 1	1983	500 Year	269.01	110.09	116.5	112.88	116.55	0.000143	0.97	265.11	146.31	0.13
Reach 1	1953.5	Bridge										
Reach 1	1927	Fish Low Pass.	0.13	110.06	110.19	110.16	110.2	0.013268	0.49	0.26	3.7	0.59
Reach 1	1927	Fish High Pass.	3.66	110.06	110.77	110.51	110.8	0.002372	0.7	5.22	11.75	0.34
Reach 1	1927	2 Year	31.15	110.06	111.67	111.23	111.83	0.005167	1.75	17.84	16.72	0.54
Reach 1	1927	3 Year	40.7	110.06	111.88	111.4	112.06	0.005606	1.9	21.41	18.43	0.56
Reach 1	1927	5 Year	49.9	110.06	112.05	111.55	112.26	0.005704	2.01	24.81	19.56	0.57
Reach 1	1927	10 Year	66.54	110.06	112.35	111.8	112.59	0.005598	2.16	30.84	22.56	0.57
Reach 1	1927	25 Year	100.52	110.06	112.87	112.19	113.15	0.004521	2.37	44.06	29.87	0.54
Reach 1	1927	50 Year	137.34	110.06	113.33	112.55	113.66	0.004027	2.58	56.74	36.54	0.52
Reach 1	1927	100 Year	176.98	110.06	113.77	112.87	114.14	0.003764	2.78	69.02	44.75	0.52
Reach 1	1927	500 Year	269.01	110.06	114.69	113.46	115.14	0.003178	3.07	96.72	62.93	0.5
Reach 1	1916.5	Bridge										
Reach 1	1900	Fish Low Pass.	0.13	109.69	110.16	109.84	110.16	0.000069	0.08	1.54	6.09	0.05
Reach 1	1900	Fish High Pass.	3.66	109.69	110.72	110.24	110.74	0.001086	0.57	6.42	10.9	0.24
Reach 1	1900	2 Year	31.15	109.69	111.38	111.1	111.6	0.007819	2.07	15.06	16.74	0.7
Reach 1	1900	3 Year	40.7	109.69	111.58	111.29	111.82	0.007341	2.19	18.57	18.4	0.7
Reach 1	1900	5 Year	49.9	109.69	111.75	111.47	112.02	0.006707	2.29	21.83	18.99	0.68
Reach 1	1900	10 Year	66.54	109.69	112.04	111.68	112.34	0.005965	2.43	27.41	19.95	0.66
Reach 1	1900	25 Year	100.52	109.69	112.52	112.04	112.89	0.005356	2.69	37.3	21.37	0.65
Reach 1	1900	50 Year	137.34	109.69	112.88	112.37	113.35	0.005582	3.03	45.33	22.46	0.68
Reach 1	1900	100 Year	176.98	109.69	113.17	112.7	113.76	0.006356	3.41	51.84	23.33	0.73
Reach 1	1900	500 Year	269.01	109.69	113.41	113.34	114.52	0.011043	4.67	57.65	25.17	0.96
Reach 1	1871	Fish Low Pass.	0.13	109.92	110.14	110.06	110.15	0.003382	0.33	0.38	6.6	0.32
Reach 1	1871	Fish High Pass.	3.66	109.92	110.53	110.46	110.62	0.012487	1.32	2.77	19.74	0.74
Reach 1	1871	2 Year	31.15	109.92	111.28	110.83	111.37	0.003199	1.42	23.91	24.59	0.45
Reach 1	1871	3 Year	40.7	109.92	111.5	110.95	111.6	0.002818	1.52	29.36	25.2	0.44
Reach 1	1871	5 Year	49.9	109.92	111.69	111.05	111.8	0.002591	1.6	34.23	25.7	0.43
Reach 1	1871	10 Year	66.54	109.92	112	111.22	112.12	0.00246	1.78	43.37	33.44	0.43
Reach 1	1871	25 Year	100.52	109.92	112.52	111.52	112.66	0.002108	1.96	61.63	35.89	0.42
Reach 1	1871	50 Year	137.34	109.92	112.91	111.85	113.09	0.002152	2.2	75.98	37.11	0.43
Reach 1	1871	100 Year	176.98	109.92	113.22	112.15	113.45	0.002365	2.49	87.44	38.09	0.46
Reach 1	1871	500 Year	269.01	109.92	113.55	112.63	113.96	0.003692	3.34	99.8	39.15	0.59
Reach 1	1837	Fish Low Pass.	0.13	109.77	109.84	109.84	109.86	0.05171	0.56	0.22	7.47	1.04
Reach 1	1837	Fish High Pass.	3.66	109.77	110.1	110.06	110.16	0.01403	1.14	3.21	15.37	0.8
Reach 1	1837	2 Year	31.15	109.77	111.21	110.62	111.29	0.001758	1.24	26.39	29.57	0.36
Reach 1	1837	3 Year	40.7	109.77	111.44	110.76	111.53	0.001571	1.32	32.68	35.87	0.35
Reach 1	1837	5 Year	49.9	109.77	111.64	110.88	111.73	0.001458	1.39	38.27	38.92	0.35
Reach 1	1837	10 Year	66.54	109.77	111.95	111.09	112.06	0.001358	1.51	47.28	42.31	0.35
Reach 1	1837	25 Year	100.52	109.77	112.47	111.39	112.61	0.001278	1.72	63.18	47.95	0.35
Reach 1	1837	50 Year	137.34	109.77	112.9	111.66	113.03	0.001058	1.74	99.67	52.61	0.33
Reach 1	1837	100 Year	176.98	109.77	113.22	111.93	113.38	0.001126	1.93	116.8	53.58	0.34
Reach 1	1837	500 Year	269.01	109.77	113.58	112.46	113.84	0.001681	2.52	135.91	54.57	0.43
Reach 1	1778	Fish Low Pass.	0.13	108.97	109.46	109.11	109.46	0.000039	0.07	1.9	6.71	0.04
Reach 1	1778	Fish High Pass.	3.66	108.97	110.01	109.5	110.02	0.000951	0.54	6.79	11.36	0.22
Reach 1	1778	2 Year	31.15	108.97	111.12	110.33	111.2	0.001603	1.29	27.16	29.02	0.34
Reach 1	1778	3 Year	40.7	108.97	111.36	110.51	111.45	0.001482	1.35	34.01	39.16	0.34
Reach 1	1778	5 Year	49.9	108.97	111.57	110.67	111.66	0.0014	1.4	40.05	48.33	0.33
Reach 1	1778	10 Year	66.54	108.97	111.89	111.01	111.99	0.00133	1.49	49.7	53.1	0.33
Reach 1	1778	25 Year	100.52	108.97	112.44	111.33	112.54	0.001053	1.56	79.96	68.14	0.31
Reach 1	1778	50 Year	137.34	108.97	112.86	111.6	112.97	0.000996	1.67	102.51	69.73	0.31
Reach 1	1778	100 Year	176.98	108.97	113.22	111.85	113.31	0.000793	1.61	150.66	71.08	0.28
Reach 1	1778	500 Year	269.01	108.97	113.58	112.41	113.73	0.001148	2.07	176.7	72.45	0.34
Reach 1	1748	Fish Low Pass.	0.13	109.06	109.46	109.17	109.46	0.000092	0.09	1.37	5.72	0.06

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	1748	Fish High Pass.	3.66	109.06	109.96	109.57	109.98	0.001744	0.68	5.35	9.87	0.3
Reach 1	1748	2 Year	31.15	109.06	110.95	110.43	111.11	0.003734	1.79	17.58	17.23	0.5
Reach 1	1748	3 Year	40.7	109.06	111.15	110.6	111.36	0.004068	2.02	20.45	24.44	0.53
Reach 1	1748	5 Year	49.9	109.06	111.32	110.76	111.57	0.004409	2.21	22.96	30.46	0.56
Reach 1	1748	10 Year	66.54	109.06	111.56	111.03	111.89	0.00489	2.55	26.82	37.77	0.6
Reach 1	1748	25 Year	100.52	109.06	111.93	111.48	112.43	0.00597	3.17	33.3	61.65	0.68
Reach 1	1748	50 Year	137.34	109.06	112.27	111.88	112.86	0.006075	3.53	49.39	78.68	0.7
Reach 1	1748	100 Year	176.98	109.06	112.55	112.51	113.2	0.006271	3.83	62.51	79.73	0.73
Reach 1	1748	500 Year	269.01	109.06	113.48	113	113.68	0.001902	2.55	175.61	83.75	0.42
Reach 1	1689	Fish Low Pass.	0.13	109.33	109.44	109.4	109.44	0.003946	0.25	0.51	8.25	0.32
Reach 1	1689	Fish High Pass.	3.66	109.33	109.76	109.63	109.8	0.00617	0.92	3.98	12.36	0.52
Reach 1	1689	2 Year	31.15	109.33	110.3	110.3	110.68	0.017539	2.73	11.39	14.86	1
Reach 1	1689	3 Year	40.7	109.33	110.46	110.46	110.9	0.016859	2.94	13.83	15.64	1
Reach 1	1689	5 Year	49.9	109.33	110.6	110.6	111.09	0.016395	3.08	16.2	16.97	1
Reach 1	1689	10 Year	66.54	109.33	110.83	110.83	111.38	0.015844	3.29	20.25	21.91	1
Reach 1	1689	25 Year	100.52	109.33	111.22	111.22	111.88	0.014942	3.59	28.02	27.22	1
Reach 1	1689	50 Year	137.34	109.33	111.57	111.57	112.31	0.01405	3.82	36.15	35.31	0.99
Reach 1	1689	100 Year	176.98	109.33	111.92	111.92	112.7	0.011345	3.94	47.84	49.6	0.92
Reach 1	1689	500 Year	269.01	109.33	112.5	112.5	113.39	0.009494	4.32	73.46	76.34	0.88
Reach 1	1620	Fish Low Pass.	0.13	108.64	108.73	108.73	108.74	0.058654	0.61	0.21	6.46	1.09
Reach 1	1620	Fish High Pass.	3.66	108.64	108.91	108.91	108.99	0.029726	1.23	2.98	19.6	1
Reach 1	1620	2 Year	31.15	108.64	109.56	109.37	109.71	0.007647	1.73	17.98	25.26	0.66
Reach 1	1620	3 Year	40.7	108.64	109.74	109.49	109.91	0.006425	1.8	22.62	26.31	0.62
Reach 1	1620	5 Year	49.9	108.64	109.89	109.59	110.07	0.005795	1.87	26.74	27.22	0.6
Reach 1	1620	10 Year	66.54	108.64	110.15	109.75	110.34	0.005078	1.97	33.79	30.18	0.58
Reach 1	1620	25 Year	100.52	108.64	110.59	110.04	110.82	0.004192	2.14	47.5	39.86	0.55
Reach 1	1620	50 Year	137.34	108.64	111	110.3	111.26	0.003647	2.28	62.78	49.42	0.53
Reach 1	1620	100 Year	176.98	108.64	111.4	110.56	111.68	0.003192	2.38	79.72	56.27	0.51
Reach 1	1620	500 Year	269.01	108.64	112.22	111.1	112.53	0.002408	2.55	126.77	109.08	0.47
Reach 1	1573	Fish Low Pass.	0.13	107.41	108.06	107.48	108.06	0.000002	0.02	5.82	15.29	0.01
Reach 1	1573	Fish High Pass.	3.66	107.41	108.78	107.79	108.78	0.000093	0.22	16.94	19.55	0.07
Reach 1	1573	2 Year	31.15	107.41	109.54	108.45	109.58	0.000984	0.93	33.56	25.36	0.26
Reach 1	1573	3 Year	40.7	107.41	109.71	108.66	109.77	0.001148	1.07	37.94	25.77	0.28
Reach 1	1573	5 Year	49.9	107.41	109.86	108.79	109.93	0.001279	1.19	41.79	26.12	0.3
Reach 1	1573	10 Year	66.54	107.41	110.1	108.98	110.2	0.001464	1.38	48.24	26.71	0.33
Reach 1	1573	25 Year	100.52	107.41	110.53	109.36	110.68	0.001715	1.67	60.09	28.41	0.36
Reach 1	1573	50 Year	137.34	107.41	110.93	109.66	111.12	0.001864	1.92	71.77	31.09	0.39
Reach 1	1573	100 Year	176.98	107.41	111.32	109.93	111.55	0.001947	2.14	83.41	33.44	0.4
Reach 1	1573	500 Year	269.01	107.41	112.09	110.5	112.42	0.002005	2.55	107.57	61.29	0.43
Reach 1	1561.5		Inl Struct									
Reach 1	1550	Fish Low Pass.	0.13	106	107.12	106.08	107.12	0.000001	0.02	8.02	15.93	0.01
Reach 1	1550	Fish High Pass.	3.66	106	107.46	106.49	107.46	0.000156	0.29	12.66	30.09	0.1
Reach 1	1550	2 Year	31.15	106	108.21	107.35	108.3	0.001488	1.34	23.27	35.3	0.33
Reach 1	1550	3 Year	40.7	106	108.36	107.5	108.49	0.00192	1.61	25.31	35.99	0.38
Reach 1	1550	5 Year	49.9	106	108.48	107.64	108.66	0.002311	1.84	27.05	36.58	0.42
Reach 1	1550	10 Year	66.54	106	108.82	107.87	108.88	0.000846	1.08	61.63	38.9	0.25
Reach 1	1550	25 Year	100.52	106	109.22	108.29	109.31	0.001005	1.34	74.98	42.53	0.29
Reach 1	1550	50 Year	137.34	106	109.52	108.5	109.65	0.001223	1.61	85.25	58.4	0.32
Reach 1	1550	100 Year	176.98	106	109.77	108.5	109.95	0.001493	1.89	93.49	76.33	0.36
Reach 1	1550	500 Year	269.01	106	110.23	108.85	110.54	0.002065	2.47	109.05	87.07	0.44
Reach 1	1536	Fish Low Pass.	0.13	107	107.11	107.09	107.12	0.014202	0.42	0.3	5.53	0.58
Reach 1	1536	Fish High Pass.	3.66	107	107.37	107.34	107.43	0.016897	1.13	3.23	15.53	0.79
Reach 1	1536	2 Year	31.15	107	108.14	107.85	108.26	0.00718	1.49	20.96	29.27	0.53
Reach 1	1536	3 Year	40.7	107	108.31	107.96	108.44	0.006628	1.61	25.21	29.98	0.52
Reach 1	1536	5 Year	49.9	107	108.44	108.05	108.59	0.006602	1.75	28.52	30.54	0.53
Reach 1	1536	10 Year	66.54	107	108.67	108.21	108.82	0.006509	1.72	38.8	31.56	0.49
Reach 1	1536	25 Year	100.52	107	109.04	108.5	109.24	0.006739	1.98	50.81	34.01	0.51
Reach 1	1536	50 Year	137.34	107	109.32	108.69	109.58	0.007408	2.28	62.6	61.24	0.54
Reach 1	1536	100 Year	176.98	107	109.52	108.93	109.86	0.008599	2.61	71.81	73.16	0.59
Reach 1	1536	500 Year	269.01	107	109.9	109.47	110.42	0.010561	3.24	89.73	79.69	0.67
Reach 1	1523	Fish Low Pass.	0.13	106.62	106.71	106.71	106.73	0.039302	0.57	0.22	5.66	0.92
Reach 1	1523	Fish High Pass.	3.66	106.62	106.96	106.96	107.06	0.026658	1.4	2.6	12.79	0.99
Reach 1	1523	2 Year	31.15	106.62	107.6	107.6	107.96	0.025345	2.69	11.58	15.76	1
Reach 1	1523	3 Year	40.7	106.62	107.81	107.81	108.15	0.039199	2.57	15.85	23.32	0.99
Reach 1	1523	5 Year	49.9	106.62	107.91	107.91	108.29	0.039104	2.73	18.27	24.01	1
Reach 1	1523	10 Year	66.54	106.62	108.15	108.08	108.54	0.031376	2.75	24.18	25.67	0.91

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	1523	25 Year	100.52	106.62	108.59	108.38	108.98	0.023476	2.78	36.17	31.77	0.79
Reach 1	1523	50 Year	137.34	106.62	108.94	108.74	109.34	0.019222	2.84	53.36	62.43	0.73
Reach 1	1523	100 Year	176.98	106.62	109.21	109.03	109.62	0.017641	2.95	68.17	67.29	0.71
Reach 1	1523	500 Year	269.01	106.62	109.69	109.41	110.18	0.015858	3.28	95.06	72.9	0.7
Reach 1	1487	Fish Low Pass.	0.13	106.13	106.26	106.21	106.26	0.004538	0.27	0.46	7.15	0.34
Reach 1	1487	Fish High Pass.	3.66	106.13	106.49	106.41	106.53	0.008012	0.84	4.38	19.09	0.56
Reach 1	1487	2 Year	31.15	106.13	107.29	106.91	107.4	0.003952	1.47	21.19	23.03	0.49
Reach 1	1487	3 Year	40.7	106.13	107.49	107.03	107.62	0.00389	1.57	25.95	24.12	0.48
Reach 1	1487	5 Year	49.9	106.13	107.69	107.14	107.82	0.004268	1.62	30.79	25.99	0.48
Reach 1	1487	10 Year	66.54	106.13	107.98	107.33	108.13	0.004949	1.71	39.02	29.35	0.47
Reach 1	1487	25 Year	100.52	106.13	108.42	107.65	108.61	0.005169	1.9	54.48	57.1	0.47
Reach 1	1487	50 Year	137.34	106.13	108.82	107.96	109.01	0.004564	1.98	80.61	63.96	0.45
Reach 1	1487	100 Year	176.98	106.13	109.08	108.24	109.3	0.004935	2.17	97.32	65.55	0.47
Reach 1	1487	500 Year	269.01	106.13	109.55	108.84	109.84	0.005454	2.54	129.52	70.26	0.5
Reach 1	1425	Fish Low Pass.	0.13	105.6	105.67	105.66	105.68	0.028271	0.54	0.24	5.16	0.8
Reach 1	1425	Fish High Pass.	3.66	105.6	106.02	105.91	106.06	0.007184	0.93	3.92	13.39	0.55
Reach 1	1425	2 Year	31.15	105.6	106.99	106.54	107.12	0.005244	1.58	20.85	24.47	0.48
Reach 1	1425	3 Year	40.7	105.6	107.19	106.7	107.34	0.005209	1.7	25.96	25.9	0.48
Reach 1	1425	5 Year	49.9	105.6	107.36	106.84	107.52	0.005264	1.81	30.44	27.1	0.49
Reach 1	1425	10 Year	66.54	105.6	107.61	107.06	107.8	0.005598	2.01	37.24	29.01	0.5
Reach 1	1425	25 Year	100.52	105.6	107.98	107.4	108.25	0.006059	2.4	48.79	48.34	0.54
Reach 1	1425	50 Year	137.34	105.6	108.29	107.7	108.65	0.006731	2.79	59.89	73.7	0.59
Reach 1	1425	100 Year	176.98	105.6	108.51	107.99	108.91	0.007142	3.06	86.37	79.17	0.61
Reach 1	1425	500 Year	269.01	105.6	109.09	108.74	109.48	0.005988	3.21	134.1	85.14	0.58
Reach 1	1370	Fish Low Pass.	0.13	104.75	104.97	104.91	104.98	0.007114	0.47	0.27	2.48	0.46
Reach 1	1370	Fish High Pass.	3.66	104.75	105.43	105.36	105.53	0.012949	1.38	2.66	7.79	0.75
Reach 1	1370	2 Year	31.15	104.75	106.41	106.19	106.66	0.013774	2.22	14.07	15.66	0.73
Reach 1	1370	3 Year	40.7	104.75	106.64	106.37	106.91	0.012087	2.3	18.35	21.41	0.69
Reach 1	1370	5 Year	49.9	104.75	106.82	106.52	107.1	0.01133	2.41	22.81	29.08	0.67
Reach 1	1370	10 Year	66.54	104.75	107.01	106.83	107.36	0.011818	2.7	28.73	31.31	0.7
Reach 1	1370	25 Year	100.52	104.75	107.43	107.19	107.83	0.010323	2.97	43	42.86	0.68
Reach 1	1370	50 Year	137.34	104.75	107.69	107.5	108.19	0.011521	3.41	57.19	71.14	0.74
Reach 1	1370	100 Year	176.98	104.75	108.11	107.88	108.53	0.008403	3.28	94.63	104.89	0.65
Reach 1	1370	500 Year	269.01	104.75	109.03	108.4	109.22	0.003357	2.54	197.24	117.18	0.43
Reach 1	1330	Fish Low Pass.	0.13	104.35	104.46	104.44	104.48	0.020398	0.57	0.22	3.47	0.72
Reach 1	1330	Fish High Pass.	3.66	104.35	104.87	104.8	104.96	0.012526	1.36	2.7	7.92	0.74
Reach 1	1330	2 Year	31.15	104.35	105.9	105.66	106.14	0.010182	2.17	14.36	15.29	0.71
Reach 1	1330	3 Year	40.7	104.35	106.14	105.85	106.39	0.01123	2.23	18.22	21.07	0.69
Reach 1	1330	5 Year	49.9	104.35	106.33	106	106.6	0.011339	2.29	21.76	27.76	0.67
Reach 1	1330	10 Year	66.54	104.35	106.66	106.24	106.91	0.008093	2.27	33.03	31.67	0.59
Reach 1	1330	25 Year	100.52	104.35	107.21	106.64	107.46	0.005716	2.35	52.68	57.21	0.52
Reach 1	1330	50 Year	137.34	104.35	107.34	106.95	107.74	0.008441	2.98	58.39	69.27	0.64
Reach 1	1330	100 Year	176.98	104.35	108.08	107.24	108.25	0.003119	2.2	141.84	121.06	0.41
Reach 1	1330	500 Year	269.01	104.35	109.01	107.97	109.11	0.001461	1.81	262.76	139.25	0.29
Reach 1	1309	Fish Low Pass.	0.13	104.12	104.26	104.2	104.26	0.005764	0.38	0.33	3.68	0.4
Reach 1	1309	Fish High Pass.	3.66	104.12	104.66	104.56	104.73	0.009429	1.18	3.1	9.08	0.64
Reach 1	1309	2 Year	31.15	104.12	105.81	105.36	105.97	0.00462	1.76	17.66	18.87	0.54
Reach 1	1309	3 Year	40.7	104.12	106.06	105.55	106.23	0.003935	1.85	23.47	24.7	0.51
Reach 1	1309	5 Year	49.9	104.12	106.27	105.7	106.45	0.003534	1.94	28.69	25.96	0.5
Reach 1	1309	10 Year	66.54	104.12	106.59	105.96	106.8	0.003146	2.07	37.56	31.79	0.49
Reach 1	1309	25 Year	100.52	104.12	107.15	106.34	107.38	0.002642	2.26	60.85	67.78	0.47
Reach 1	1309	50 Year	137.34	104.12	107.22	106.68	107.62	0.004399	2.98	64.4	74.09	0.6
Reach 1	1309	100 Year	176.98	104.12	107.98	107	108.19	0.001978	2.39	141.68	103.19	0.42
Reach 1	1309	500 Year	269.01	104.12	108.93	107.43	109.07	0.001175	2.18	245.25	116.5	0.34
Reach 1	1277	Fish Low Pass.	0.13	103.81	104.01	103.96	104.02	0.011501	0.48	0.26	3.41	0.55
Reach 1	1277	Fish High Pass.	3.66	103.81	104.57	104.28	104.59	0.002058	0.69	5.32	11.02	0.32
Reach 1	1277	2 Year	31.15	103.81	105.79	105.06	105.86	0.001727	1.16	26.84	24.61	0.35
Reach 1	1277	3 Year	40.7	103.81	106.05	105.24	106.12	0.001701	1.22	33.52	27.48	0.35
Reach 1	1277	5 Year	49.9	103.81	106.26	105.37	106.35	0.001683	1.27	39.71	32.25	0.34
Reach 1	1277	10 Year	66.54	103.81	106.6	105.57	106.69	0.001618	1.35	53.69	58.25	0.32
Reach 1	1277	25 Year	100.52	103.81	107.19	105.91	107.28	0.001292	1.37	97.4	81.05	0.28
Reach 1	1277	50 Year	137.34	103.81	107.31	106.2	107.44	0.001963	1.73	107.43	85.96	0.35
Reach 1	1277	100 Year	176.98	103.81	108.02	106.52	108.11	0.001079	1.46	170.63	91.47	0.26
Reach 1	1277	500 Year	269.01	103.81	108.95	107.15	109.02	0.00081	1.45	254.8	106.55	0.23
Reach 1	1260.5	Bridge										

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	1246	Fish Low Pass.	0.13	103.7	103.92	103.76	103.92	0.000242	0.11	1.12	7.2	0.09
Reach 1	1246	Fish High Pass.	3.66	103.7	104.5	104.07	104.51	0.000908	0.53	6.91	11.47	0.22
Reach 1	1246	2 Year	31.15	103.7	105.69	104.82	105.78	0.001782	1.31	24.48	23.35	0.35
Reach 1	1246	3 Year	40.7	103.7	105.93	105	106.03	0.001787	1.45	30.26	31.9	0.36
Reach 1	1246	5 Year	49.9	103.7	106.12	105.15	106.25	0.001809	1.57	35.29	36.09	0.37
Reach 1	1246	10 Year	66.54	103.7	106.43	105.41	106.58	0.001874	1.77	43.24	41.66	0.38
Reach 1	1246	25 Year	100.52	103.7	106.61	105.86	106.9	0.003195	2.44	48.31	48.19	0.51
Reach 1	1246	50 Year	137.34	103.7	107	106.22	107.41	0.003666	2.89	59.27	78.5	0.56
Reach 1	1246	100 Year	176.98	103.7	107.73	106.55	107.98	0.001933	2.46	111.16	87.94	0.42
Reach 1	1246	500 Year	269.01	103.7	108.76	107.55	108.95	0.001209	2.31	184.39	102.6	0.35
Reach 1	1198.5	Bridge										
Reach 1	1162	Fish Low Pass.	0.13	103.32	103.4	103.4	103.42	0.053983	0.66	0.19	4.91	1.08
Reach 1	1162	Fish High Pass.	3.66	103.32	103.8		103.84	0.004296	0.83	4.39	11.86	0.44
Reach 1	1162	2 Year	31.15	103.32	104.69		104.87	0.005603	1.91	16.3	15.05	0.59
Reach 1	1162	3 Year	40.7	103.32	104.87		105.1	0.006195	2.14	19.06	15.66	0.62
Reach 1	1162	5 Year	49.9	103.32	105.02		105.29	0.006785	2.32	21.5	16.2	0.64
Reach 1	1162	10 Year	66.54	103.32	105.26		105.6	0.007793	2.62	25.42	17.02	0.68
Reach 1	1162	25 Year	100.52	103.32	105.66		106.15	0.009316	3.08	32.64	18.44	0.74
Reach 1	1162	50 Year	137.34	103.32	106.13		106.68	0.00954	3.3	41.64	22.5	0.73
Reach 1	1162	100 Year	176.98	103.32	106.67		107.24	0.007286	3.36	55.21	47.69	0.66
Reach 1	1162	500 Year	269.01	103.32	106.44	106.96	108.05	0.02303	5.63	48.21	29.47	1.15
Reach 1	1153	Fish Low Pass.	0.13	103.08	103.36	103.17	103.36	0.000123	0.09	1.44	8.11	0.07
Reach 1	1153	Fish High Pass.	3.66	103.08	103.79	103.47	103.81	0.001611	0.62	5.94	12.15	0.28
Reach 1	1153	2 Year	31.15	103.08	104.65	104.18	104.81	0.004238	1.78	17.53	14.63	0.52
Reach 1	1153	3 Year	40.7	103.08	104.83	104.35	105.04	0.004821	2.02	20.11	15.12	0.56
Reach 1	1153	5 Year	49.9	103.08	104.97	104.5	105.23	0.005307	2.23	22.36	15.53	0.59
Reach 1	1153	10 Year	66.54	103.08	105.2	104.75	105.53	0.00613	2.57	25.92	16.16	0.65
Reach 1	1153	25 Year	100.52	103.08	105.53	105.17	106.05	0.00818	3.2	31.45	17.14	0.75
Reach 1	1153	50 Year	137.34	103.08	105.82	105.57	106.54	0.010575	3.76	36.52	18.01	0.84
Reach 1	1153	100 Year	176.98	103.08	105.94	105.94	107.01	0.014787	4.56	38.78	18.39	1
Reach 1	1153	500 Year	269.01	103.08	106.99	106.99	107.7	0.006479	3.93	75.2	81.41	0.71
Reach 1	1107	Fish Low Pass.	0.13	103.28	103.33	103.33	103.34	0.055619	0.55	0.23	8.19	1.04
Reach 1	1107	Fish High Pass.	3.66	103.28	103.52	103.52	103.61	0.027953	1.36	2.69	14.47	1.01
Reach 1	1107	2 Year	31.15	103.28	104.1	104.1	104.44	0.018232	2.59	12.01	17.54	1
Reach 1	1107	3 Year	40.7	103.28	104.24	104.24	104.64	0.017334	2.79	14.57	18.3	1
Reach 1	1107	5 Year	49.9	103.28	104.36	104.36	104.81	0.016788	2.96	16.87	18.95	1
Reach 1	1107	10 Year	66.54	103.28	104.57	104.57	105.09	0.016	3.2	20.81	20.02	1
Reach 1	1107	25 Year	100.52	103.28	104.97	104.92	105.57	0.013609	3.44	29.22	22.23	0.96
Reach 1	1107	50 Year	137.34	103.28	105.35	105.25	106.01	0.011822	3.59	38.3	62.91	0.92
Reach 1	1107	100 Year	176.98	103.28	105.59	105.83	106.4	0.013229	3.99	44.62	116.13	0.97
Reach 1	1107	500 Year	269.01	103.28	106.04	106.04	106.38	0.005806	3.08	132.82	166.59	0.67
Reach 1	1003	Fish Low Pass.	0.13	101.7	101.78	101.75	101.78	0.005669	0.26	0.48	9.11	0.37
Reach 1	1003	Fish High Pass.	3.66	101.7	102.1	101.97	102.15	0.005715	0.93	3.93	11.16	0.5
Reach 1	1003	2 Year	31.15	101.7	102.99	102.68	103.2	0.006602	2.04	15.28	14.61	0.64
Reach 1	1003	3 Year	40.7	101.7	103.18	102.85	103.43	0.006841	2.24	18.13	15.35	0.66
Reach 1	1003	5 Year	49.9	101.7	103.35	103	103.64	0.006899	2.4	20.81	16	0.67
Reach 1	1003	10 Year	66.54	101.7	103.63	103.24	103.97	0.006907	2.62	25.42	17.07	0.68
Reach 1	1003	25 Year	100.52	101.7	104.12	103.67	104.56	0.006731	2.93	34.32	18.96	0.69
Reach 1	1003	50 Year	137.34	101.7	104.53	104.05	105.07	0.006718	3.24	42.5	38.17	0.71
Reach 1	1003	100 Year	176.98	101.7	104.89	104.41	105.53	0.00666	3.55	51.15	80.85	0.72
Reach 1	1003	500 Year	269.01	101.7	105.65	105.47	105.9	0.002632	2.67	178.24	189.05	0.48
Reach 1	894	Fish Low Pass.	0.13	100.2	100.35	100.35	100.39	0.041641	0.89	0.14	1.89	1.04
Reach 1	894	Fish High Pass.	3.66	100.2	100.78	100.78	100.93	0.025217	1.71	2.14	7.41	1.01
Reach 1	894	2 Year	31.15	100.2	101.65	101.62	102.06	0.01577	2.83	10.99	12.11	0.95
Reach 1	894	3 Year	40.7	100.2	101.86	101.81	102.32	0.014564	3.02	13.49	12.65	0.93
Reach 1	894	5 Year	49.9	100.2	102.03	101.96	102.54	0.013713	3.16	15.8	13.12	0.92
Reach 1	894	10 Year	66.54	100.2	102.32	102.23	102.9	0.012742	3.38	19.71	13.89	0.9
Reach 1	894	25 Year	100.52	100.2	102.84	102.69	103.53	0.011945	3.68	27.35	16.06	0.9
Reach 1	894	50 Year	137.34	100.2	103.32	103.13	104.08	0.010993	3.86	35.59	18.22	0.88
Reach 1	894	100 Year	176.98	100.2	103.72	103.51	104.57	0.010232	4.1	43.37	21.04	0.87
Reach 1	894	500 Year	269.01	100.2	104.58	104.58	105.39	0.006861	4.16	90.22	133.62	0.75
Reach 1	809	Fish Low Pass.	0.13	99.48	99.68	99.6	99.69	0.002611	0.28	0.45	4.42	0.28
Reach 1	809	Fish High Pass.	3.66	99.48	100.16	99.95	100.2	0.003801	0.86	4.24	9.93	0.42
Reach 1	809	2 Year	31.15	99.48	101.14		101.33	0.005069	1.93	16.11	13.35	0.56
Reach 1	809	3 Year	40.7	99.48	101.36		101.59	0.005209	2.13	19.07	13.72	0.58
Reach 1	809	5 Year	49.9	99.48	101.54		101.81	0.005441	2.32	21.55	14.03	0.6

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	809	10 Year	66.54	99.48	101.74		102.12	0.006747	2.73	24.34	14.37	0.67
Reach 1	809	25 Year	100.52	99.48	102.21		102.74	0.00736	3.21	31.35	15.18	0.71
Reach 1	809	50 Year	137.34	99.48	102.71	102.16	103.34	0.007074	3.51	39.13	16.23	0.71
Reach 1	809	100 Year	176.98	99.48	103.06	102.56	103.86	0.00756	3.96	44.93	17.18	0.75
Reach 1	809	500 Year	269.01	99.48	103.61	103.87	104.74	0.008761	4.81	73.51	82.92	0.84
Reach 1	714	Fish Low Pass.	0.13	98.89	99	99	99.03	0.046933	0.77	0.16	3.02	1.06
Reach 1	714	Fish High Pass.	3.66	98.89	99.3	99.3	99.43	0.025847	1.57	2.34	9.53	1.01
Reach 1	714	2 Year	31.15	98.89	100.05	100.05	100.49	0.017421	2.92	10.68	12.37	1
Reach 1	714	3 Year	40.7	98.89	100.24	100.24	100.74	0.016598	3.13	12.99	12.94	1
Reach 1	714	5 Year	49.9	98.89	100.41	100.4	100.95	0.015635	3.28	15.23	13.5	0.98
Reach 1	714	10 Year	66.54	98.89	100.91	100.65	101.36	0.009042	2.96	22.46	15.18	0.78
Reach 1	714	25 Year	100.52	98.89	101.51	101.09	102.01	0.007423	3.12	32.23	17.19	0.73
Reach 1	714	50 Year	137.34	98.89	102.13	101.51	102.64	0.006638	3.17	43.39	44.43	0.67
Reach 1	714	100 Year	176.98	98.89	102.39	101.89	103.07	0.00791	3.65	48.67	64.91	0.74
Reach 1	714	500 Year	269.01	98.89	102.4	102.78	103.63	0.015331	5.09	63.14	65.11	1.03

**MAD RIVER - EXISTING CONDITION, DESIGN DISCHARGE**  
**HEC-RAS 4.1.0 - "Six XS Bridge" Output**

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	2130	Fish Low Pass.	112.56	112.54	112.54	0.1	0.01	2.58		0.1		0.75
Reach 1	2130	Fish High Pass.	112.95	112.87	112.82	0.12	0.01	7.51		2.75		1.31
Reach 1	2130	2 Year	113.94	113.64	113.52	0.21	0	10.19		21.8		2.44
Reach 1	2130	3 Year	114.18	113.83	113.69	0.23	0	10.83		28.6		2.61
Reach 1	2130	5 Year	114.39	114.02	113.84	0.24	0.01	11.96		35		2.67
Reach 1	2130	10 Year	114.83	114.59	114.1	0.11	0	17.01		46.72		2.2
Reach 1	2130	25 Year	115.32	115.04	114.53	0.12	0.01	38.67	0.06	70.03	0.7	2.35
Reach 1	2130	50 Year	115.67	115.47	114.86	0.12	0.05	92.27	6.15	76.38	13.75	1.99
Reach 1	2130	100 Year	115.9	115.67	115.37	0.07	0	106.67	14.22	86.6	23.77	2.05
Reach 1	2130	500 Year	116.73	116.54	115.62	0.02	0.01	106.67	46.45	86.85	55.02	1.46
Reach 1	2116	Fish Low Pass.	112.41	112.4	112.33	0.14	0.01	3.77		0.1		0.28
Reach 1	2116	Fish High Pass.	112.83	112.78	112.64	0.16	0.01	8.41		2.75		0.92
Reach 1	2116	2 Year	113.73	113.44	113.31	0.28	0	10.32		21.8		2.39
Reach 1	2116	3 Year	113.95	113.58	113.48	0.28	0.02	10.74		28.6		2.7
Reach 1	2116	5 Year	114.14	113.7	113.62	0.28	0.04	11.09		35		2.94
Reach 1	2116	10 Year	114.72	114.48	113.86			17.3	0.34	46.23	0.14	2.2
Reach 1	2116	25 Year	115.19	114.82	114.27			21.4	1.65	68.59	0.55	2.74
Reach 1	2116	50 Year	115.51	114.84	114.66			22.81	2.35	93.13	0.8	3.68
Reach 1	2116	100 Year	115.83	115.55	115.36			124.78	17.57	87.67	19.35	2.6
Reach 1	2116	500 Year	116.69	116.55	115.65			136.78	52.62	83.78	51.91	1.84
Reach 1	2095.5 BR U	Fish Low Pass.	112.26	112.23	112.23			1.96		0.1		0.83
Reach 1	2095.5 BR U	Fish High Pass.	112.66	112.6	112.54	0.24	0.02	9.65		2.75		1.13
Reach 1	2095.5 BR U	2 Year	113.45	113.16	113.12	0.18	0.02	13.1		21.8		2.39
Reach 1	2095.5 BR U	3 Year	113.65	113.32	113.25	0.15	0.03	13.1		28.6		2.55
Reach 1	2095.5 BR U	5 Year	113.82	113.46	113.36	0.13	0.04	13.1		35		2.68
Reach 1	2095.5 BR U	10 Year	114.72	114.26	113.55					46.72		2.03
Reach 1	2095.5 BR U	25 Year	115.19	114.82	113.9				3.36	65.77	1.6	2.79
Reach 1	2095.5 BR U	50 Year	115.51	114.84	114.18				15.32	74.97	5.99	2.76
Reach 1	2095.5 BR U	100 Year	115.82	115.55	114.22			57.57	31.97	80.34	11.99	2.58
Reach 1	2095.5 BR U	500 Year	116.69	116.55	115.73			59	88.45	69.1	31.72	1.63
Reach 1	2095.5 BR D	Fish Low Pass.	111.96	111.94	111.94	0.57	0.01	2.82		0.1		0.69
Reach 1	2095.5 BR D	Fish High Pass.	112.4	112.27	112.27	0.29	0.02	6.6		2.75		1.6
Reach 1	2095.5 BR D	2 Year	113.25	112.99	112.9	0.17	0.02	13.1		21.8		2.22
Reach 1	2095.5 BR D	3 Year	113.47	113.2	113.03	0.14	0.02	13.1		28.6		2.28
Reach 1	2095.5 BR D	5 Year	113.65	113.36	113.14	0.13	0.02	13.1		35		2.39
Reach 1	2095.5 BR D	10 Year	113.88	113.34	113.34			13.1		46.72		3.27
Reach 1	2095.5 BR D	25 Year	115.19	114.82	113.68				3.36	65.77	1.6	2.5
Reach 1	2095.5 BR D	50 Year	115.51	114.84	114.01				15.32	74.97	5.99	2.5
Reach 1	2095.5 BR D	100 Year	115.82	115.55	114.17			71.61	31.97	80.34	11.99	2.37
Reach 1	2095.5 BR D	500 Year	116.69	116.5	115.6			72.98	88.45	69.1	31.72	1.52
Reach 1	2079	Fish Low Pass.	111.45	111.43	111.4	0.07	0.01	1.82		0.1		0.58
Reach 1	2079	Fish High Pass.	112.04	111.95	111.85	0.09	0.02	5.13		2.75		1.38
Reach 1	2079	2 Year	113.06	112.84	112.65	0.1	0	12.14		21.8		2.07
Reach 1	2079	3 Year	113.31	113.08	112.8	0.13	0.07	12.82		28.6		2.1
Reach 1	2079	5 Year	113.51	113.26	112.92	0.12	0.08	13.3		35		2.2
Reach 1	2079	10 Year	113.69	113.19	113.13	0.14	0.05	13.12		46.72		3.11
Reach 1	2079	25 Year	114.19	113.51	113.51	0.15	0.12	13.98		70.79		3.68
Reach 1	2079	50 Year	114.66	113.89	113.85	0.04	0.35	15.04		96.28		3.88
Reach 1	2079	100 Year	115.38	115.07	114.18	0.02	0.13	151.88	11.98	111.55	1.06	2.61
Reach 1	2079	500 Year	116.63	116.5	115.06	0.01	0.04	222.74	49.93	121.58	16.8	1.89
Reach 1	2067	Fish Low Pass.	111.37	111.37	111.3	0.5	0.01	3.02		0.1		0.33
Reach 1	2067	Fish High Pass.	111.93	111.88	111.68	0.57	0.02	9.12		2.75		1.01
Reach 1	2067	2 Year	112.95	112.72	112.5	0.57	0.05	92.89	1.62	20.13	0.06	2.21
Reach 1	2067	3 Year	113.12	112.67	112.67	0.05	0.21	90.8	1.93	26.61	0.06	3.05
Reach 1	2067	5 Year	113.31	112.81	112.81	0.05	0.24	96.09	2.99	31.9	0.12	3.26
Reach 1	2067	10 Year	113.49	113.1	113.1	0.04	0.18	101.19	9.47	37.01	0.24	3.07
Reach 1	2067	25 Year	113.86	113.41	113.37	0.03	0.21	102.69	20.63	49.7	0.46	3.43
Reach 1	2067	50 Year	114.27	114.2	113.6	0.02	0.02	107.92	62.37	33.34	0.57	1.62
Reach 1	2067	100 Year	115.24	115.19	113.83	0.01	0.01	115.99	85.1	37.99	1.5	1.34
Reach 1	2067	500 Year	116.58	116.53	114	0.01	0.01	164.74	131.2	52	5.1	1.34
Reach 1	2004	Fish Low Pass.	110.33	110.33	110.01	0	0	19.24		0.13		0.03
Reach 1	2004	Fish High Pass.	110.94	110.93	110.24	0.01	0	30.61	0	3.61	0.05	0.21
Reach 1	2004	2 Year	112.1	112.09	110.74	0.01	0.01	78.3	0.16	21.72	9.27	0.5

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	2004	3 Year	112.36	112.35	110.88	0.01	0.01	90.93	0.23	26.8	13.67	0.54
Reach 1	2004	5 Year	112.58	112.57	111	0.01	0.01	94.42	0.31	31.34	18.25	0.57
Reach 1	2004	10 Year	112.95	112.94	111.15	0.01	0.01	95.68	0.44	39.15	26.94	0.62
Reach 1	2004	25 Year	113.61	113.59	111.47	0.01	0.01	99.29	0.72	54.35	45.46	0.7
Reach 1	2004	50 Year	114.22	114.2	111.66	0	0.01	103.55	1.02	70.22	66.1	0.76
Reach 1	2004	100 Year	115.21	115.19	111.84	0	0.01	122.07	1.36	85.05	90.57	0.74
Reach 1	2004	500 Year	116.56	116.53	112.2	0	0.01	164.66	2.07	122.62	144.33	0.84
Reach 1	1983	Fish Low Pass.	110.33	110.33	110.16	0	0	9.35		0.13		0.08
Reach 1	1983	Fish High Pass.	110.93	110.92	110.42	0.01	0	15.22		3.66		0.4
Reach 1	1983	2 Year	112.08	112.04	111.09	0.02	0.02	33.07	0.01	28.67	2.47	0.97
Reach 1	1983	3 Year	112.34	112.29	111.23	0.02	0.03	57.08	0.04	35.19	5.47	1.02
Reach 1	1983	5 Year	112.57	112.53	111.35	0.02	0.05	69.05	0.09	38.69	11.12	0.99
Reach 1	1983	10 Year	112.94	112.9	111.6	0.01	0.06	75.85	0.18	44.63	21.72	0.97
Reach 1	1983	25 Year	113.6	113.55	111.95	0.01	0.1	78.53	0.38	56.61	43.53	0.96
Reach 1	1983	50 Year	114.21	114.16	112.37	0.01	0.13	84.09	0.59	69.52	67.23	0.99
Reach 1	1983	100 Year	115.2	115.16	112.55			122.7	0.85	80.1	96.03	0.9
Reach 1	1983	500 Year	116.55	116.5	112.88			146.31	1.39	111.33	156.28	0.97
Reach 1	1953.5 BR U	Fish Low Pass.	110.33	110.33	110.08	0.02	0	5		0.13		0.12
Reach 1	1953.5 BR U	Fish High Pass.	110.91	110.89	110.5	0.08	0	11.25		3.66		0.67
Reach 1	1953.5 BR U	2 Year	112.04	111.91	111.31	0.12	0.02	14.48	0	31.15		1.58
Reach 1	1953.5 BR U	3 Year	112.29	112.13	111.47	0.13	0.02	14.62	0	40.7		1.78
Reach 1	1953.5 BR U	5 Year	112.51	112.31	111.61	0.13	0.03	14.75	0	49.9		1.95
Reach 1	1953.5 BR U	10 Year	112.86	112.61	111.84	0.14	0.03	14.94	0	66.54		2.21
Reach 1	1953.5 BR U	25 Year	113.49	113.13	112.25	0.15	0.04	15.15	0	100.52	0	2.66
Reach 1	1953.5 BR U	50 Year	114.07	113.6	112.65	0.15	0.05	15.16	0	137.34	0	3.06
Reach 1	1953.5 BR U	100 Year	115.2	114.53	113.04				0.01	176.97	0	3.04
Reach 1	1953.5 BR U	500 Year	116.55	116.5	113.82			47.18	0.01	268.74	0.26	4.62
Reach 1	1953.5 BR D	Fish Low Pass.	110.31	110.3	110.28	0.11	0	6.31		0.13		0.39
Reach 1	1953.5 BR D	Fish High Pass.	110.83	110.79	110.55	0.03	0.01	9.39		3.66		0.86
Reach 1	1953.5 BR D	2 Year	111.9	111.7	111.34	0.05	0.02	14.06		31.15		1.96
Reach 1	1953.5 BR D	3 Year	112.14	111.9	111.51	0.05	0.03	14.4		40.7	0	2.17
Reach 1	1953.5 BR D	5 Year	112.35	112.07	111.65	0.05	0.04	14.65		49.9	0	2.36
Reach 1	1953.5 BR D	10 Year	112.69	112.34	111.89	0.05	0.06	15.29	0	66.53	0	2.64
Reach 1	1953.5 BR D	25 Year	113.3	112.81	112.32	0.05	0.1	15.49	0.04	100.45	0.03	3.11
Reach 1	1953.5 BR D	50 Year	113.87	113.22	112.7	0.04	0.16	15.62	0.12	137.17	0.06	3.57
Reach 1	1953.5 BR D	100 Year	114.28	113.77	113.08			15.7	0.27	176.6	0.11	3.78
Reach 1	1953.5 BR D	500 Year	116.55	116.5	113.86				0.68	267.94	0.4	4.93
Reach 1	1927	Fish Low Pass.	110.2	110.19	110.16	0.02	0.01	3.7		0.13		0.49
Reach 1	1927	Fish High Pass.	110.8	110.77	110.51	0.01	0.01	11.75		3.66		0.7
Reach 1	1927	2 Year	111.83	111.67	111.23	0.03	0.02	16.72		31.15		1.75
Reach 1	1927	3 Year	112.06	111.88	111.4	0.03	0.02	18.43		40.7		1.9
Reach 1	1927	5 Year	112.26	112.05	111.55	0.03	0.01	19.56		49.9		2.01
Reach 1	1927	10 Year	112.59	112.35	111.8	0.03	0.01	22.56		66.52	0.02	2.16
Reach 1	1927	25 Year	113.15	112.87	112.19	0.03	0.01	29.87	0.16	98.97	1.39	2.37
Reach 1	1927	50 Year	113.66	113.33	112.55	0.03	0.02	36.54	0.9	132.47	3.97	2.58
Reach 1	1927	100 Year	114.14	113.77	112.87	0.03	0.03	44.75	1.94	167.89	7.15	2.78
Reach 1	1927	500 Year	115.14	114.69	113.46	0.03	0.06	62.93	8.75	244.9	15.36	3.07
Reach 1	1916.5 BR U	Fish Low Pass.	110.17	110.17	110.07	0.01	0	5.75		0.13		0.2
Reach 1	1916.5 BR U	Fish High Pass.	110.78	110.76	110.39	0.01	0	13.43		3.66		0.53
Reach 1	1916.5 BR U	2 Year	111.78	111.66	111.08	0.04	0	18.04		31.15		1.52
Reach 1	1916.5 BR U	3 Year	112.01	111.86	111.23	0.04	0.01	19.11		40.7		1.71
Reach 1	1916.5 BR U	5 Year	112.21	112.04	111.37	0.04	0.01	20.43		49.9		1.87
Reach 1	1916.5 BR U	10 Year	112.55	112.32	111.59	0.04	0.02	22.53		66.54		2.09
Reach 1	1916.5 BR U	25 Year	113.12	112.81	112	0.04	0.05	30.57	0	100.52		2.43
Reach 1	1916.5 BR U	50 Year	113.62	113.23	112.38	0.04	0.07	40.24	0.26	137.08		2.76
Reach 1	1916.5 BR U	100 Year	114.08	113.61	112.75	0.04	0.1	46.07	1.06	175.92		3.07
Reach 1	1916.5 BR U	500 Year	115.05	114.4	113.42	0.03	0.16	49.68	4.49	264.52		3.61
Reach 1	1916.5 BR D	Fish Low Pass.	110.16	110.16	110.06	0	0	6.06		0.13		0.18
Reach 1	1916.5 BR D	Fish High Pass.	110.76	110.75	110.38	0.03	0	13.16		3.66		0.56
Reach 1	1916.5 BR D	2 Year	111.74	111.63	111.1	0.11	0.03	19.44		31.15		1.51
Reach 1	1916.5 BR D	3 Year	111.97	111.83	111.26	0.11	0.03	21.09		40.7		1.65
Reach 1	1916.5 BR D	5 Year	112.16	112.01	111.4	0.11	0.03	22.74		49.9		1.74
Reach 1	1916.5 BR D	10 Year	112.48	112.3	111.63	0.1	0.04	25.53		66.54		1.86
Reach 1	1916.5 BR D	25 Year	113.03	112.82	112.01	0.09	0.05	30.98	0.15	100.37		2.02
Reach 1	1916.5 BR D	50 Year	113.51	113.27	112.35	0.09	0.07	40.57	1.03	136.04	0.27	2.18
Reach 1	1916.5 BR D	100 Year	113.95	113.67	112.63	0.09	0.1	41.72	2.49	172.59	1.9	2.33
Reach 1	1916.5 BR D	500 Year	114.85	114.53	113.21	0.09	0.24	43.44	7.09	254.06	7.86	2.59



HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	1900	Fish Low Pass.	110.16	110.16	109.84	0.01	0	6.09		0.13		0.08
Reach 1	1900	Fish High Pass.	110.74	110.72	110.24	0.1	0.02	10.9		3.66		0.57
Reach 1	1900	2 Year	111.6	111.38	111.1	0.17	0.06	16.74		31.15		2.07
Reach 1	1900	3 Year	111.82	111.58	111.29	0.15	0.07	18.4		40.7		2.19
Reach 1	1900	5 Year	112.02	111.75	111.47	0.14	0.08	18.99		49.9		2.29
Reach 1	1900	10 Year	112.34	112.04	111.68	0.13	0.09	19.95		66.54		2.43
Reach 1	1900	25 Year	112.89	112.52	112.04	0.11	0.11	21.37		100.52		2.69
Reach 1	1900	50 Year	113.35	112.88	112.37	0.12	0.14	22.46		137.34		3.03
Reach 1	1900	100 Year	113.76	113.17	112.7	0.13	0.18	23.33		176.98		3.41
Reach 1	1900	500 Year	114.52	113.41	113.34	0.21	0.35	25.17	0.01	269		4.67
Reach 1	1871	Fish Low Pass.	110.15	110.14	110.06	0.29	0	6.6		0.13		0.33
Reach 1	1871	Fish High Pass.	110.62	110.53	110.46	0.45	0.01	19.74		3.66		1.32
Reach 1	1871	2 Year	111.37	111.28	110.83	0.08	0	24.59	16.55	14.4	0.21	1.42
Reach 1	1871	3 Year	111.6	111.5	110.95	0.07	0	25.2	21.54	18.7	0.46	1.52
Reach 1	1871	5 Year	111.8	111.69	111.05	0.06	0.01	25.7	26.32	22.8	0.78	1.6
Reach 1	1871	10 Year	112.12	112	111.22	0.06	0.01	33.44	34.15	30.71	1.68	1.78
Reach 1	1871	25 Year	112.66	112.52	111.52	0.05	0	35.89	52.58	44.06	3.87	1.96
Reach 1	1871	50 Year	113.09	112.91	111.85	0.05	0.02	37.11	72.76	58.27	6.31	2.2
Reach 1	1871	100 Year	113.45	113.22	112.15	0.05	0.02	38.09	94.51	73.49	8.98	2.49
Reach 1	1871	500 Year	113.96	113.55	112.63	0.08	0.04	39.15	144.6	109.58	14.87	3.34
Reach 1	1309	Fish Low Pass.	104.26	104.26	104.2	0.25	0	3.68		0.13		0.38
Reach 1	1309	Fish High Pass.	104.73	104.66	104.56	0.12	0.01	9.08		3.66		1.18
Reach 1	1309	2 Year	105.97	105.81	105.36	0.09	0.03	18.87		31.15		1.76
Reach 1	1309	3 Year	106.23	106.06	105.55	0.08	0.03	24.7	0.5	40.19	0.01	1.85
Reach 1	1309	5 Year	106.45	106.27	105.7	0.08	0.03	25.96	1.37	48.47	0.07	1.94
Reach 1	1309	10 Year	106.8	106.59	105.96	0.07	0.04	31.79	3.32	62.93	0.29	2.07
Reach 1	1309	25 Year	107.38	107.15	106.34	0.06	0.04	67.78	7.99	89.21	3.32	2.26
Reach 1	1309	50 Year	107.62	107.22	106.68	0.09	0.08	74.09	11.12	120.72	5.5	2.98
Reach 1	1309	100 Year	108.19	107.98	107	0.05	0.04	103.19	28.47	126.59	21.92	2.39
Reach 1	1309	500 Year	109.07	108.93	107.43	0.03	0.02	116.5	59.44	149.59	59.98	2.18
Reach 1	1277	Fish Low Pass.	104.02	104.01	103.96	0.07	0	3.41		0.13		0.48
Reach 1	1277	Fish High Pass.	104.59	104.57	104.28	0.04	0	11.02		3.66		0.69
Reach 1	1277	2 Year	105.86	105.79	105.06	0.03	0.01	24.61		31.15		1.16
Reach 1	1277	3 Year	106.12	106.05	105.24	0.03	0.02	27.48		40.7	0	1.22
Reach 1	1277	5 Year	106.35	106.26	105.37	0.03	0.02	32.25	0	49.84	0.06	1.27
Reach 1	1277	10 Year	106.69	106.6	105.57	0.03	0.03	58.25	0.56	65.26	0.72	1.35
Reach 1	1277	25 Year	107.28	107.19	105.91			81.05	3.65	88.19	8.67	1.37
Reach 1	1277	50 Year	107.44	107.31	106.2			85.96	5.62	116.92	14.81	1.73
Reach 1	1277	100 Year	108.11	108.02	106.52	0.03	0.03	91.47	11.33	126.8	38.85	1.46
Reach 1	1277	500 Year	109.02	108.95	107.15	0.01	0.01	106.55	23.79	162.62	82.59	1.45
Reach 1	1260.5 BR U	Fish Low Pass.	103.94	103.94	103.87	0.01	0	4.5		0.13		0.27
Reach 1	1260.5 BR U	Fish High Pass.	104.55	104.52	104.22	0.01	0	10.69		3.66		0.77
Reach 1	1260.5 BR U	2 Year	105.82	105.71	105.03	0.01	0	16.73		31.15		1.42
Reach 1	1260.5 BR U	3 Year	106.08	105.95	105.19	0.01	0	17.62		40.7		1.57
Reach 1	1260.5 BR U	5 Year	106.29	106.15	105.33	0.01	0	18.39		49.9		1.69
Reach 1	1260.5 BR U	10 Year	106.63	106.45	105.56	0.01	0	19.6		66.54		1.89
Reach 1	1260.5 BR U	25 Year	107.28	107.19	105.97			55.43	2.76	78.13	19.43	1.7
Reach 1	1260.5 BR U	50 Year	107.44	107.31	106.35			58.27	6.25	100.82	30.3	2.19
Reach 1	1260.5 BR U	100 Year	108.05	107.89	106.69	0.01	0.02	87.59	22.4	57.63	96.95	1.2
Reach 1	1260.5 BR U	500 Year	108.99	108.87	107.42	0	0.02	102.42	48.61	58.61	161.79	0.87
Reach 1	1260.5 BR D	Fish Low Pass.	103.93	103.93	103.86	0.01	0	4.39		0.13		0.29
Reach 1	1260.5 BR D	Fish High Pass.	104.54	104.51	104.22	0.02	0.01	10.58		3.66		0.79
Reach 1	1260.5 BR D	2 Year	105.81	105.71	105.03	0.02	0.01	16.7		31.15		1.43
Reach 1	1260.5 BR D	3 Year	106.07	105.94	105.19	0.03	0.01	17.58		40.7		1.58
Reach 1	1260.5 BR D	5 Year	106.29	106.14	105.33	0.03	0.01	18.35		49.9		1.7
Reach 1	1260.5 BR D	10 Year	106.62	106.44	105.57	0.03	0.02	19.56		66.54		1.9
Reach 1	1260.5 BR D	25 Year	107.28	107.19	105.97			60.15	2.76	78.13	19.43	1.7
Reach 1	1260.5 BR D	50 Year	107.44	107.31	106.35			61.66	6.25	100.82	30.29	2.19
Reach 1	1260.5 BR D	100 Year	108.02	107.79	106.69	0.04	0.01	80.08	28.13	83.44	65.42	1.8
Reach 1	1260.5 BR D	500 Year	108.97	108.77	107.57	0.02	0	102.03	58.91	72.99	137.11	1.12
Reach 1	1246	Fish Low Pass.	103.92	103.92	103.76			7.2		0.13		0.11
Reach 1	1246	Fish High Pass.	104.51	104.5	104.07			11.47		3.66		0.53
Reach 1	1246	2 Year	105.78	105.69	104.82			23.35	0.16	30.99	0	1.31
Reach 1	1246	3 Year	106.03	105.93	105			31.9	0.42	40.03	0.26	1.45
Reach 1	1246	5 Year	106.25	106.12	105.15			36.09	0.8	48.44	0.66	1.57

HEC-RAS Plan: EX-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	E.G. Elev (m)	W.S. Elev (m)	Crit W.S. (m)	Frctn Loss (m)	C & E Loss (m)	Top Width (m)	Q Left (m3/s)	Q Channel (m3/s)	Q Right (m3/s)	Vel Chnl (m/s)
Reach 1	1246	10 Year	106.58	106.43	105.41			41.66	1.62	63.33	1.59	1.77
Reach 1	1246	25 Year	106.9	106.61	105.86			48.19	2.95	94.6	2.98	2.44
Reach 1	1246	50 Year	107.41	107	106.22			78.5	5.16	130.74	1.44	2.89
Reach 1	1246	100 Year	107.98	107.73	106.55			87.94	19.26	140.37	17.35	2.46
Reach 1	1246	500 Year	108.95	108.76	107.55	0.09	0.34	102.6	48.93	170.85	49.23	2.31
Reach 1	1198.5 BR U	Fish Low Pass.	103.57	103.57	103.44			5.77		0.13		0.16
Reach 1	1198.5 BR U	Fish High Pass.	104.12	104.1	103.77			10.75		3.66		0.66
Reach 1	1198.5 BR U	2 Year	105.33	105.19	104.55			13.67		31.15		1.66
Reach 1	1198.5 BR U	3 Year	105.59	105.42	104.73			14.42		40.7		1.85
Reach 1	1198.5 BR U	5 Year	105.82	105.62	104.89			15.07		49.9		2
Reach 1	1198.5 BR U	10 Year	106.19	105.94	105.15			16.1		66.54		2.22
Reach 1	1198.5 BR U	25 Year	106.45	105.62	105.62			15.06		100.52		4.03
Reach 1	1198.5 BR U	50 Year	107	106.05	106.05			16.43		137.34		4.34
Reach 1	1198.5 BR U	100 Year	107.93	107.45	106.44			23.96		176.98		3.05
Reach 1	1198.5 BR U	500 Year	108.52	107.21	107.21			23.18		269.01		5.07
Reach 1	1198.5 BR D	Fish Low Pass.	103.47	103.47	103.4			7.7		0.13		0.2
Reach 1	1198.5 BR D	Fish High Pass.	103.89	103.85	103.67			10.13		3.66		0.9
Reach 1	1198.5 BR D	2 Year	104.96	104.7	104.44			12.71		31.15		2.26
Reach 1	1198.5 BR D	3 Year	105.2	104.86	104.63			13.18		40.7		2.56
Reach 1	1198.5 BR D	5 Year	105.4	105	104.78			13.57		49.9		2.81
Reach 1	1198.5 BR D	10 Year	105.74	105.2	105.04			14.23		66.54		3.24
Reach 1	1198.5 BR D	25 Year	106.33	105.51	105.51			15.24		100.52		4.01
Reach 1	1198.5 BR D	50 Year	106.88	105.93	105.93			16.61		137.34		4.33
Reach 1	1198.5 BR D	100 Year	107.4	106.42	106.32			18.2		176.98		4.38
Reach 1	1198.5 BR D	500 Year	108.39	107.09	107.09			20.29		269.01		5.07
Reach 1	1162	Fish Low Pass.	103.42	103.4	103.4	0	0.01	4.91		0.13		0.66
Reach 1	1162	Fish High Pass.	103.84	103.8		0.02	0.01	11.86		3.66		0.83
Reach 1	1162	2 Year	104.87	104.69		0.05	0.01	15.05		31.15		1.91
Reach 1	1162	3 Year	105.1	104.87		0.05	0.01	15.66		40.7		2.14
Reach 1	1162	5 Year	105.29	105.02		0.06	0.01	16.2		49.9		2.32
Reach 1	1162	10 Year	105.6	105.26		0.06	0.01	17.02		66.54		2.62
Reach 1	1162	25 Year	106.15	105.66		0.08	0.01	18.44		100.52		3.08
Reach 1	1162	50 Year	106.68	106.13		0.09	0.05	22.5	0.01	137.33	0.01	3.3
Reach 1	1162	100 Year	107.24	106.67		0.09	0.15	47.69	0.98	175.82	0.18	3.36
Reach 1	1162	500 Year	108.05	106.44	106.96	0.25	0.09	29.47	0.28	268.61	0.12	5.63
Reach 1	1153	Fish Low Pass.	103.36	103.36	103.17	0.02	0	8.11		0.13		0.09
Reach 1	1153	Fish High Pass.	103.81	103.79	103.47	0.19	0.01	12.15		3.66		0.62
Reach 1	1153	2 Year	104.81	104.65	104.18	0.35	0.02	14.63		31.15		1.78
Reach 1	1153	3 Year	105.04	104.83	104.35	0.38	0.02	15.12		40.7		2.02
Reach 1	1153	5 Year	105.23	104.97	104.5	0.4	0.02	15.53		49.9		2.23
Reach 1	1153	10 Year	105.53	105.2	104.75	0.43	0.02	16.16		66.54		2.57
Reach 1	1153	25 Year	106.05	105.53	105.17	0.48	0.01	17.14		100.52		3.2
Reach 1	1153	50 Year	106.54	105.82	105.57	0.51	0.02	18.01		137.34		3.76
Reach 1	1153	100 Year	107.01	105.94	105.94	0.34	0.24	18.39		176.98	0	4.56
Reach 1	1153	500 Year	107.7	106.99	106.99	0.29	0.11	81.41	40.79	227.71	0.51	3.93

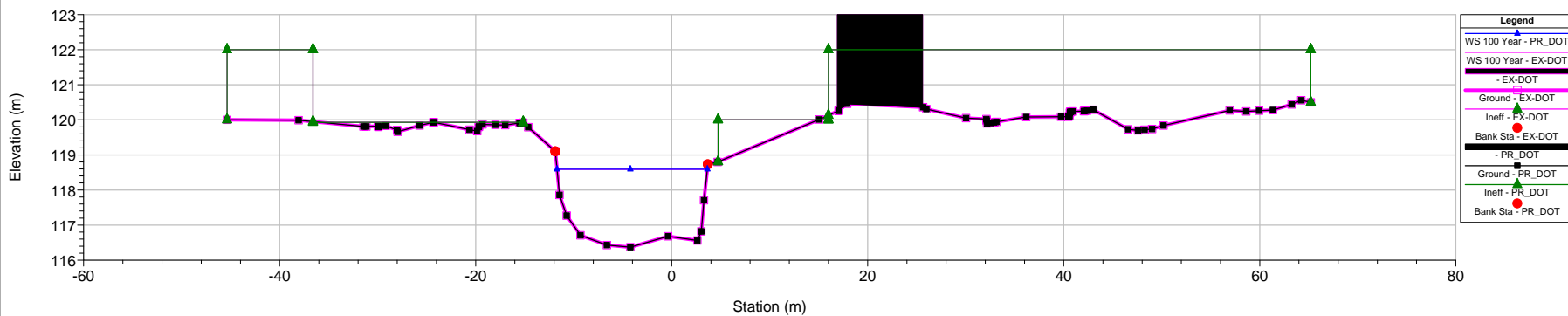
**MAD RIVER - NATURAL CONDITION 1 (using EXISTING geometry)**  
**HEC-RAS 4.1.0 - "Standard Table 1" Output**

HEC-RAS Plan: NT-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2409	100 Year	124.59	116.37	118.59	118.59	119.54	0.016952	4.31	28.89	15.33	1
Reach 1	2337	100 Year	124.59	114.97	116.79	117.14	118	0.026982	4.93	27.24	26.89	1.35
Reach 1	2280	100 Year	124.59	114.06	116.47	116.47	117.23	0.011093	3.97	38.36	32.88	0.89
Reach 1	2238	100 Year	124.59	113.86	116.48	115.79	116.74	0.0061	2.3	56.54	49.75	0.52
Reach 1	2207	100 Year	124.59	113.6	116.16	115.65	116.51	0.007622	2.73	50.24	62.3	0.6
Reach 1	2202	100 Year	124.59	113.57	116.1	115.58	116.48	0.009306	2.75	46.34	63.99	0.62
Reach 1	2168	100 Year	124.59	113.02	115.91	115.57	116.16	0.00713	2.31	56.57	65.28	0.52
Reach 1	2130	100 Year	124.59	112.43	115.65	115.37	115.89	0.007041	2.09	58.87	106.16	0.46
Reach 1	2116	100 Year	124.59	112.21	115.36	115.36	115.78	0.006639	3.15	51.63	106.68	0.62
Reach 1	2079	100 Year	124.59	111.29	114	114.18	115.13	0.031296	4.7	26.55	16.12	1.14
Reach 1	2067	100 Year	124.59	111.17	114.05	113.3	114.19	0.00261	2.27	91.09	106.51	0.46
Reach 1	2020	100 Year	176.98	110.75	114.05	112.16	114.11	0.000455	1.03	176.45	133.43	0.2
Reach 1	2004	100 Year	176.98	109.92	114.06	111.84	114.09	0.000238	0.95	236.9	102.7	0.15
Reach 1	1983	100 Year	176.98	110.09	114.01	112.56	114.08	0.00049	1.26	176.02	81.79	0.21
Reach 1	1927	100 Year	176.98	110.06	113.56		113.98	0.00475	2.97	68.58	40.06	0.58
Reach 1	1900	100 Year	176.98	109.69	112.76	112.7	113.64	0.011201	4.16	42.54	22.09	0.96
Reach 1	1871	100 Year	176.98	109.92	112.99	112.15	113.27	0.00324	2.75	78.8	37.34	0.53
Reach 1	1837	100 Year	176.98	109.77	112.97	111.93	113.17	0.001587	2.16	103.42	52.85	0.4
Reach 1	1778	100 Year	176.98	108.97	112.95	111.85	113.08	0.001157	1.84	132.05	70.09	0.33
Reach 1	1748	100 Year	176.98	109.06	112.81	112.32	113.02	0.002321	2.47	120.35	80.87	0.45
Reach 1	1689	100 Year	176.98	109.33	111.92	111.92	112.7	0.011345	3.94	47.84	49.6	0.92
Reach 1	1620	100 Year	176.98	108.64	110.22	110.56	111.46	0.029784	4.92	35.97	31.45	1.41
Reach 1	1573	100 Year	176.98	107.41	109.86	109.86	110.69	0.013875	4.05	43.7	26.13	1
Reach 1	1536	100 Year	176.98	107	109.48	108.93	109.82	0.008849	2.62	75.34	71.96	0.6
Reach 1	1523	100 Year	176.98	106.62	109.23	109.04	109.61	0.016579	2.88	73.2	67.45	0.69
Reach 1	1487	100 Year	176.98	106.13	109.08	108.24	109.3	0.00494	2.17	97.27	65.55	0.47
Reach 1	1425	100 Year	176.98	105.6	108.52	107.99	108.92	0.006985	3.03	87.28	79.33	0.61
Reach 1	1370	100 Year	176.98	104.75	107.99	107.88	108.49	0.010324	3.52	77.25	97.07	0.71
Reach 1	1330	100 Year	176.98	104.35	107.61	107.24	108.07	0.008784	3.28	80.16	105.2	0.67
Reach 1	1309	100 Year	176.98	104.12	107.36	107	107.92	0.005815	3.55	71.96	86.33	0.7
Reach 1	1277	100 Year	176.98	103.81	107.53	106.52	107.69	0.002259	1.93	126.56	87.82	0.37
Reach 1	1246	100 Year	176.98	103.7	107.27	106.51	107.59	0.003028	2.8	104.27	81.37	0.51
Reach 1	1162	100 Year	176.98	103.32	106.5	106.02	107.15	0.009091	3.59	51.76	30.26	0.73
Reach 1	1153	100 Year	176.98	103.08	105.94	105.94	107.01	0.014787	4.56	38.78	18.39	1
Reach 1	1107	100 Year	176.98	103.28	105.59	105.83	106.4	0.013229	3.99	44.62	116.13	0.97
Reach 1	1003	100 Year	176.98	101.7	104.89	104.41	105.53	0.00666	3.55	51.15	80.85	0.72
Reach 1	894	100 Year	176.98	100.2	103.72	103.51	104.57	0.010232	4.1	43.37	21.04	0.87
Reach 1	809	100 Year	176.98	99.48	103.06		103.86	0.007558	3.96	44.93	17.18	0.75
Reach 1	714	100 Year	176.98	98.89	102.39	101.89	103.07	0.00791	3.65	48.67	64.91	0.74

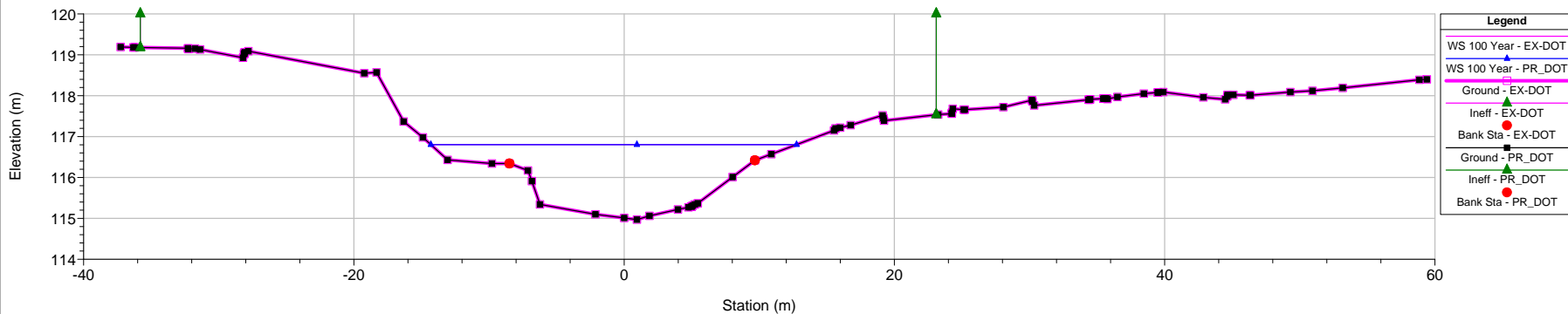
**MAD RIVER - NATURAL CONDITION 2 (partially using PROPOSED geometry)**  
**HEC-RAS 4.1.0 - "Standard Table 1" Output**

HEC-RAS Plan: NT2-DOT River: Mad River Reach: Reach 1												
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Reach 1	2409	100 Year	124.59	116.37	118.59	118.59	119.54	0.016952	4.31	28.89	15.33	1
Reach 1	2337	100 Year	124.59	114.97	116.79	117.14	118	0.026982	4.93	27.24	26.89	1.35
Reach 1	2280	100 Year	124.59	114.06	116.49	116.47	117.23	0.010802	3.94	38.84	33.16	0.88
Reach 1	2238	100 Year	124.59	113.86	116.48	115.79	116.74	0.006293	2.28	57.08	50.06	0.52
Reach 1	2207	100 Year	124.59	113.6	116.3	115.65	116.56	0.005248	2.36	58.68	69.77	0.5
Reach 1	2202	100 Year	124.59	113.57	116.2	115.58	116.52	0.007693	2.56	49.65	67.71	0.57
Reach 1	2168	100 Year	124.59	113.02	115.57	115.57	116.11	0.018325	3.29	38.95	47.12	0.81
Reach 1	2130	100 Year	124.59	112.45	114.66	114.43	115.26	0.011234	3.44	36.38	22.84	0.81
Reach 1	2116	100 Year	124.59	112.3	114.29	114.27	115.08	0.012505	3.95	31.84	19.97	0.95
Reach 1	2079	100 Year	124.59	111.89	114.31	113.7	114.67	0.005336	2.63	47.37	25.04	0.61
Reach 1	2067	100 Year	124.59	111.76	114.41	113.05	114.5	0.00168	1.27	95.65	100.69	0.25
Reach 1	2020	100 Year	176.98	111.25	114.4	112.27	114.45	0.000504	1.17	207.68	133.33	0.21
Reach 1	2004	100 Year	176.98	111.07	114.4	112.13	114.43	0.000362	1.01	262.18	102.52	0.18
Reach 1	1983	100 Year	176.98	110.84	114.36	112.21	114.41	0.000525	1.27	200.1	72.46	0.22
Reach 1	1972	100 Year	176.98	110.72	114.34	112.41	114.4	0.000631	1.42	168.8	64.41	0.24
Reach 1	1953	100 Year	176.98	110.59	113.87		114.27	0.004339	2.81	62.9	26.75	0.59
Reach 1	1900	100 Year	176.98	110.32	113.8		114.06	0.002565	2.25	79.31	31.89	0.44
Reach 1	1871	100 Year	176.98	110.17	113.55		113.94	0.004588	2.77	63.79	25.68	0.56
Reach 1	1748	100 Year	176.98	109.64	112.81		113.25	0.006992	2.95	59.99	25.27	0.61
Reach 1	1689	100 Year	176.98	109.33	111.92	111.92	112.7	0.011345	3.94	47.84	49.6	0.92
Reach 1	1620	100 Year	176.98	108.64	110.22	110.56	111.46	0.029784	4.92	35.97	31.45	1.41
Reach 1	1573	100 Year	176.98	107.41	109.86	109.86	110.69	0.013875	4.05	43.7	26.13	1
Reach 1	1536	100 Year	176.98	107	109.48	108.93	109.82	0.008849	2.62	75.34	71.96	0.6
Reach 1	1523	100 Year	176.98	106.62	109.23	109.04	109.61	0.016579	2.88	73.2	67.45	0.69
Reach 1	1487	100 Year	176.98	106.13	109.08	108.24	109.3	0.00494	2.17	97.27	65.55	0.47
Reach 1	1425	100 Year	176.98	105.6	108.52	107.99	108.92	0.006985	3.03	87.28	79.33	0.61
Reach 1	1370	100 Year	176.98	104.75	107.99	107.88	108.49	0.010324	3.52	77.25	97.07	0.71
Reach 1	1330	100 Year	176.98	104.35	107.61	107.24	108.07	0.008784	3.28	80.16	105.2	0.67
Reach 1	1309	100 Year	176.98	104.12	107.36	107	107.92	0.005815	3.55	71.96	86.33	0.7
Reach 1	1277	100 Year	176.98	103.81	107.53	106.52	107.69	0.002259	1.93	126.56	87.82	0.37
Reach 1	1246	100 Year	176.98	103.7	107.27	106.51	107.59	0.003028	2.8	104.27	81.37	0.51
Reach 1	1162	100 Year	176.98	103.32	106.5	106.02	107.15	0.009091	3.59	51.76	30.26	0.73
Reach 1	1153	100 Year	176.98	103.08	105.94	105.94	107.01	0.014787	4.56	38.78	18.39	1
Reach 1	1107	100 Year	176.98	103.28	105.59	105.83	106.4	0.013229	3.99	44.62	116.13	0.97
Reach 1	1003	100 Year	176.98	101.7	104.92	104.44	105.47	0.005896	3.37	66.19	83.93	0.68
Reach 1	894	100 Year	176.98	100.2	103.72	103.51	104.57	0.010232	4.1	43.37	21.04	0.87
Reach 1	809	100 Year	176.98	99.48	103.06		103.86	0.007558	3.96	44.93	17.18	0.75
Reach 1	714	100 Year	176.98	98.89	102.39	101.89	103.07	0.00791	3.65	48.67	64.91	0.74

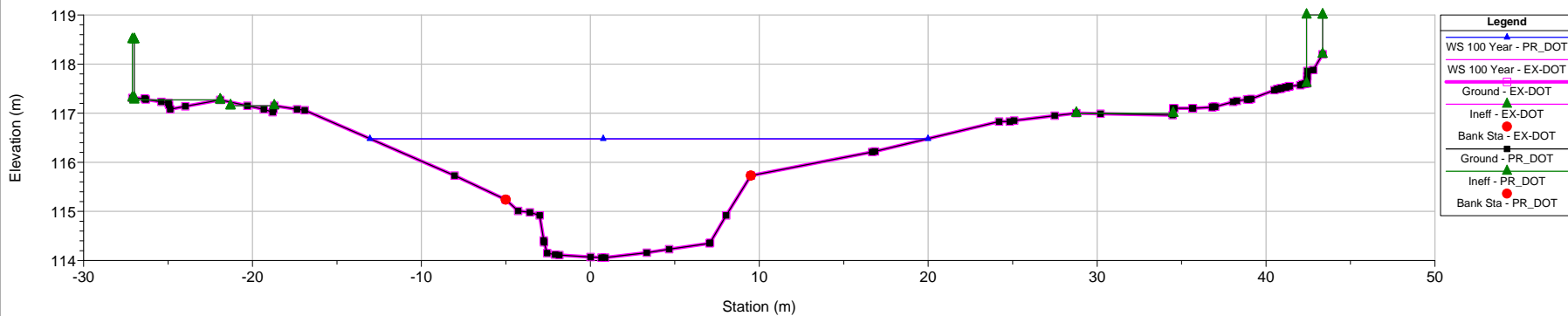
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2409 FEMA STATION 5143, CROSS SECTION AM



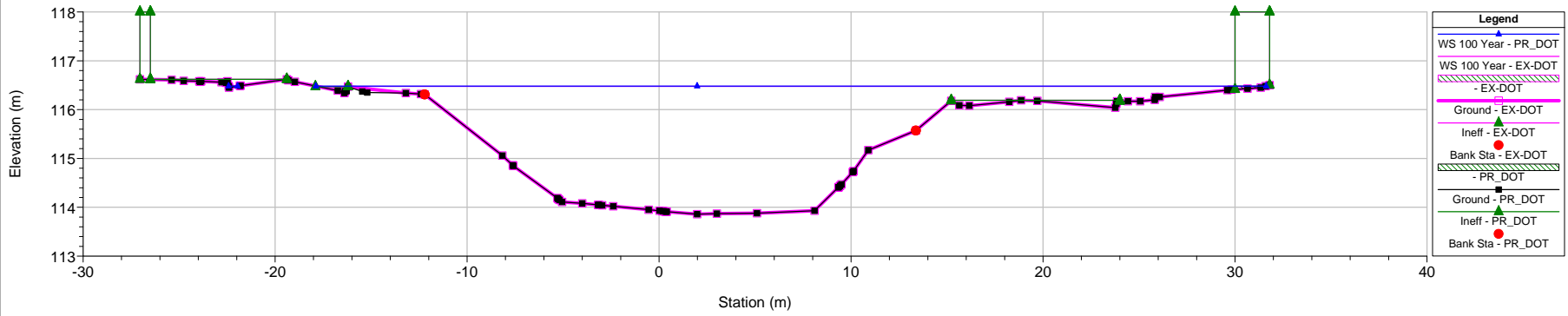
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2337 85m D/S of East Main St.



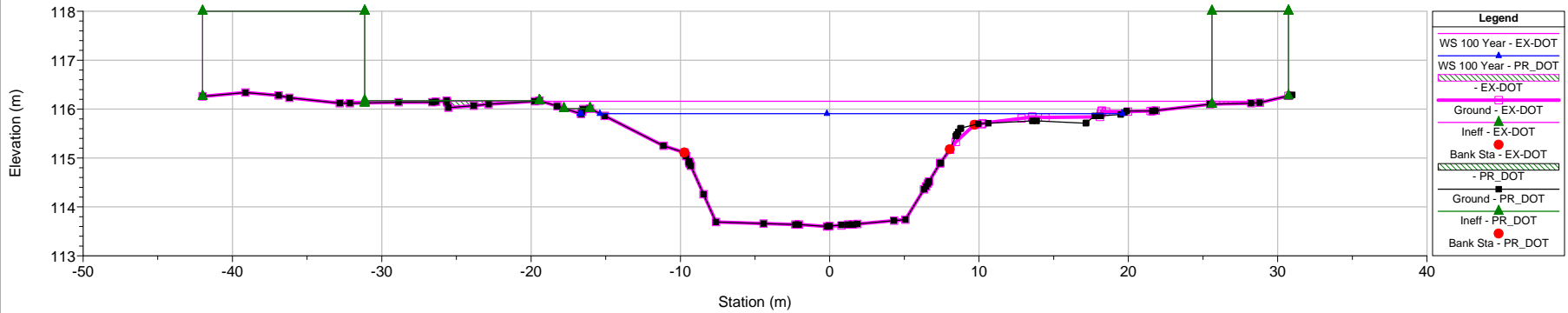
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2280 New BLA surveyed cross section



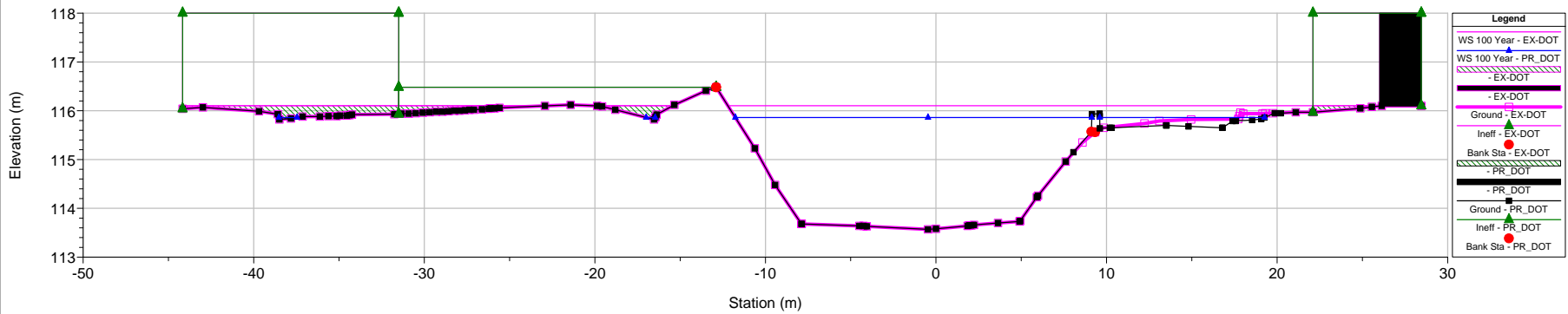
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2238 FEMA Station 5142, Cross Section AL



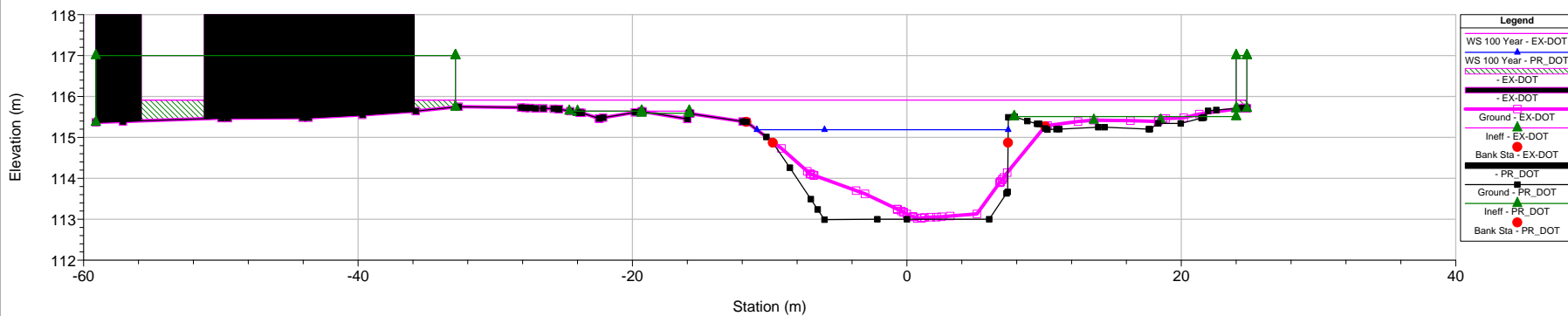
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2207 5m U/S of U/S End of Proposed Ret. Wall 105



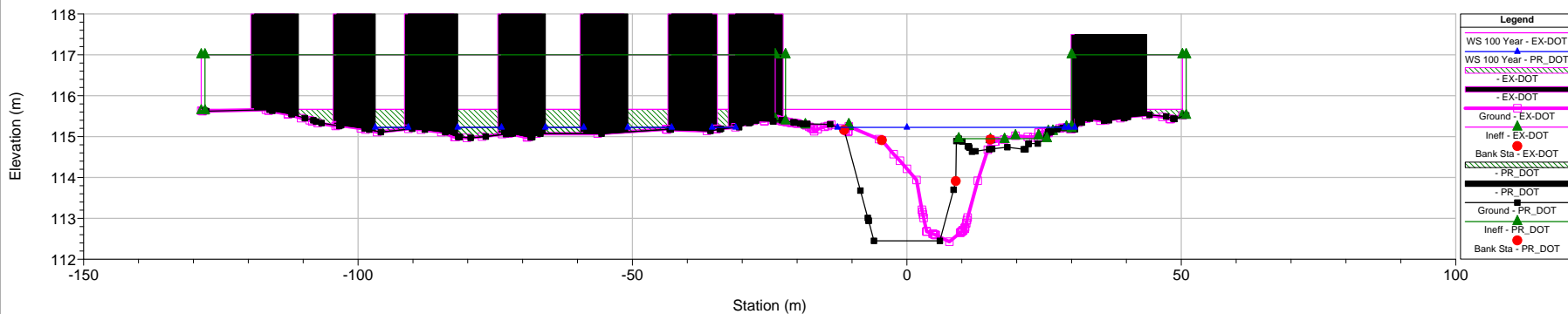
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2202 97m upstream of Plank Road bridge



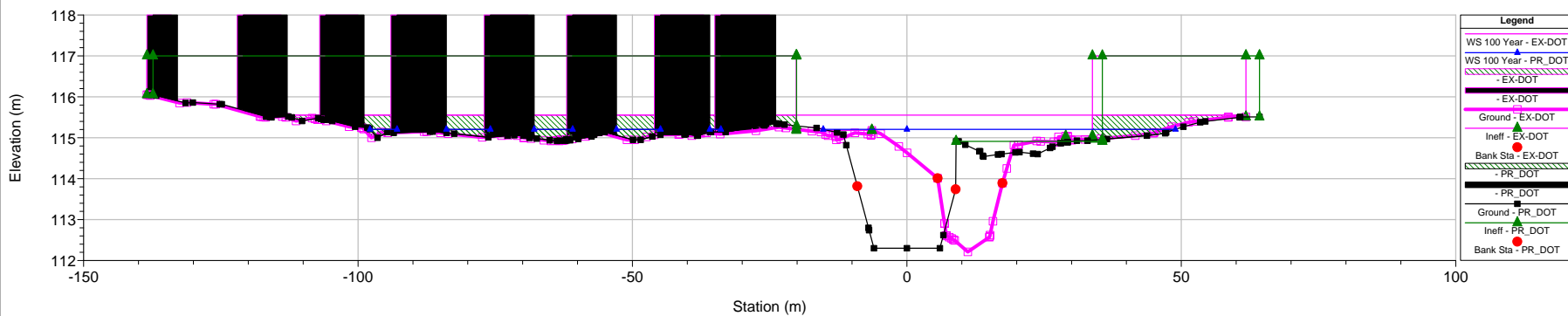
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2168 U/S Limit of Proposed Channelization-Full width; (Taper to EX to



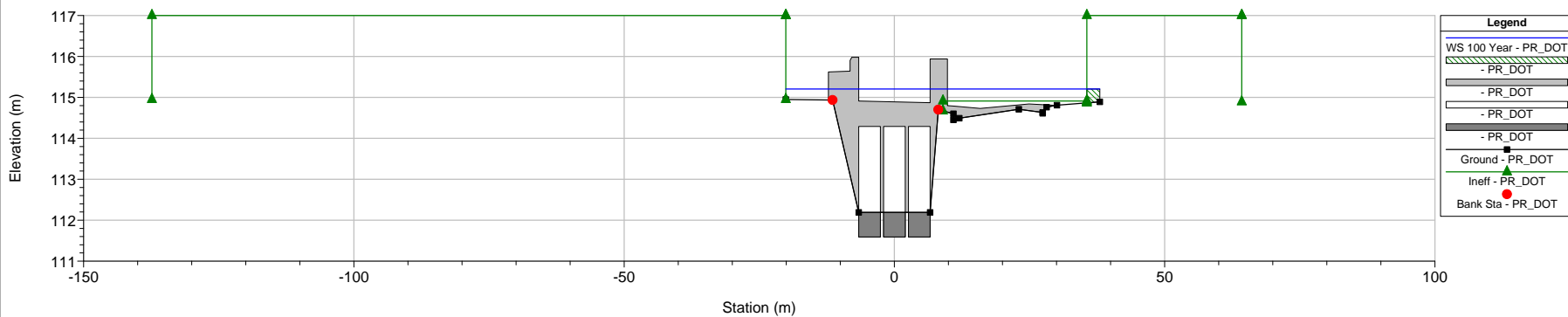
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2130 26m U/S Plank Road Bridge



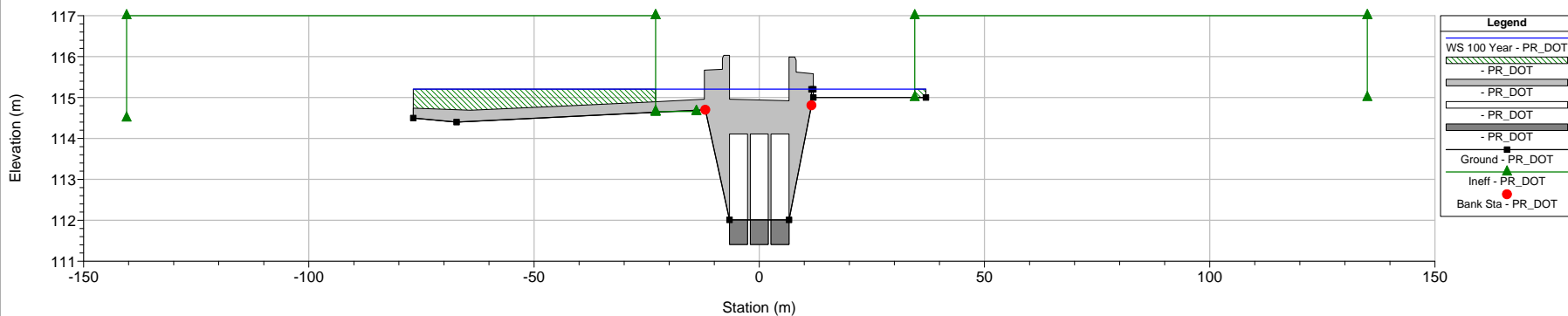
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2116 U/S of Plank Rd. Culvert No. 05668 (FEMA Sta 5141, Sec AK)



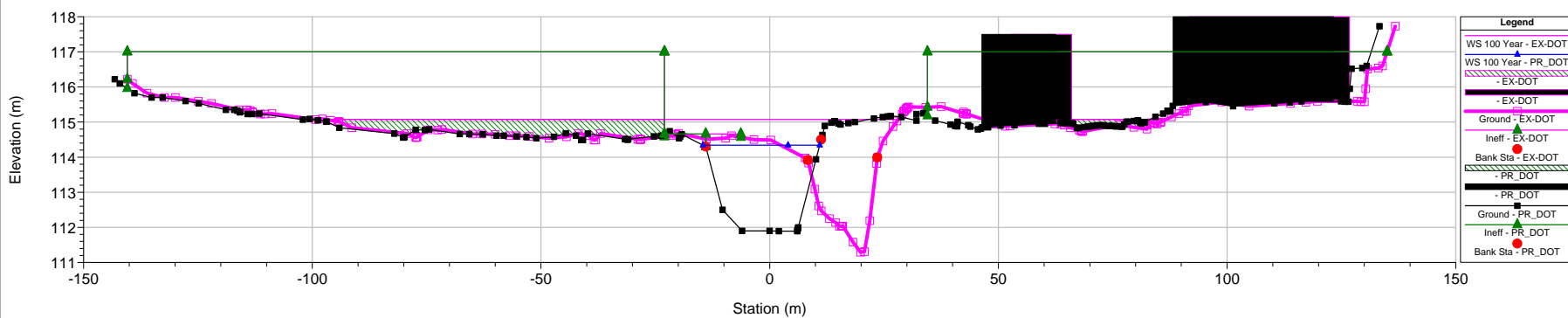
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2098.5 Culv Proposed Plank Road Culvert No. 05668



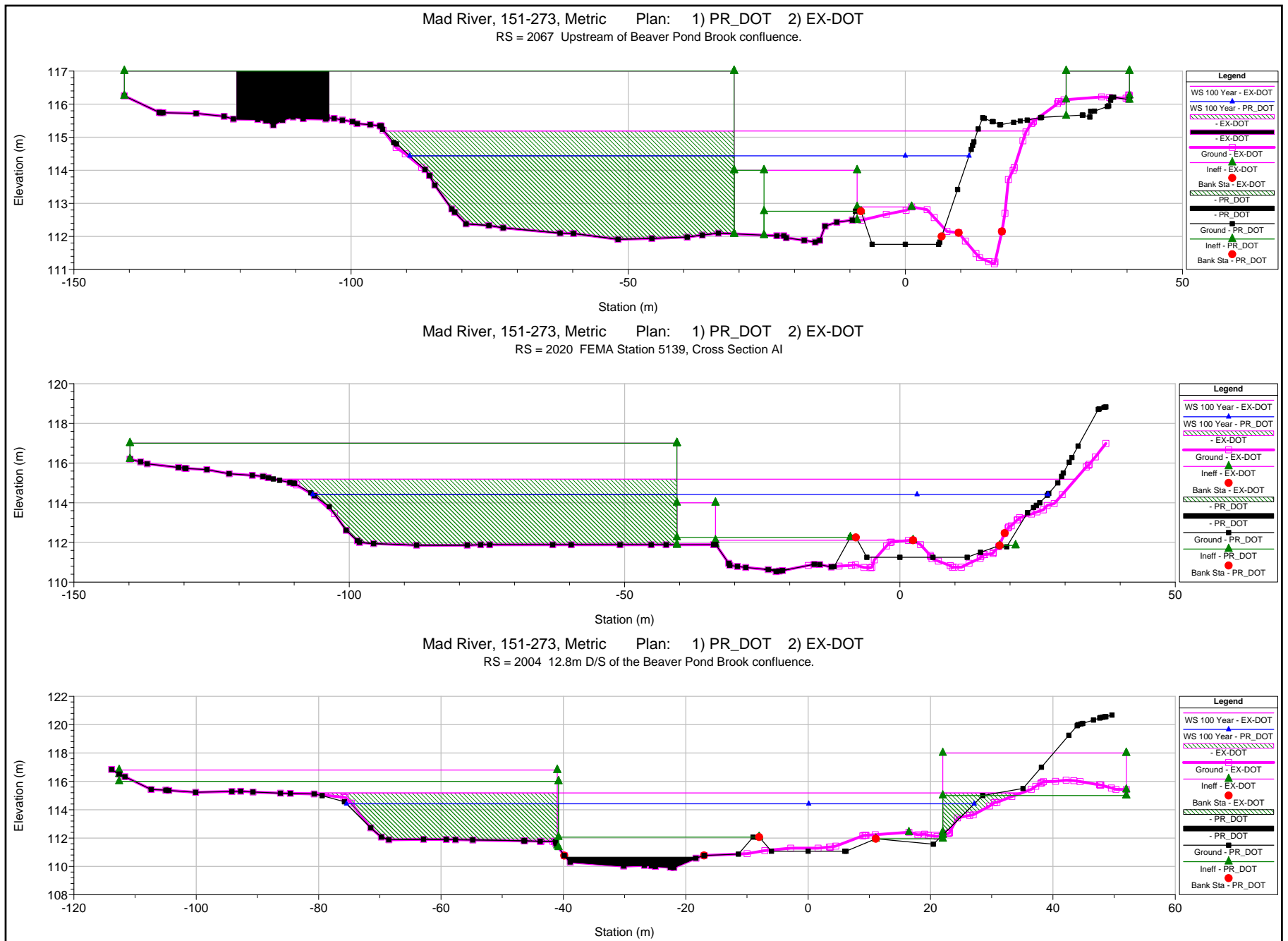
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2098.5 Culv Proposed Plank Road Culvert No. 05668



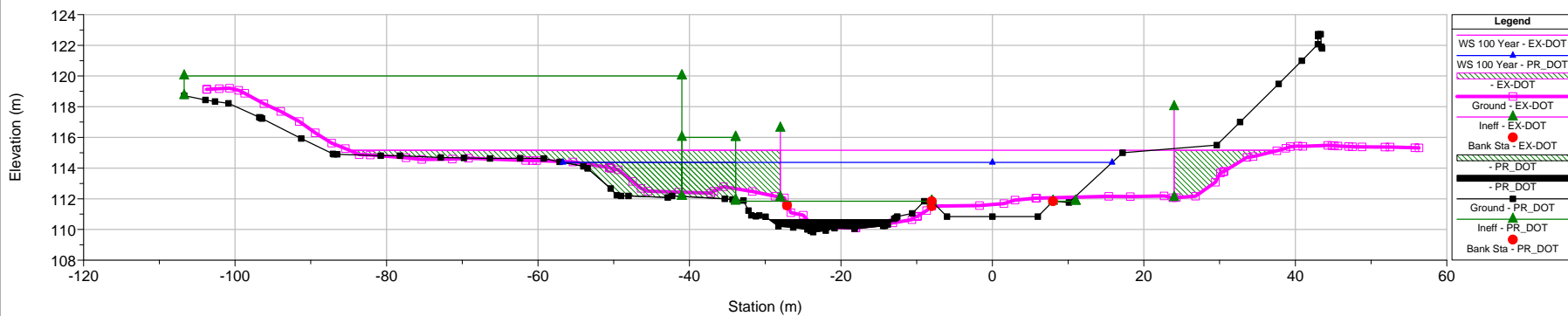
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 2079 D/S of Plank Rd. Bridge (FEMA Sta 5140, Sec. AJ)



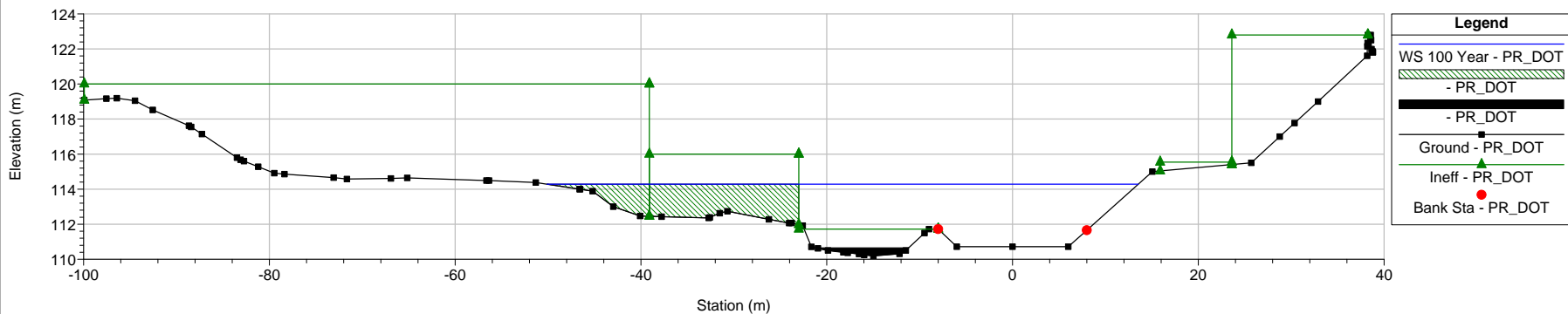




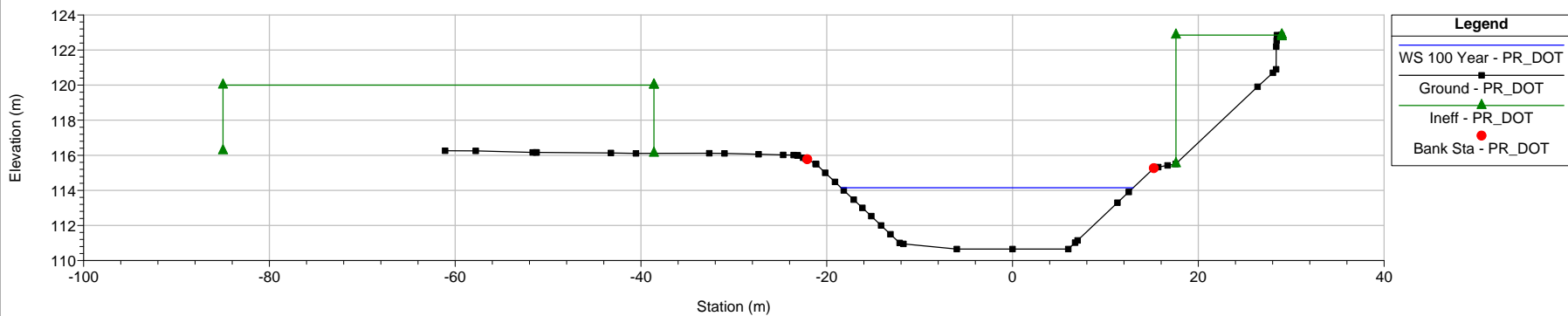
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1983 37.9m U/S I-84 WB Exit 24 On-Ramp from Harpers Ferry Rd.



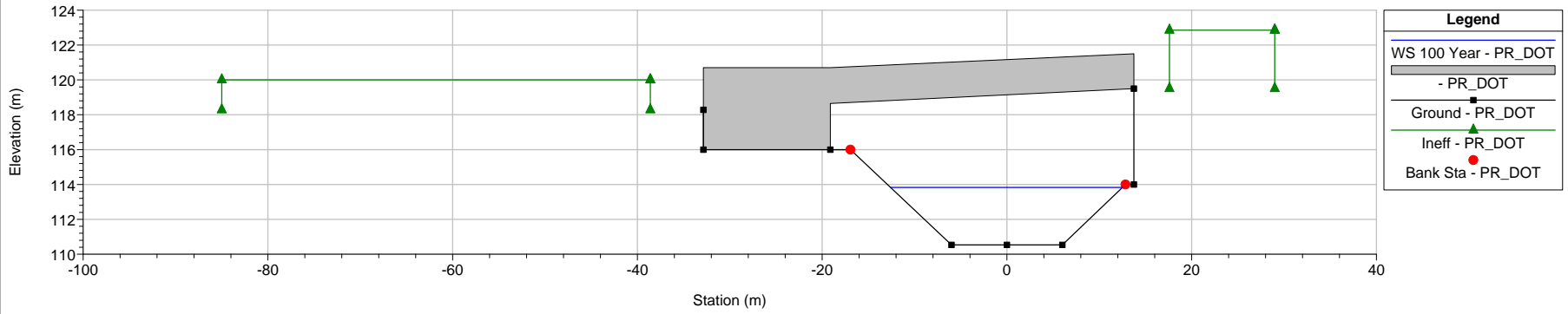
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1972 26.7m U/S I-84 WB Exit 24 On-Ramp from Harpers Ferry Rd.



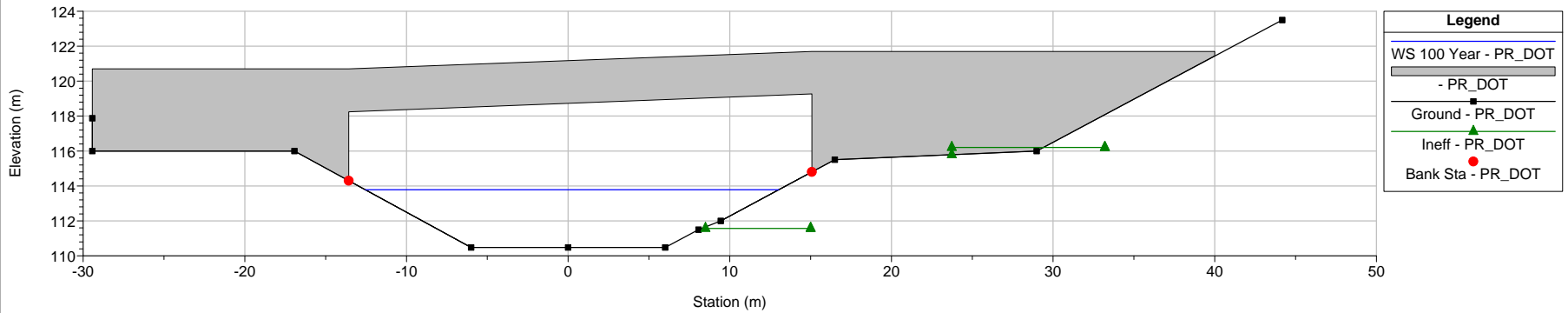
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1962 U/S of I-84 WB Exit 24 On-Ramp (06591) from Harpers Ferry Rd.



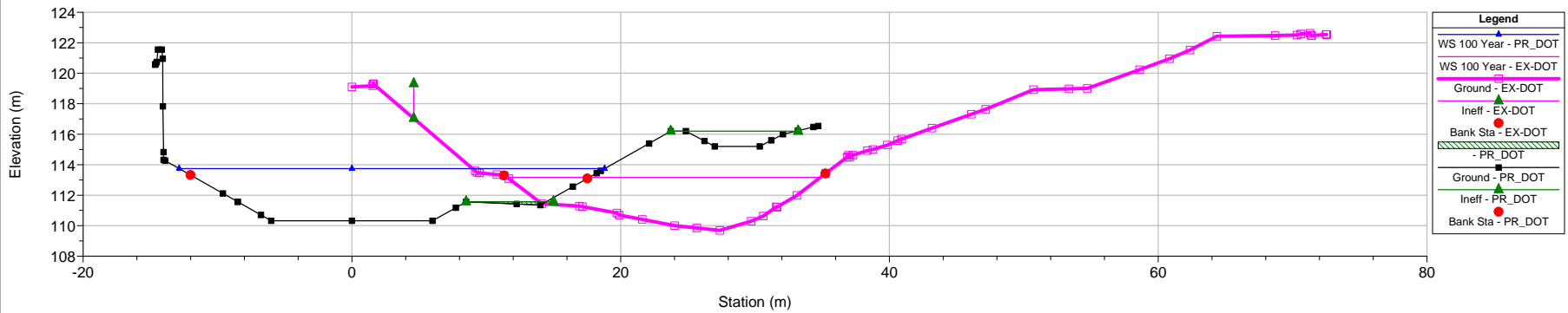
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1938.5 BR Proposed Bridge No. 06591



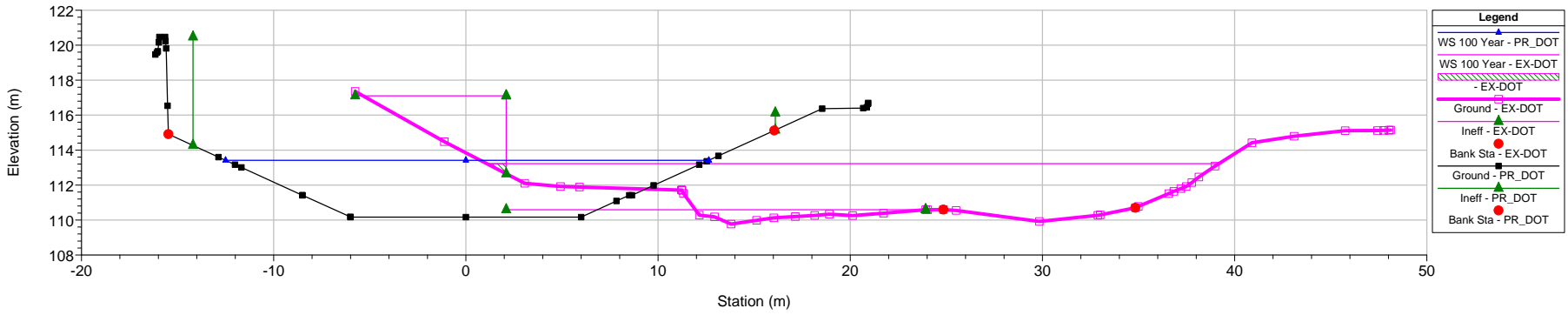
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1938.5 BR Proposed Bridge No. 06591



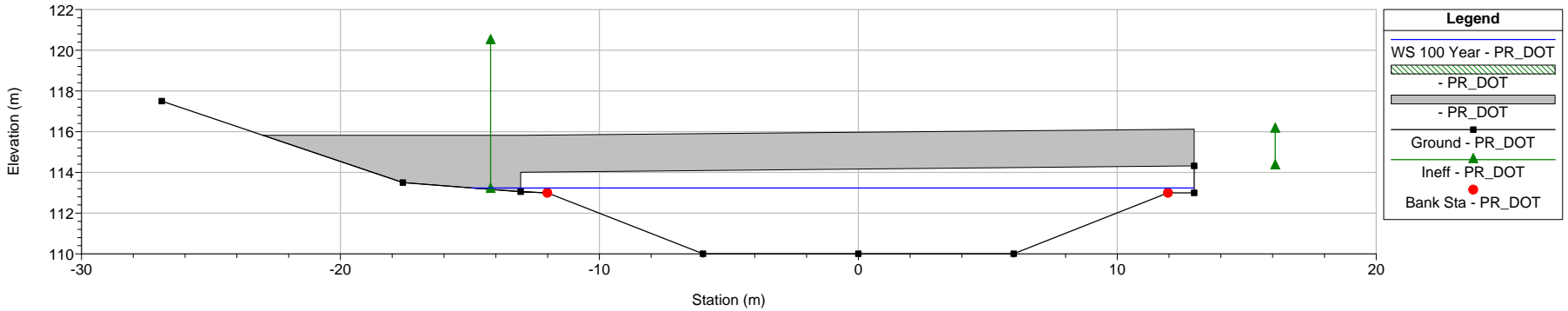
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1900 Between I-84 (05774) and WB Exit 24 On-Ramp (06591)



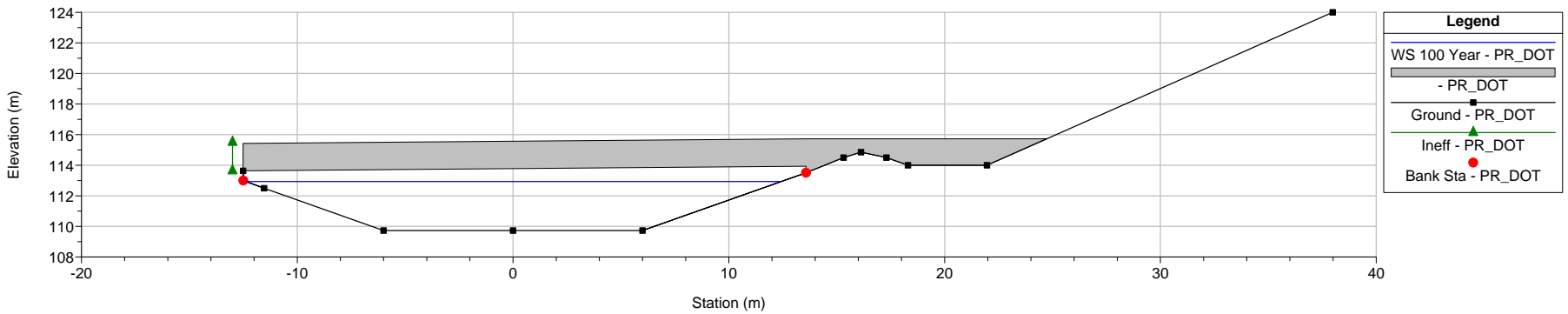
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1871 U/S of Prop I-84 Bridge 05774



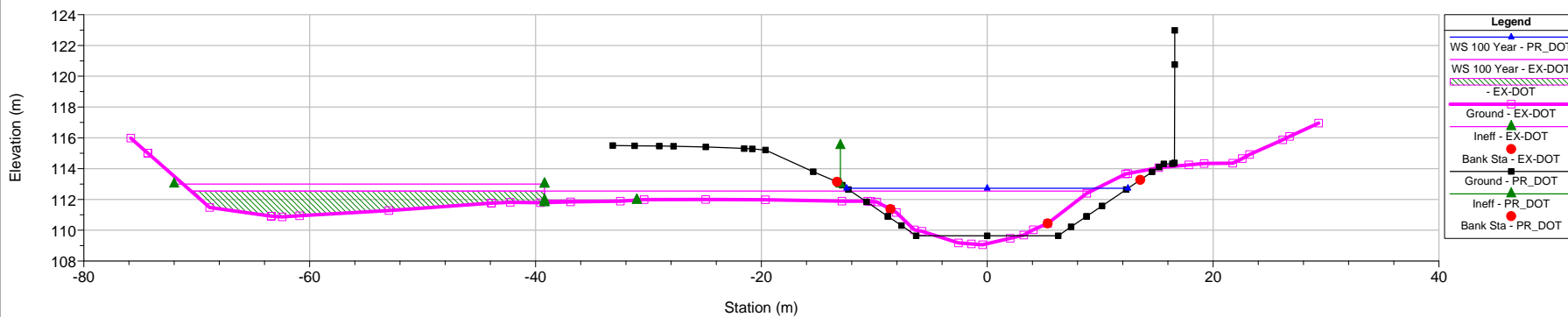
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1807.5 BR Proposed I-84 Bridge No. 05774



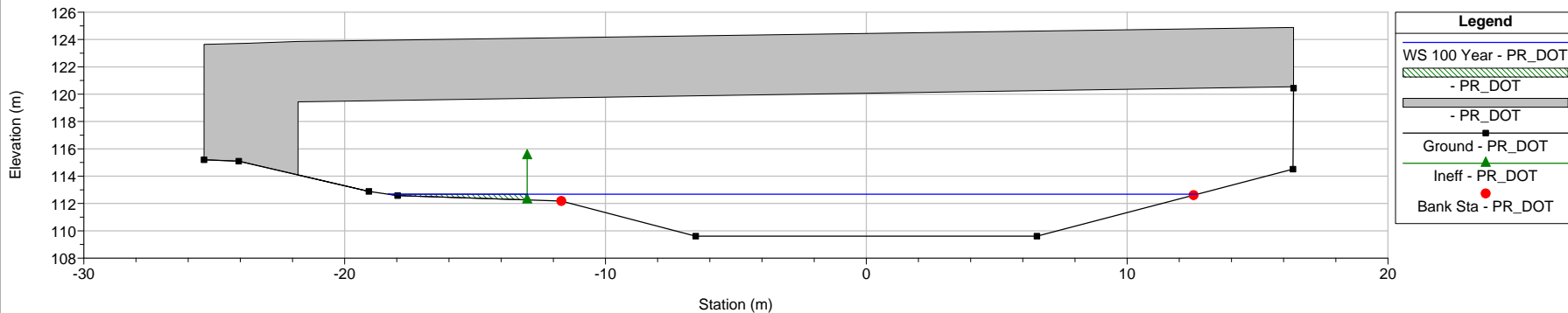
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1807.5 BR Proposed I-84 Bridge No. 05774



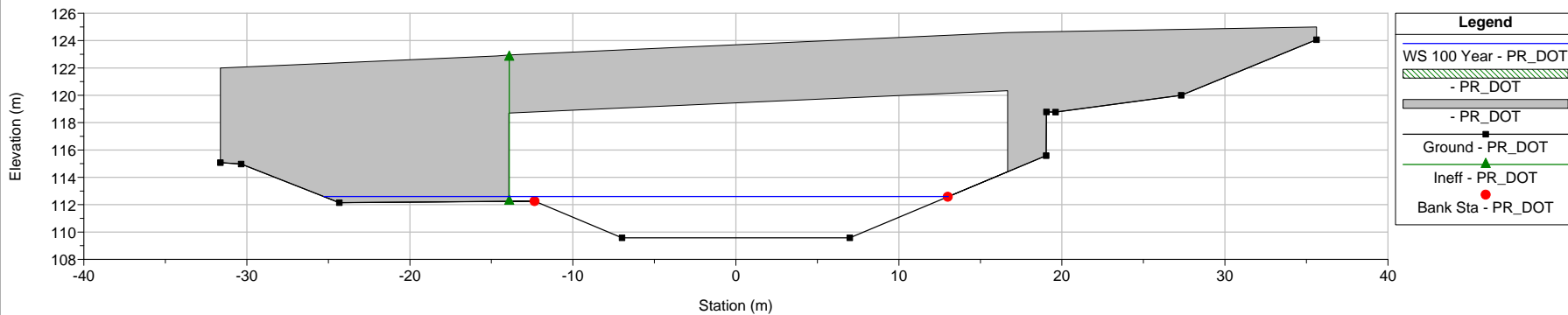
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
RS = 1748 Between Proposed Bridges 06284 & 05774



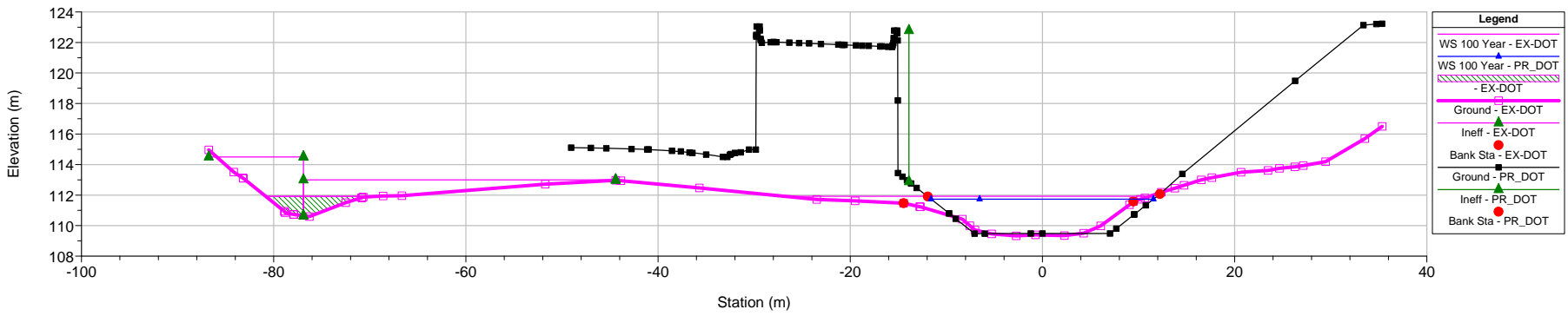
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
RS = 1727.5 BR Proposed I-84 E24 Off-Ramp Bridge No.06284



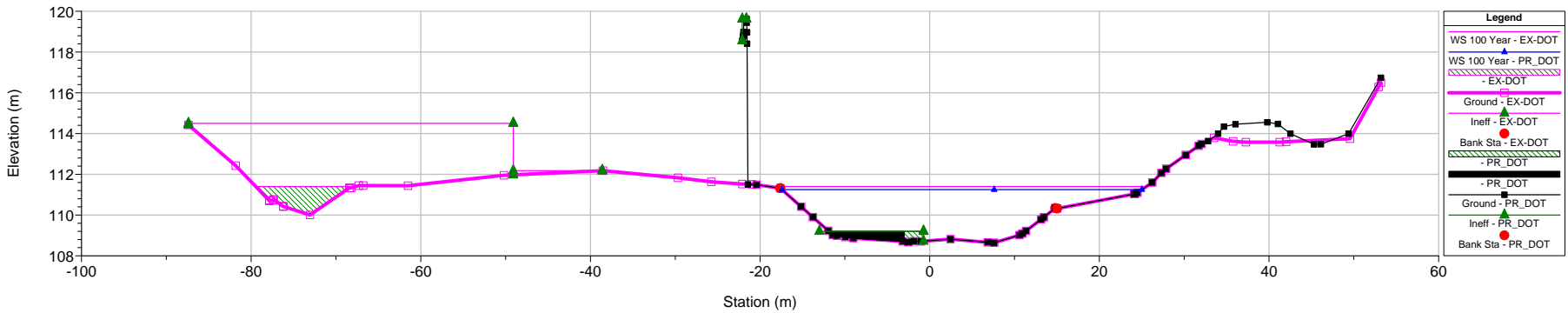
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
RS = 1727.5 BR Proposed I-84 E24 Off-Ramp Bridge No.06284



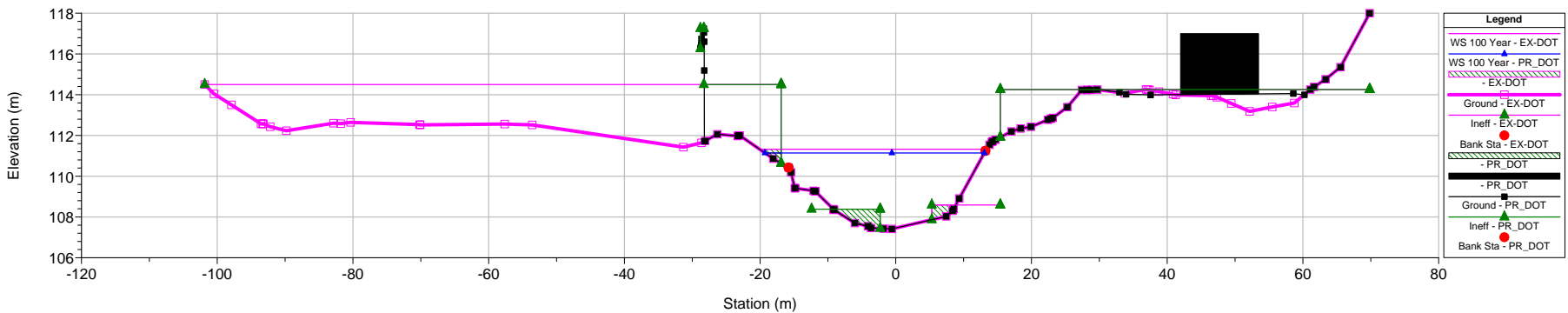
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1689 FEMA Station 5137, Cross Section AG



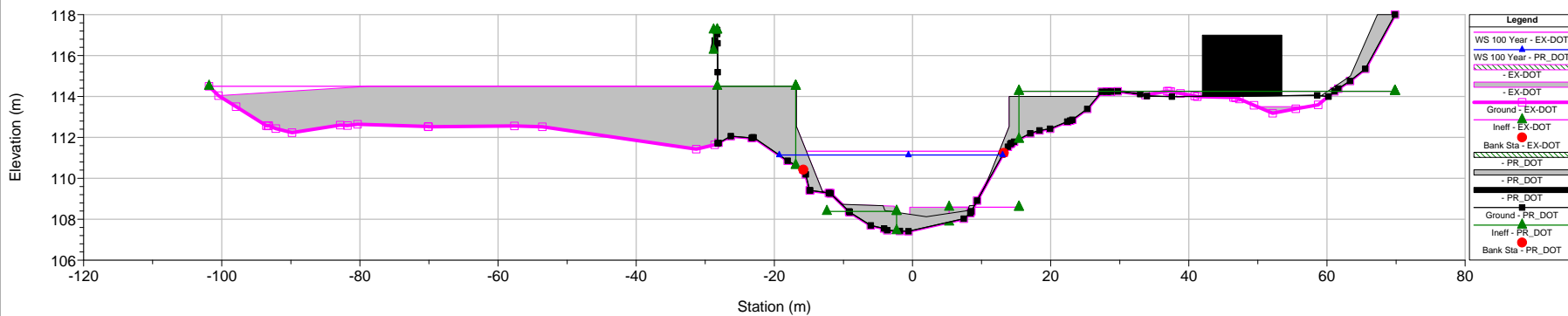
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1620 Cross Section within Former Century Pond



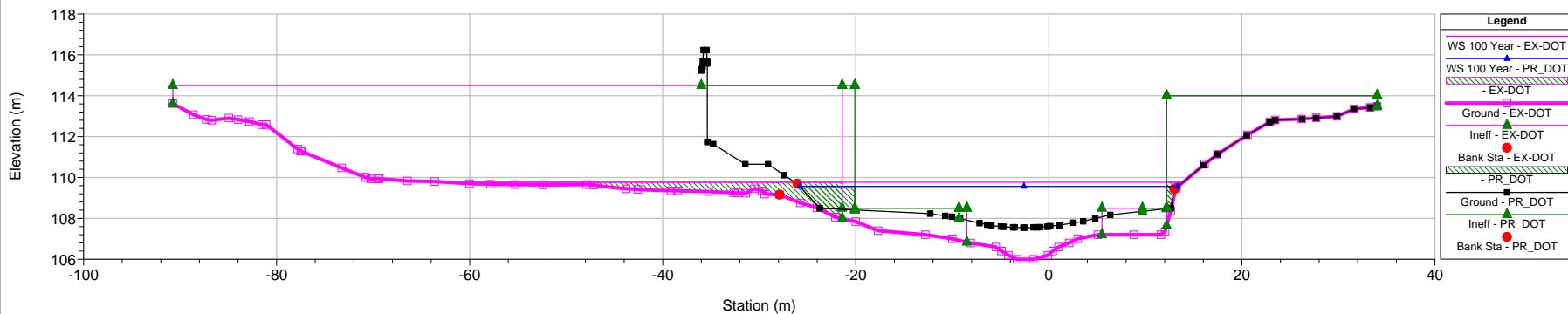
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1573 Upstream Heel Breached Century Dam



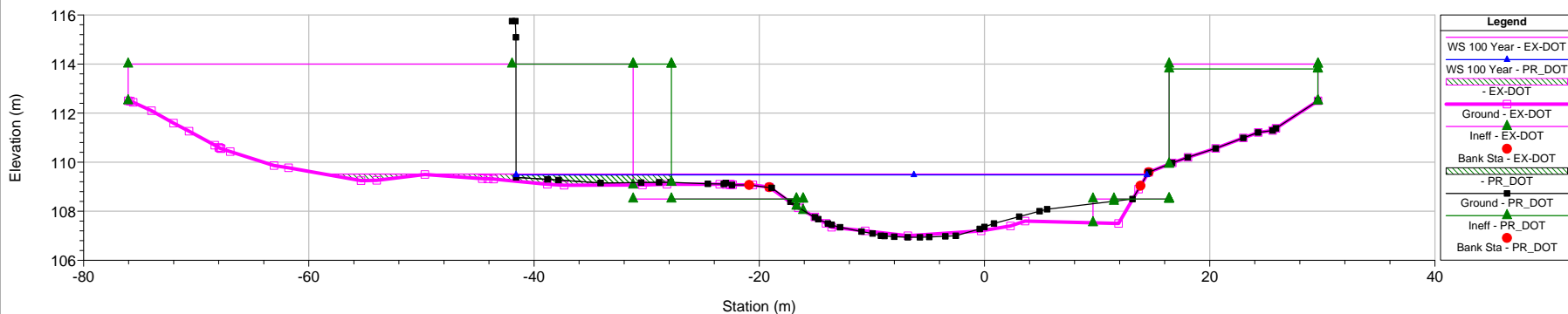
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1561.5 IS Breached Century Dam



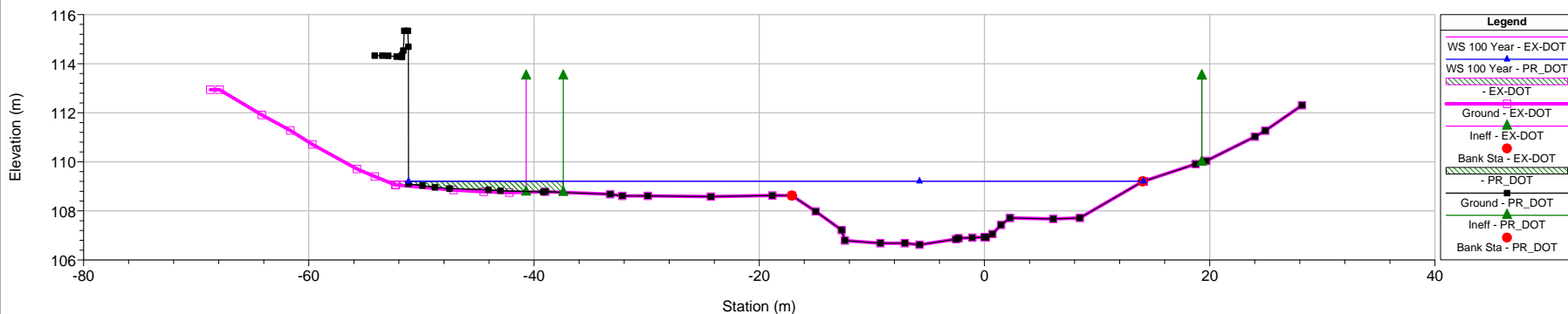
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1550 Middle of proposed Rock Ramp Fishway (downstream of dam)



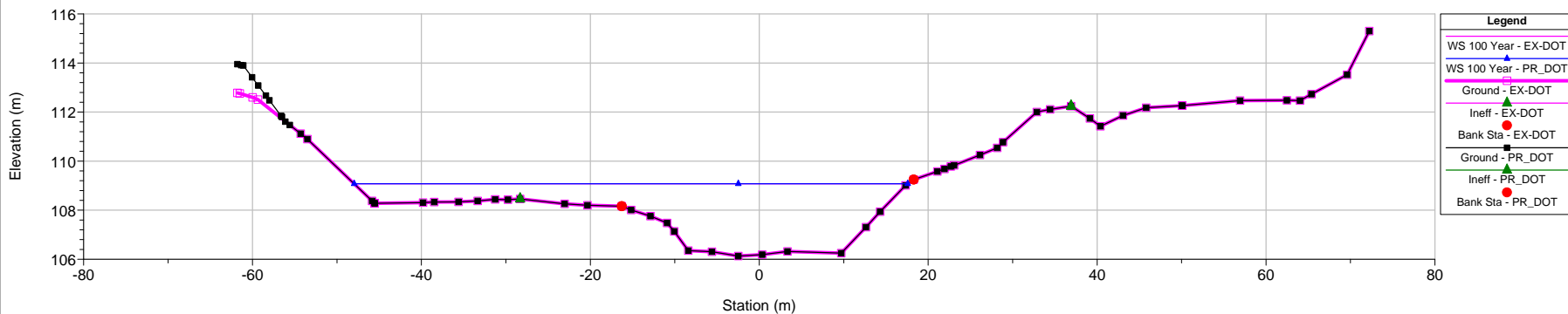
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1536 Downstream Toe of Proposed Rock Ramp



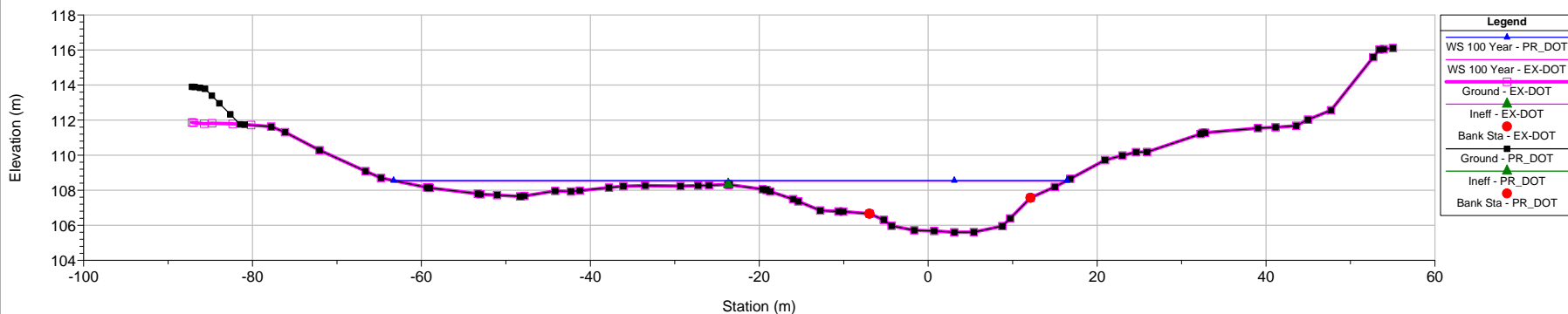
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1523 FEMA STATION 5136, CROSS SECTION AF



Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1487 73 m D/S of Century Dam

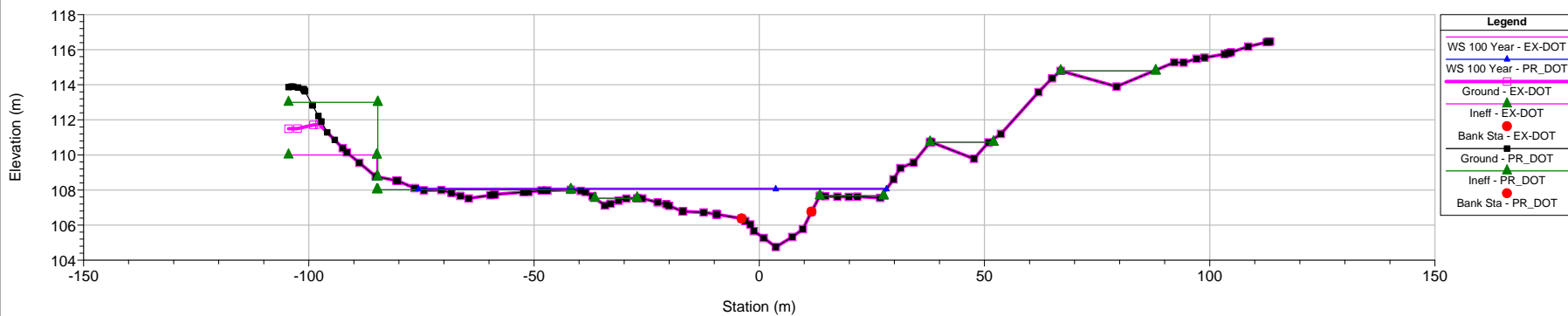


Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1425 135 m D/S of Century Dam

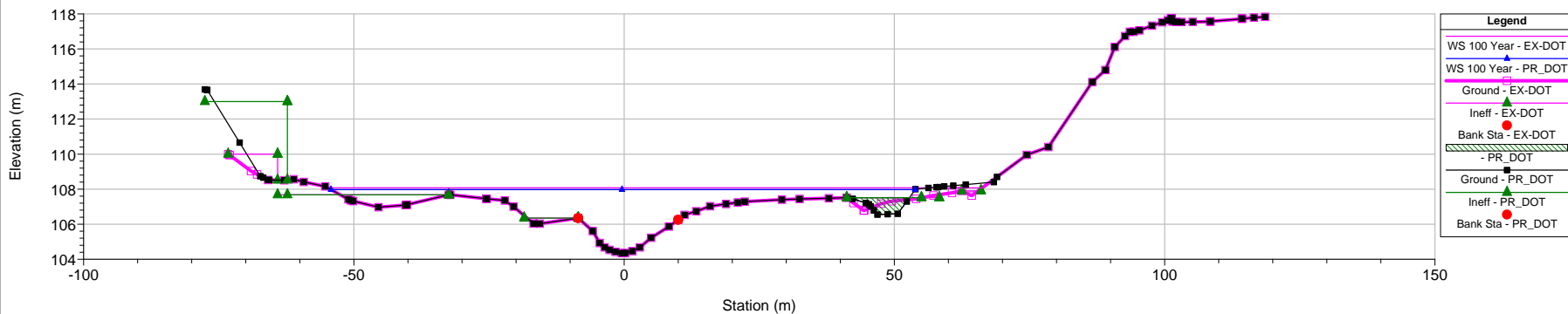




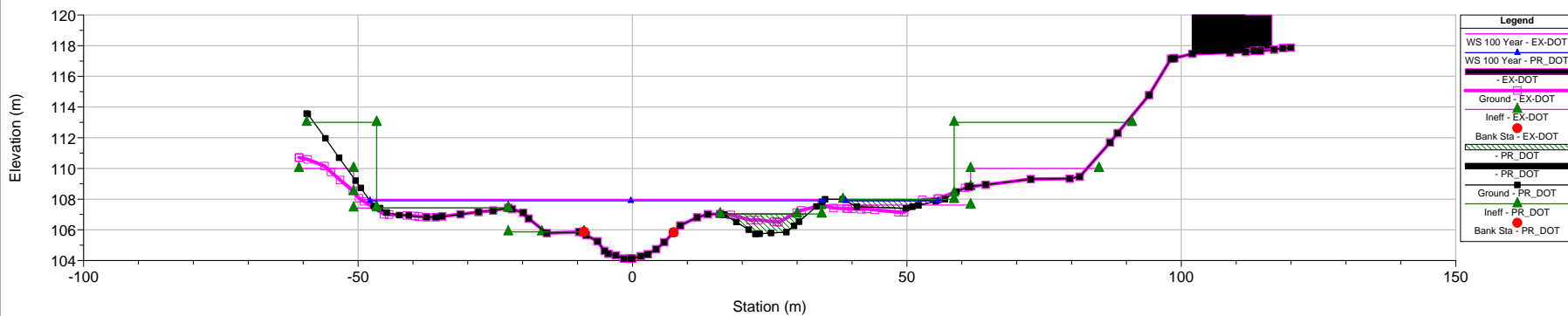
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1370 FEMA STATION 5135, CROSS SECTION AE



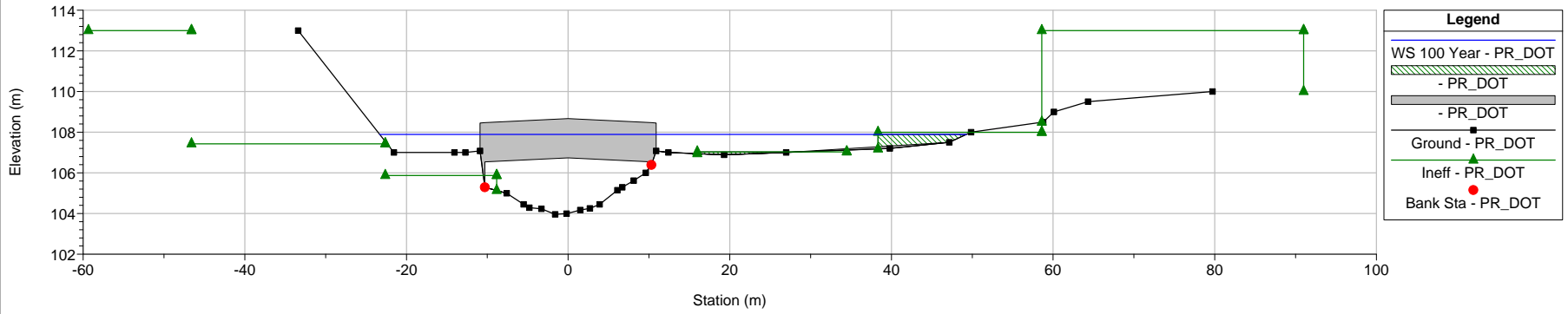
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1330 39m U/S Proposed Pedestrian Bridge



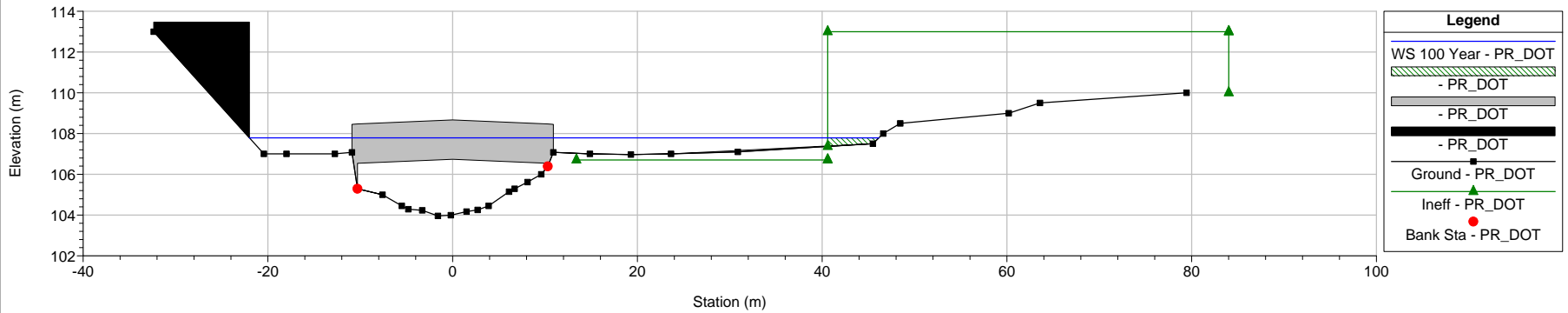
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1309 U/S of Proposed Pedestrian Bridge



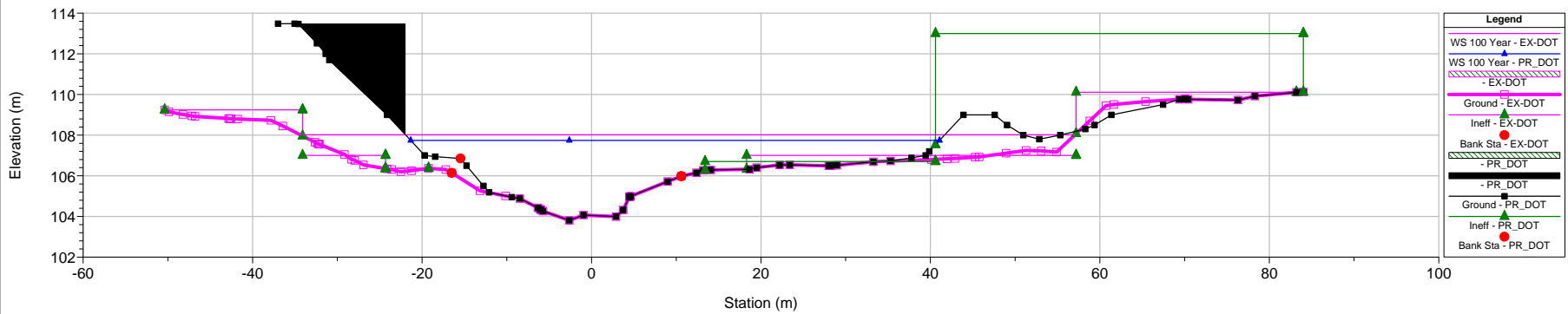
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1288.5 BR Proposed Pedestrian Bridge



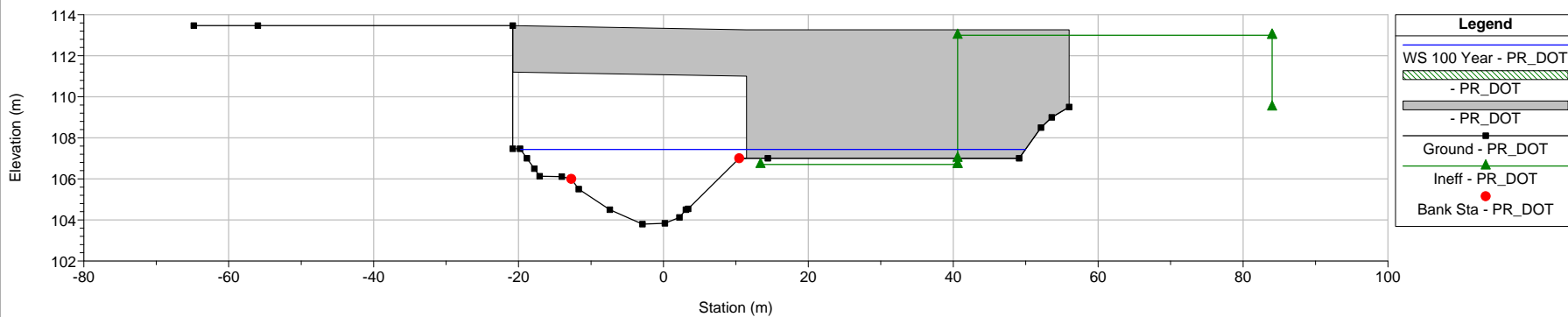
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1288.5 BR Proposed Pedestrian Bridge



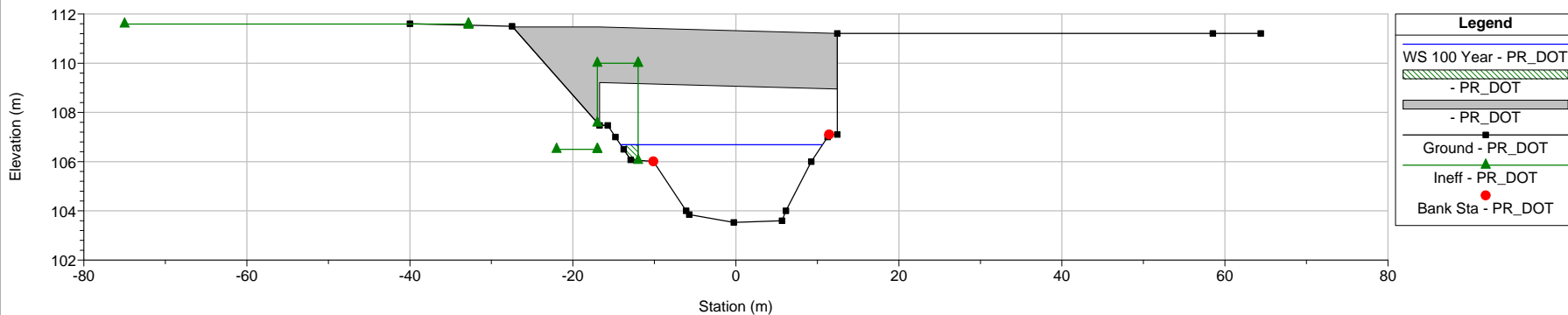
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1277 Between I-84 / Pedestrian bridges (FEMA Sta 5134, Sec AD)



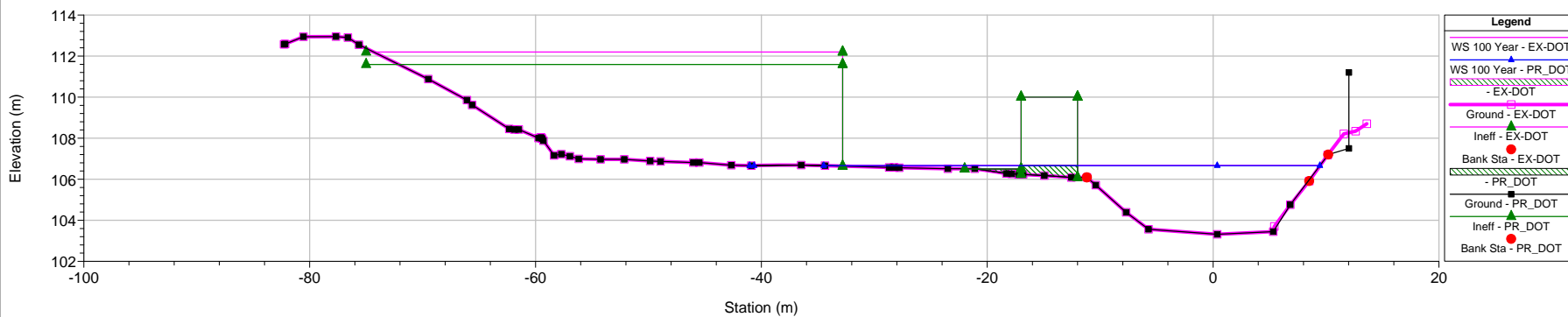
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1214.5 BR Proposed I-84 Bridge No. 01224



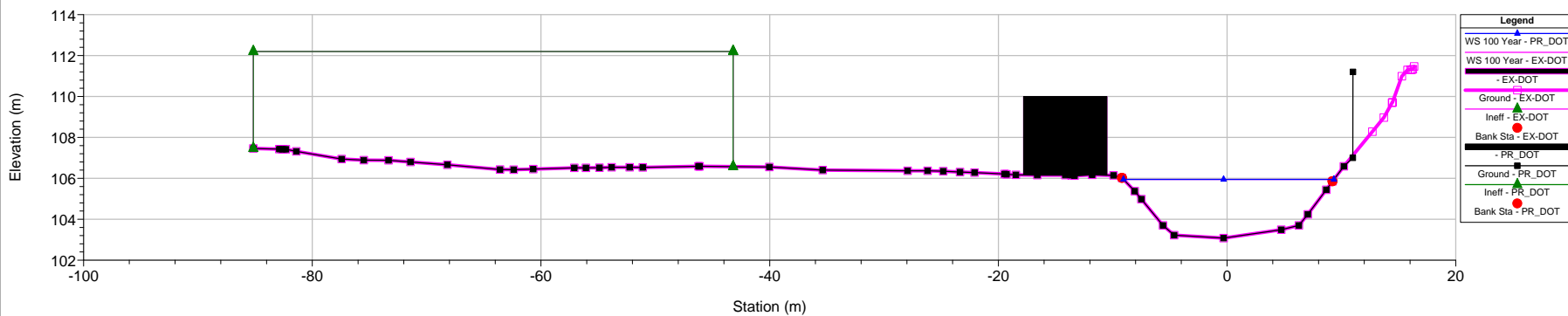
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1214.5 BR Proposed I-84 Bridge No. 01224



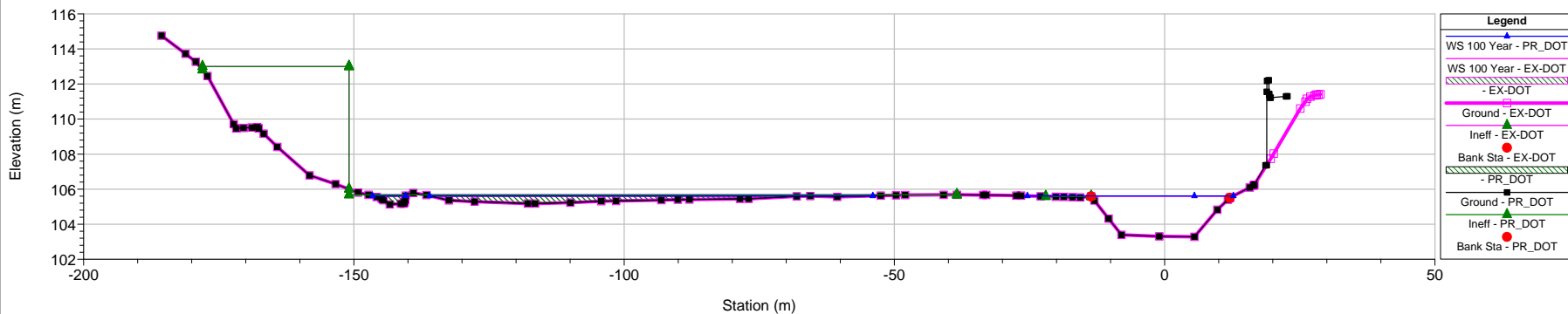
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1162 7m D/S Proposed I-84 Bridge 01224



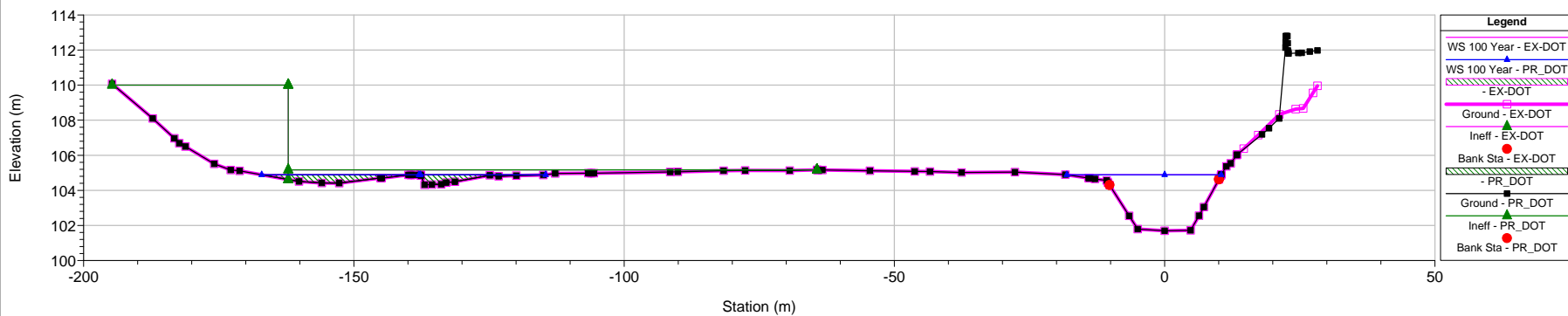
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1153 15m downstream of Proposed I-84 Bridge No. 01224



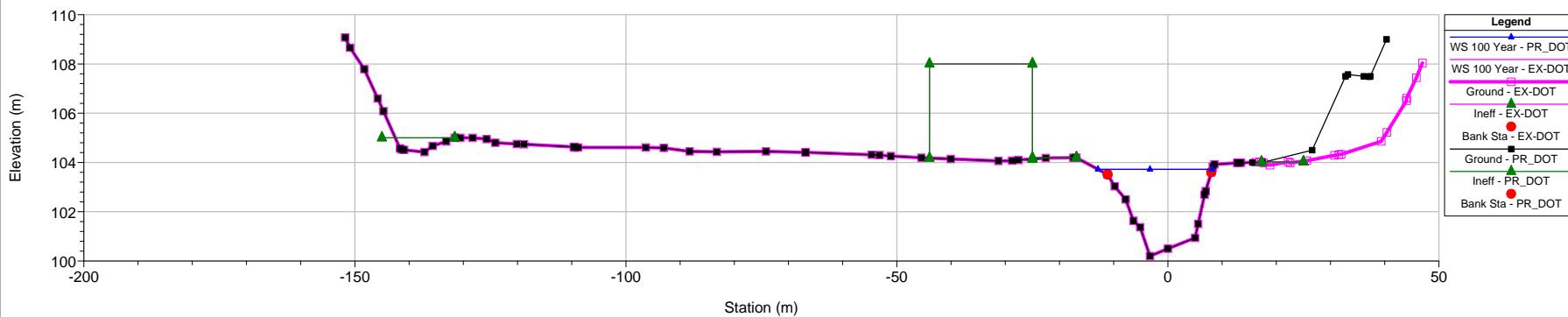
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1107 62 m downstream of Proposed I-84 Br 01224



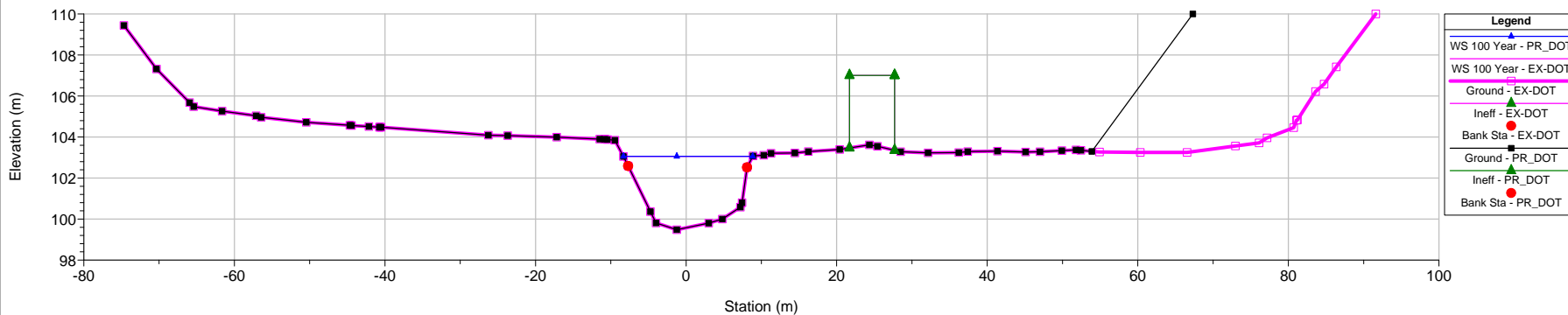
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 1003 166 m downstream of Proposed I-84 Br 01224



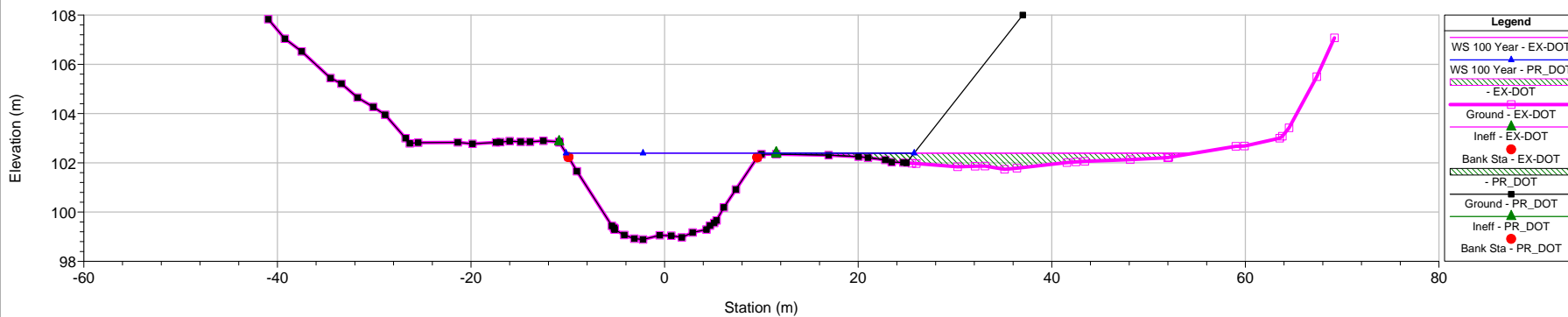
Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 894 FEMA STATION 5131, CROSS SECTION AA



Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 809 360 m downstream of Proposed I-84 Br 01224

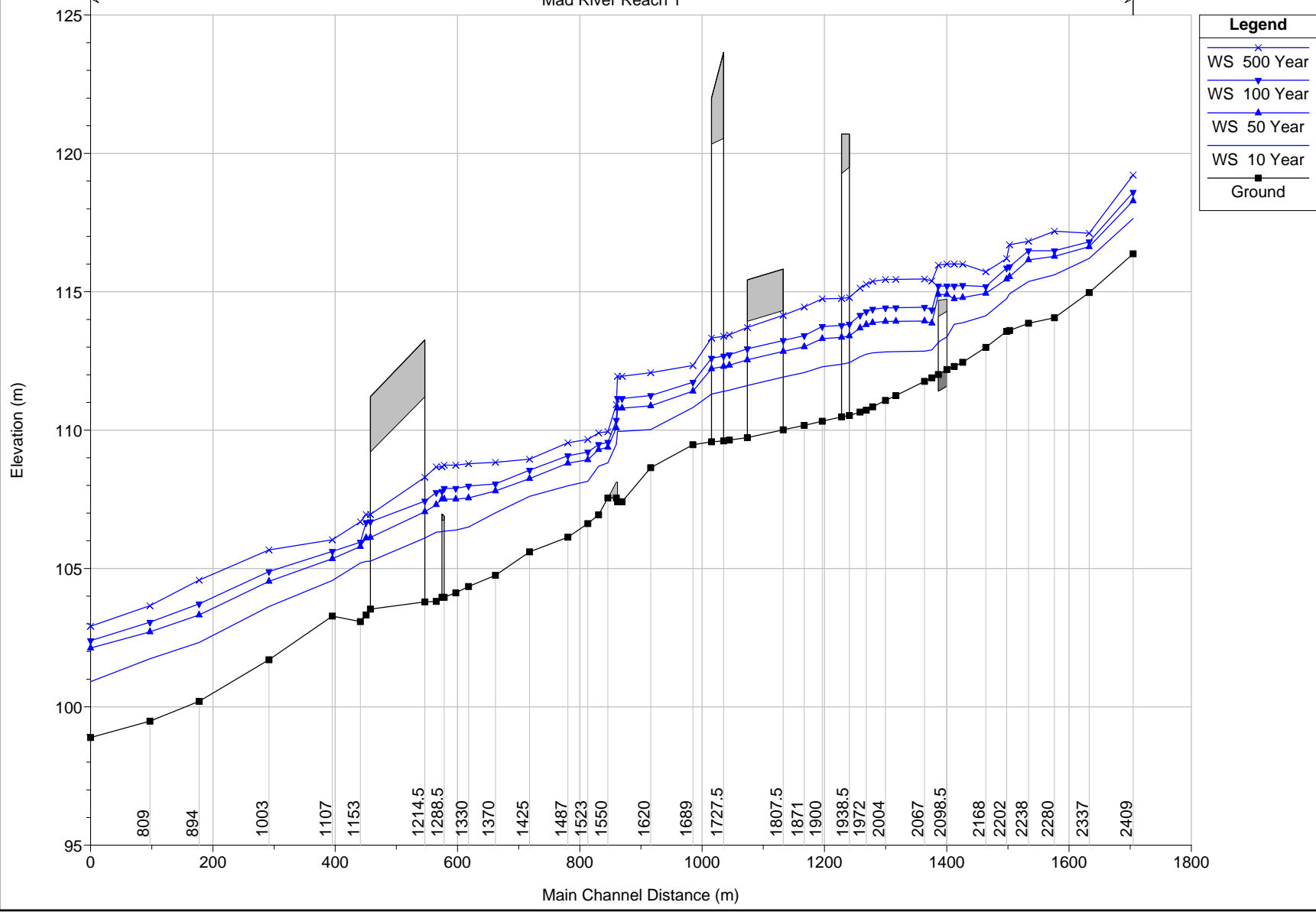


Mad River, 151-273, Metric Plan: 1) PR\_DOT 2) EX-DOT  
 RS = 714 FEMA STATION 5130, CROSS SECTION Z



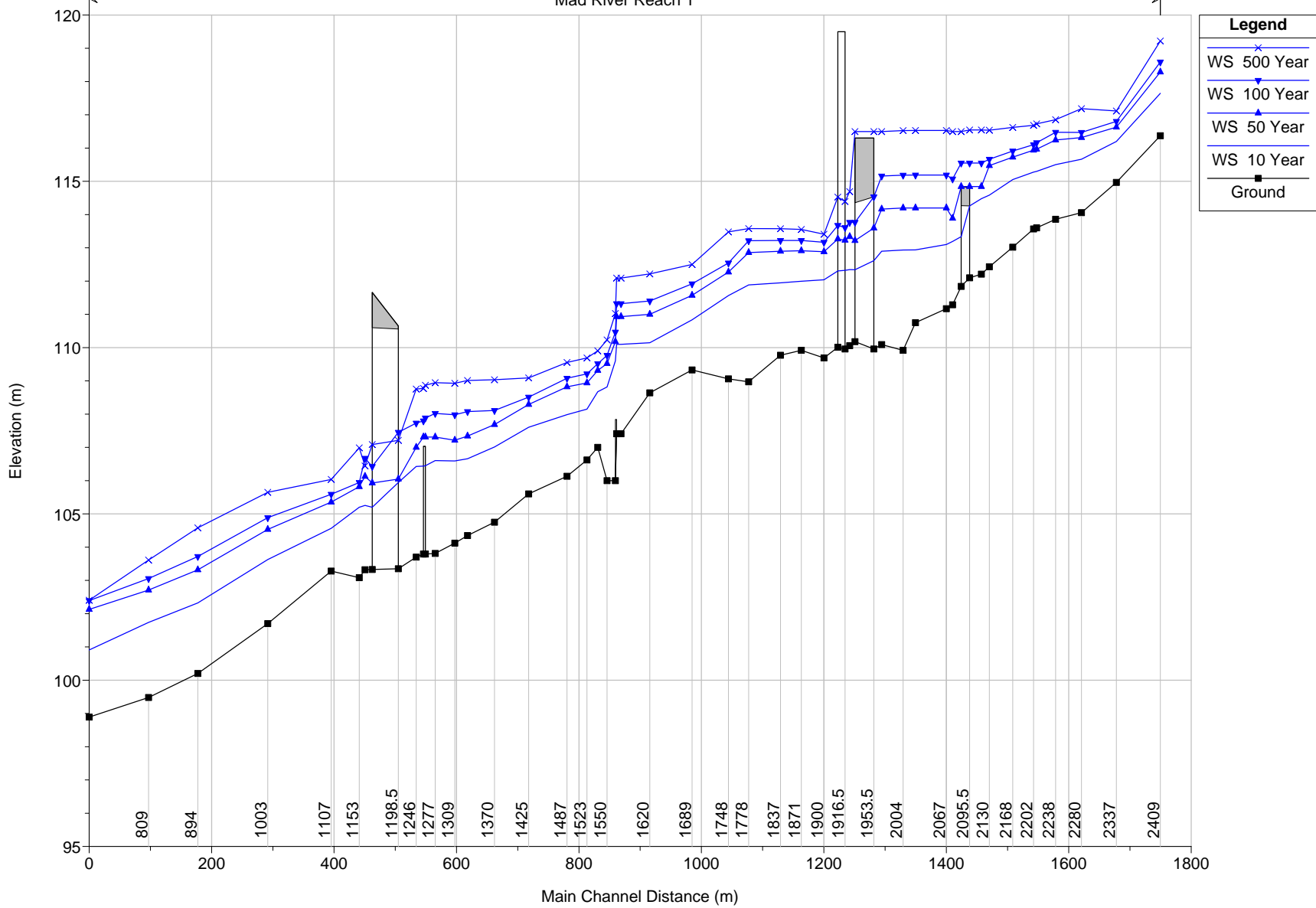
Mad River, 151-273, Metric Plan: PROPOSED (New Survey), ConnDOT Q 10/4/2013

Mad River Reach 1



Mad River, 151-273, Metric Plan: EXISTING (New Survey), ConnDOT Q 9/12/2013

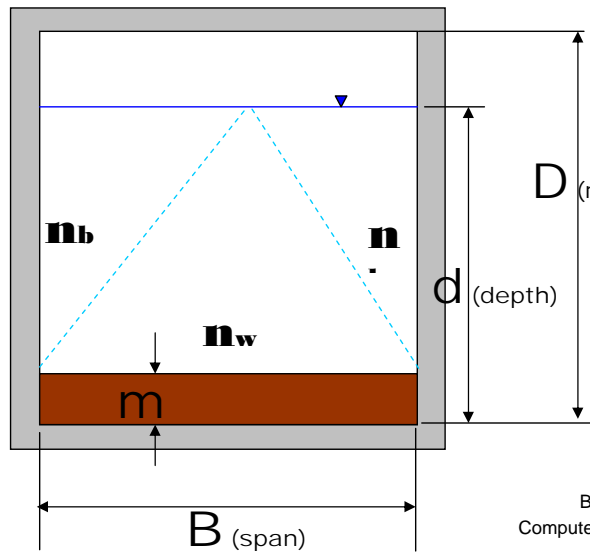
Mad River Reach 1



**APPENDIX C. MANNING'S ROUGHNESS COEFFICIENT COMPUTATION FOR CULVERT NO. 05668**

**Culvert Filled with Natural Streambed Material**

Project No.	151-273	Prepared by	W. SONG	Date	2/1/2006
Route No.	I-84	Checked by		Date	
Town	Waterbury	Stream	Mad River	Unit	Metric



$$n = \frac{n_w}{\sqrt{1 + \frac{P_w}{P_b}}} \left[ \left( \frac{P_w}{P_b} \right)^{3/4} + \left( \frac{n_b}{n_w} \right)^{3/2} \right]^{2/3}$$

where: n = composite roughness coefficient  
 nb = roughness coefficient of culvert bed  
 nw = roughness coefficient of culvert walls  
 Pb = culvert bottom contribution to the wetted perimeter  
 Pw = addition to the wetted perimeter from the walls and ceiling  
 P = Pb + Pw = total wetted perimeter of the culvert opening.

Pb = B  
 Pw = 2d, if flowing partial  
 = 2d + B, if flowing full

Height: D = 2.7 m      nb = 0.035 (gravel)  
 Span: B = 4 m      nw = 0.012 (concrete)  
 Bedding Depth: m = 0.6 m      Pb = 4  
 Computed Flow Depth: d = 2.7 m      Pw = 4.2  
 Flowing Full -  No      (100-YR) n = **0.0277**

Design Freq. (Year)	Q in Barrel (cu.m/s)	Normal Depth (m)	Flowing Full	Pw	n
10	15.57	1.78	No	2.36	0.0312
25	23.6	2.18	No	3.16	0.0299
50	29.96	2.49	No	3.78	0.0290
100	31.56	2.7	Yes	8.2	0.0248
500	26.67	2.7	Yes	8.2	0.0248
				Ave. =	<b>0.028</b>

**Recommendation: Use 0.028 for all flow conditions**



**Culvert with Baffle**

**Culvert No. 05668 when baffles are exposed**

Procedure from "Design Considerations and Calculations for Fishway Through Box Culverts,"  
by F.M. Chang and J.M. Norman, September 1976

**Baffle Info**

Ratio - Spacing:Baffle Height = 10:1  
 Height: h = 22.0 cm = 0.22 m  
 Spacing: λ = 2.2 m  
 Notch Width: = 15.0 cm = 0.15 m  
 Length: l = 4 m

**Culvert**

Height: D = 2.7 m  
 Span: B = 4 m  
 h/D = 0.08  
 λ/D = 0.81

**Box Culvert Without Baffle**

*Friction Factor without baffle*

$f_w = [2 \log_{10} (R_H / K_s) + 2.34]^2 = 0.044$   
 $R_H = 0.81$  m (hydraulic radius)  
 Normal Depth = 2.7 m (from HEC-RAS run w/o baffle)  
 Q barrel = 37.23 cu.m/s  
 Cross-Sectional Area = 10.8 sq.m (for box)  
 Wetted Perimeter = 13.4 m (for box)  
 $K_s = 0.049$  cm (for concrete pipe)

**Box Culvert With Baffle**

*Friction Factor for baffle*

$f_b = C_D (h/\lambda) (R_H/D) (f_w/2) [6.25 (\ln h/K_s)^2 + 30.0 (\ln h/K_s) + 42.2]$   
 $C_D = 0.126$   
 $C_D = 1.90$  (Drag Coefficient)

*Combined Friction Factor*

$f_T = f_b + f_w = 0.170$

*Adjusted Friction Factor for notch in baffle*

$f'_T = f_w + (f_T - f_w) l/B = 0.165$

*Manning's Roughness Coefficient*

$n = 0.0926 R_H^{1/6} f_T^{1/2} = 0.0363$  (100-YR)

$f_T = 0.165$  (=  $f'_T$ )  
 $R_H = 0.81$  m (for concrete pipe)  
 Normal Depth = 2.7 m (from HEC-RAS run w/ baffle)  
 Q barrel = 33.35 cu.m/s  
 Cross-Sectional Area = 10.8 sq.m (for box)  
 Wetted Perimeter = 13.4 m (for box)  
 Flowing Full - Yes

Design Freq. (Year)	WITHOUT BAFFLE								WITH BAFFLE										
	Q in Barrel (cu.m/s)	Normal Depth (m)	X-sec. Area (sq.m)	Wet. Perim. (m)	$R_H$ (m)	$K_s$ (cm)	$f_w$	$n$	Q in Barrel (cu.m/s)	Normal Depth (m)	Full Flow	X-sec. Area (sq.m)	Wet. Perim. (m)	$R_H$ (m)	$C_D$	$f_b$	$f_T$	$f'_T$	$n$
10	15.57	0.9	3.6	9.8	0.37	0.049	0.060	0.019	15.57	1.54	No	5.3	6.64	0.80	1.90	0.078	0.138	0.135	0.033
25	23.6	1.2	4.8	10.4	0.46	0.049	0.054	0.019	23.60	2.09	No	7.5	7.74	0.97	1.90	0.090	0.144	0.141	0.035
50	32.09	1.49	6.0	10.98	0.54	0.049	0.051	0.019	32.09	2.63	No	9.6	8.82	1.09	1.90	0.099	0.150	0.146	0.036
100	37.23	2.7	10.8	13.4	0.81	0.049	0.044	0.019	33.35	2.7	Yes	9.9	12.96	0.77	1.90	0.126	0.170	0.165	0.036
500	33	2.7	10.8	13.4	0.81	0.049	0.044	0.019	28.80	2.7	Yes	9.9	12.96	0.77	1.90	0.126	0.170	0.165	0.036
Ave. =																			0.035

**Recommendation:** Use **0.035** for all flow conditions

## APPENDIX D. Return Frequency Determination For Overtopping Condition

- UPSTREAM OF PLANK ROAD CROSSING
  - Section 2168 (Proposed Condition) ..... 1
  - Section 2168 (Existing Condition) ..... 3
  
- PLANK ROAD CROSSING
  - Culvert No. 05668 (Proposed Condition) ..... 5
  - Structure No. 05668 (Existing Condition) ..... 8
  
- PEDESTRIAN CROSSING
  - Proposed Bridge ..... 11
  - Existing Bridge ..... 13

## Upstream of Plank Road (Proposed Condition) Overtopping Flow

### KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
2			
10	0.1	1650	46.72
25	0.04	2500	70.79
50	0.02	3400	96.28
100	0.01	4400	124.59
500			

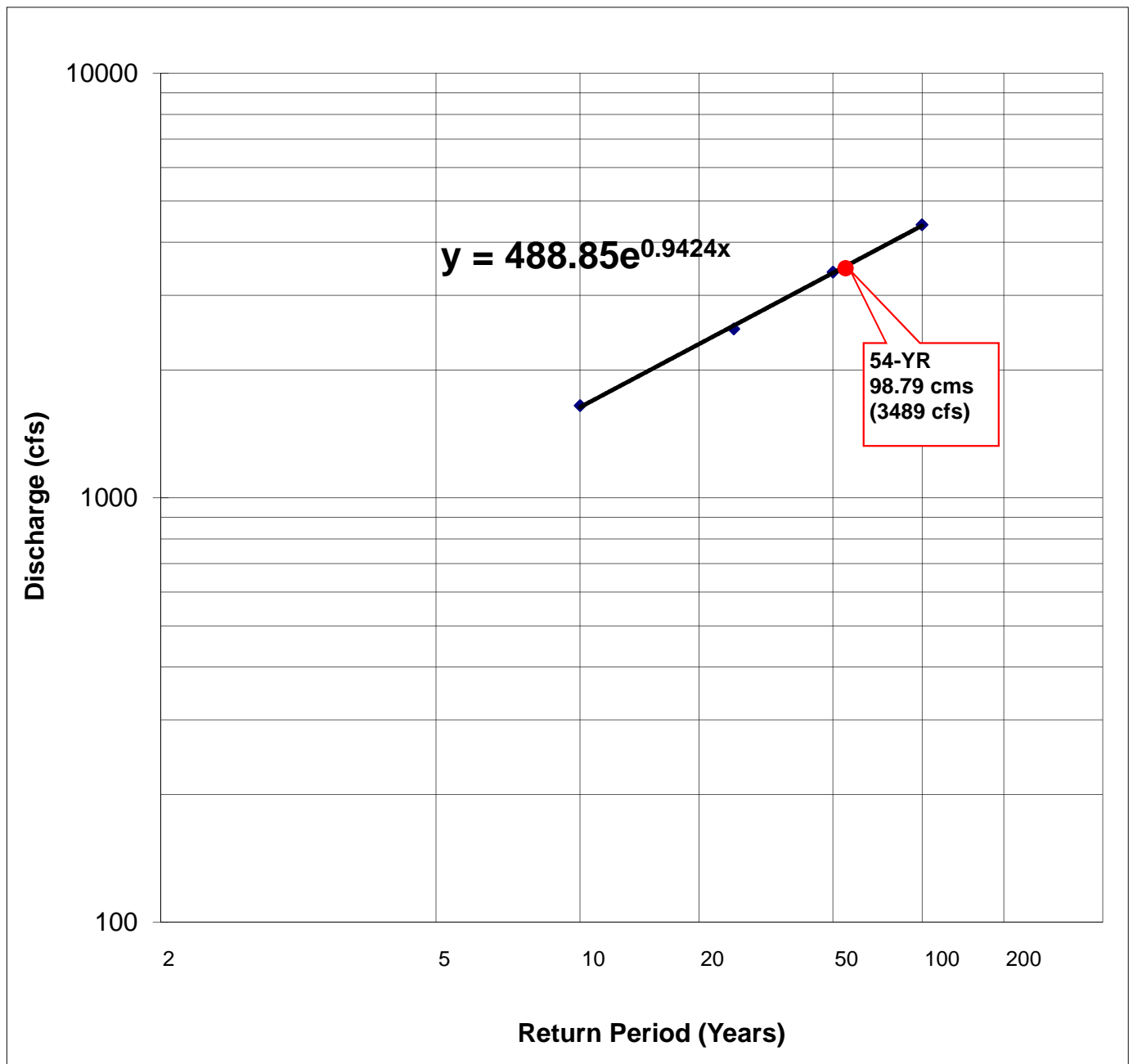
$$y = C \times \text{EXP}(p \times F) = 488.85e^{0.9424x}$$

$$= 3489 \text{ cfs}$$

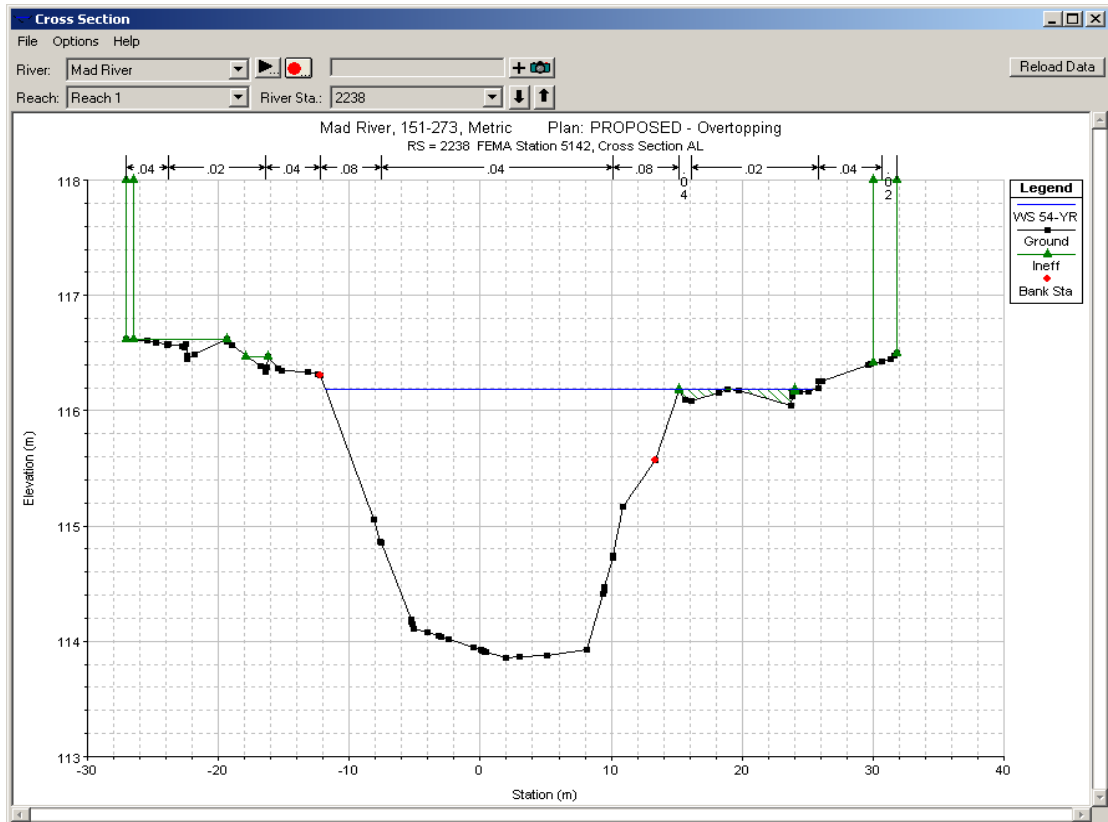
$$= 98.79 \text{ cms}$$

C =	488.85
p =	0.9424
y =	discharge
F =	x-axis value of return frequency
	= 2.0854

F of 2.0854 equals to Return Frequency of 54-YR



# Upstream of Plank Road (Proposed Condition) Overtopping Flow HEC-RAS Output



**Cross Section Output**

River: Mad River Profile: 54-YR  
Reach: Reach 1 RS: 2238 Plan: PR\_DOT\_OVT

Plan: PR_DOT_OVT		Mad River	Reach 1	RS: 2238	Profile: 54-YR
E.G. Elev (m)	116.45				
Vel Head (m)	0.26				
W.S. Elev (m)	116.18				
Crit W.S. (m)	115.57				
E.G. Slope (m/m)	0.007477				
Q Total (m3/s)	98.79				
Top Width (m)	36.68				
Vel Total (m/s)	2.25				
Max Chl Dpth (m)	2.32				
Conv. Total (m3/s)	1142.5				
Length Wtd. (m)	31.00				
Min Ch El (m)	113.86				
Alpha	1.02				
Frictn Loss (m)	0.30				
C & E Loss (m)	0.03				
Element		Left OB	Channel	Right OB	
W/t. n-Val.			0.054	0.079	
Reach Len. (m)		30.00	31.00	32.00	
Flow Area (m2)			43.32	0.59	
Area (m2)			43.32	1.12	
Flow (m3/s)			98.51	0.28	
Top Width (m)			25.18	11.49	
Avg. Vel. (m/s)			2.27	0.47	
Hydr. Depth (m)			1.72	0.18	
Conv. (m3/s)			1139.3	3.2	
Wetted Per. (m)			25.80	3.37	
Shear (N/m2)			123.10	12.79	
Stream Power (N/m s)			279.91	6.02	
Cum Volume (1000 m3)		20.54	71.38	3.06	
Cum SA (1000 m2)		23.56	34.84	7.93	

**Errors, Warnings and Notes**

- Warning:** Divided flow computed for this cross-section.
- Warning:** The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
- Warning:** The energy loss was greater than 1.0 ft (0.3 m) between the current and previous cross section. This may indicate the need for additional cross sections.
- Note:** Manning's n values were composited to a single value in the main channel

Select Profile

# Upstream of Plank Road (Existing Condition) Overtopping Flow

## KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
2			
10	0.1	1650	46.72
25	0.04	2500	70.79
50	0.02	3400	96.28
100	0.01	4400	124.59
500			

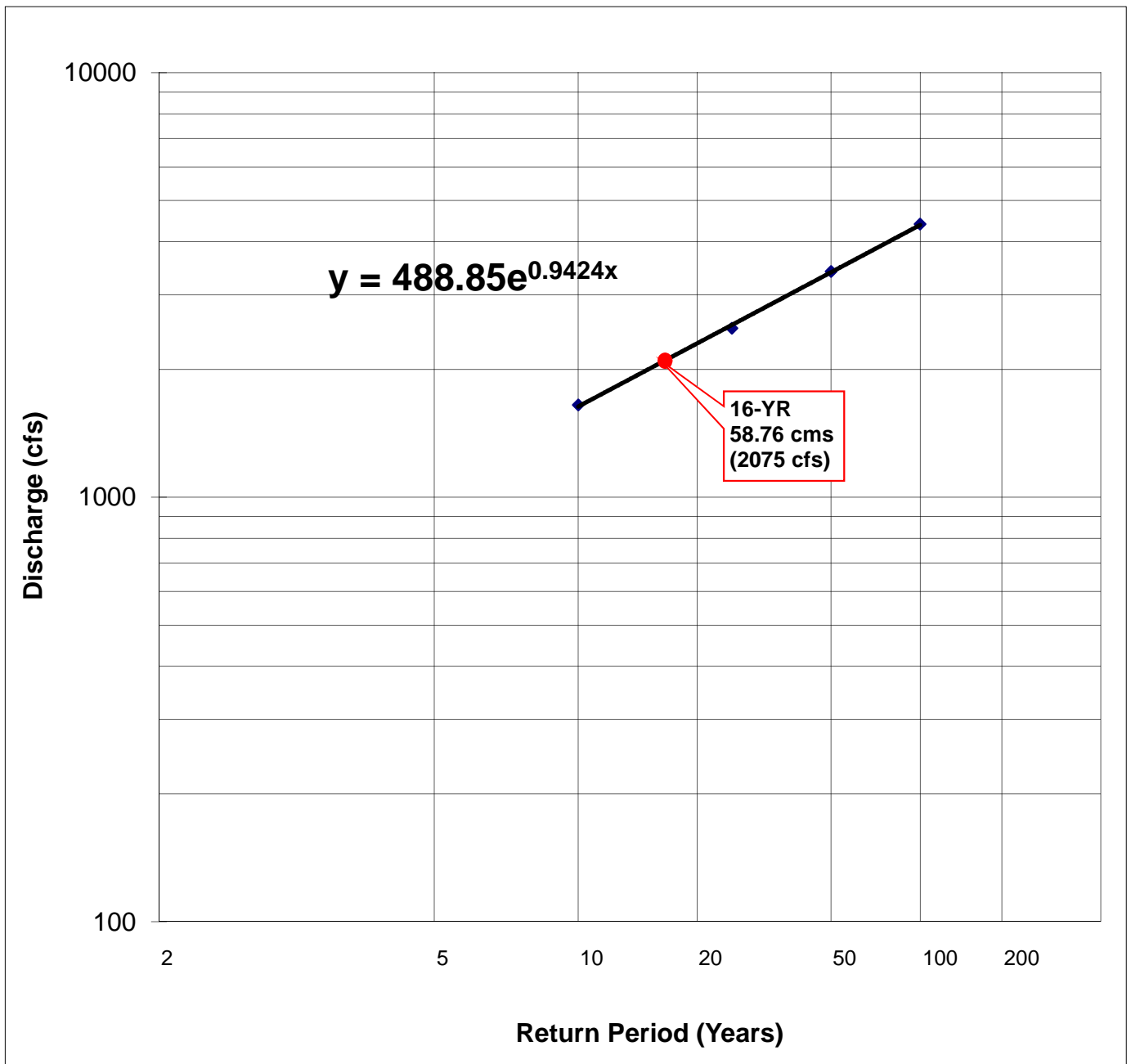
$$y = C \times \text{EXP}(p \times F) = 488.85e^{0.9424x}$$

$$= 2075 \text{ cfs}$$

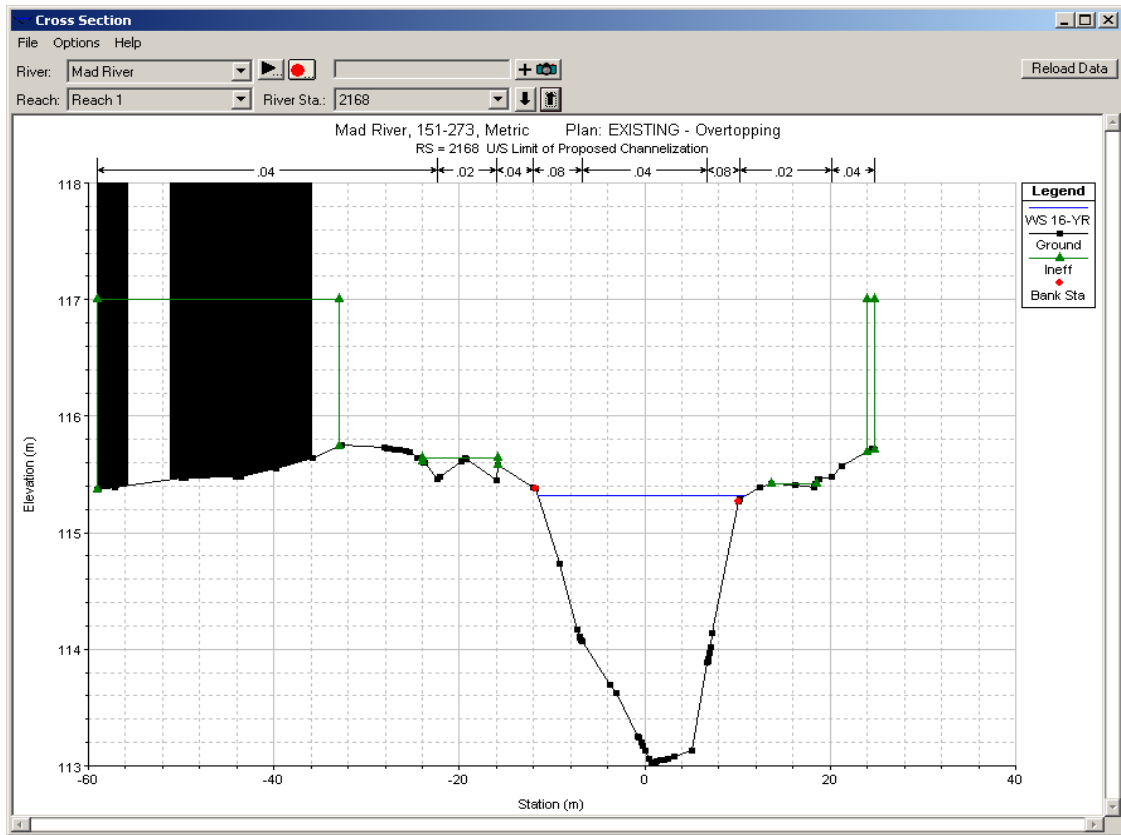
$$= 58.76 \text{ cms}$$

C = 488.85  
 p = 0.9424  
 y = discharge  
 F = x-axis value of return frequency  
 = 1.5341

F of 1.5341 equals to Return Frequency of 16-YR



# Upstream of Plank Road (Existing Condition) Overtopping Flow HEC-RAS Output



Cross Section Output					
File Type Options Help					
River:	Mad River	Profile:	16-YR		
Reach:	Reach 1	RS:	2168	Plan:	EX-DOT_OT
Plan: EX-DOT_OT Mad River Reach 1 RS: 2168 Profile: 16-YR					
E.G. Elev (m)	115.50	Element	Left OB	Channel	Right OB
Vel Head (m)	0.18	Wt. n-Val.		0.057	0.039
W.S. Elev (m)	115.31	Reach Len. (m)	38.00	38.20	39.00
Crit W.S. (m)	114.66	Flow Area (m2)		31.07	0.01
E.G. Slope (m/m)	0.007390	Area (m2)		31.07	0.01
Q Total (m3/s)	58.76	Flow (m3/s)		58.76	0.00
Top Width (m)	22.23	Top Width (m)		21.51	0.72
Vel Total (m/s)	1.89	Avg. Vel. (m/s)		1.89	0.17
Max Chl Dpth (m)	2.29	Hydr. Depth (m)		1.44	0.02
Conv. Total (m3/s)	683.5	Conv. (m3/s)		683.5	0.0
Length Wtd. (m)	38.20	Wetted Per. (m)		22.20	0.72
Min Ch El (m)	113.02	Shear (N/m2)		101.43	1.28
Alpha	1.00	Stream Power (N/m s)	1186.41	0.00	0.00
Frctn Loss (m)	0.39	Cum Volume (1000 m3)	14.84	51.91	3.48
C & E Loss (m)	0.01	Cum SA (1000 m2)	15.60	29.46	4.48
Errors, Warnings and Notes					
<b>Warning:</b>	The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.				
<b>Warning:</b>	The energy loss was greater than 1.0 ft (0.3 m) between the current and previous cross section. This may indicate the need for additional cross sections.				
<b>Note:</b>	Manning's n values were composited to a single value in the main channel.				
<b>Note:</b>	Multiple critical depths were found at this location. The critical depth with the lowest valid energy was used.				
Select Profile					

## Proposed Culvert No. 05668 (Plank Road) Overtopping Flow

### KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
2			
10	0.1	1650	46.72
25	0.04	2500	70.79
50	0.02	3400	96.28
100	0.01	4400	124.59
500			

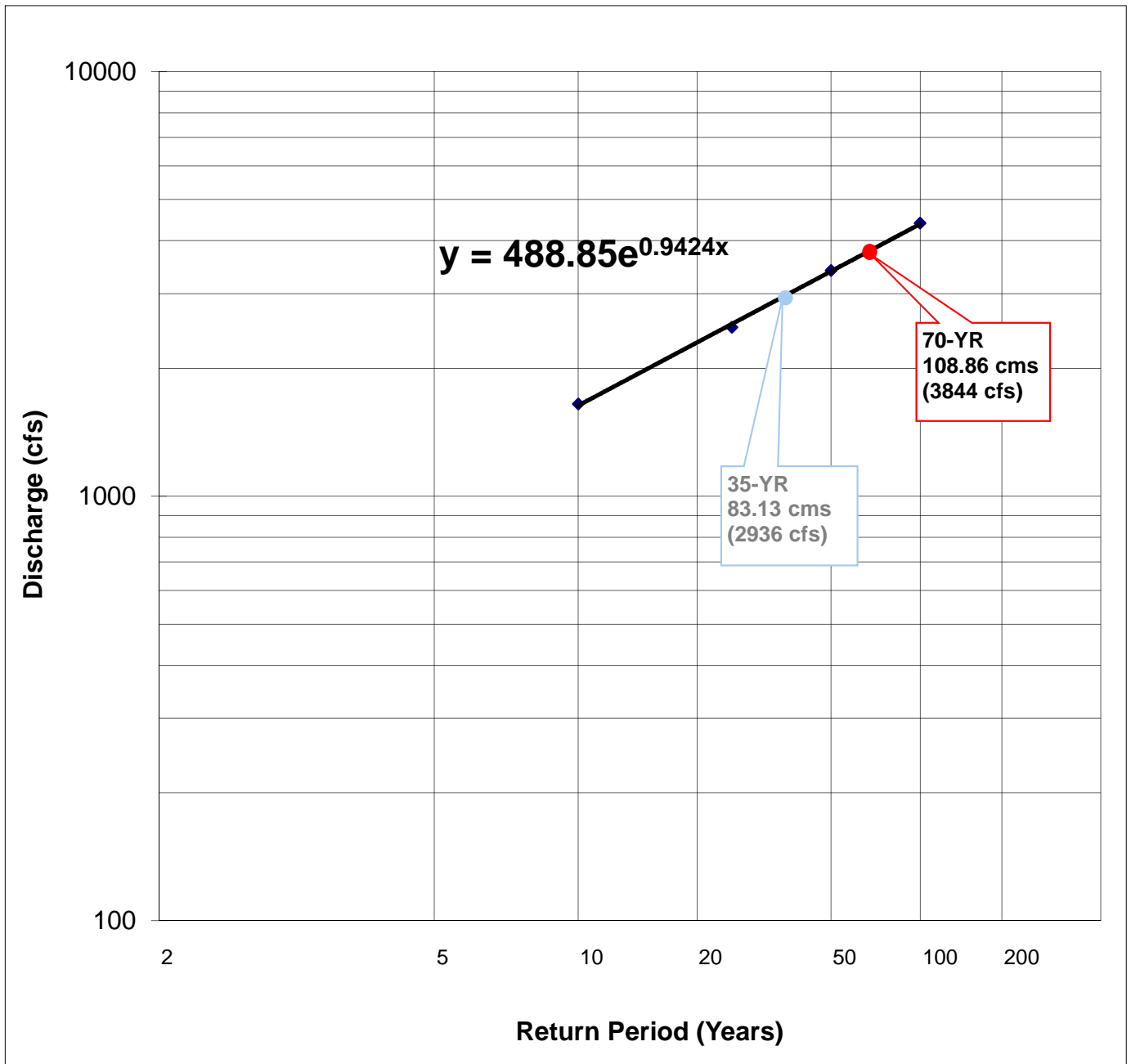
$$y = C \times \text{EXP}(p \times F) = 488.85e^{0.9424x}$$

$$= 3844 \text{ cfs}$$

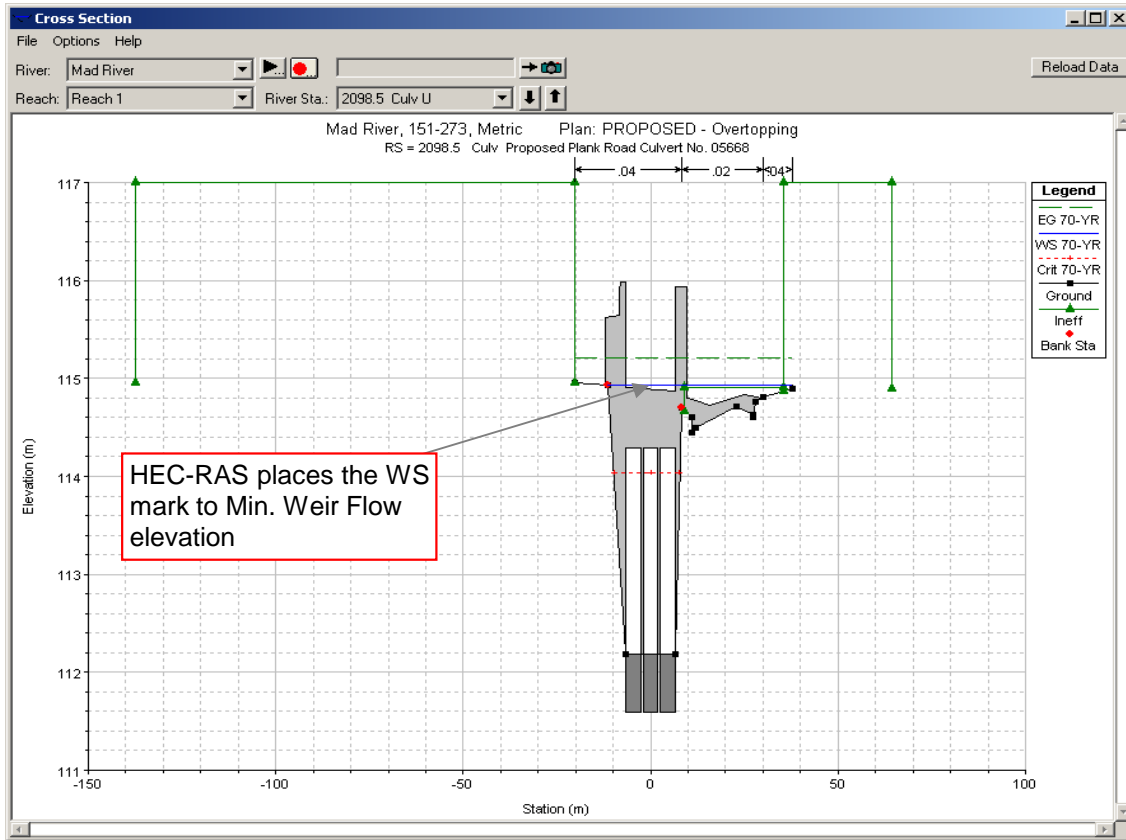
$$= 108.86 \text{ cms}$$

C =	488.85
p =	0.9424
y =	discharge
F =	x-axis value of return frequency
	= 2.1883

F of 2.1883 equals to Return Frequency of 69.82-YR



# Proposed Culvert No. 05668 (Plank Road) Overtopping Flow Based on Water Surface HEC-RAS Output



**Culvert Output**

River: Mad River Profile: 70-YR Culv Group: Box Culvert  
 Reach: Reach 1 RS: 2098.5 Plan: PR\_DOT\_OVT

Plan: PR\_DOT\_OVT Mad River Reach 1 RS: 2098.5 Culv Group: Box Culvert Profile: 70-YR

Q Culv Group (m3/s)	96.21	Culv Full Len (m)	
# Barrels	3	Culv Vel US (m/s)	3.94
Q Barrel (m3/s)	32.07	Culv Vel DS (m/s)	3.82
E.G. US. (m)	115.17	Culv Inv El Up (m)	111.59
W.S. US. (m)	114.81	Culv Inv El Dn (m)	111.41
E.G. DS (m)	114.45	Culv Frctn Ls (m)	0.16
W.S. DS (m)	114.11	Culv Exit Loss (m)	0.41
Delta EG (m)	0.73	Culv Entr Loss (m)	0.16
Delta WS (m)	0.70	Q Weir (m3/s)	12.65
E.G. IC (m)	115.15	Weir Sta Lft (m)	-20.10
E.G. OC (m)	115.17	Weir Sta Rgt (m)	35.60
Culvert Control	Outlet	Weir Submerg	0.00
Culv WS Inlet (m)	114.29	Weir Max Depth (m)	0.44
Culv WS Outlet (m)	114.11	Weir Avg Depth (m)	0.32
Culv Nml Depth (m)	2.59	Weir Flow Area (m2)	15.13
Culv Crt Depth (m)	2.47	Min El Weir Flow (m)	114.90

Errors, Warnings and Notes

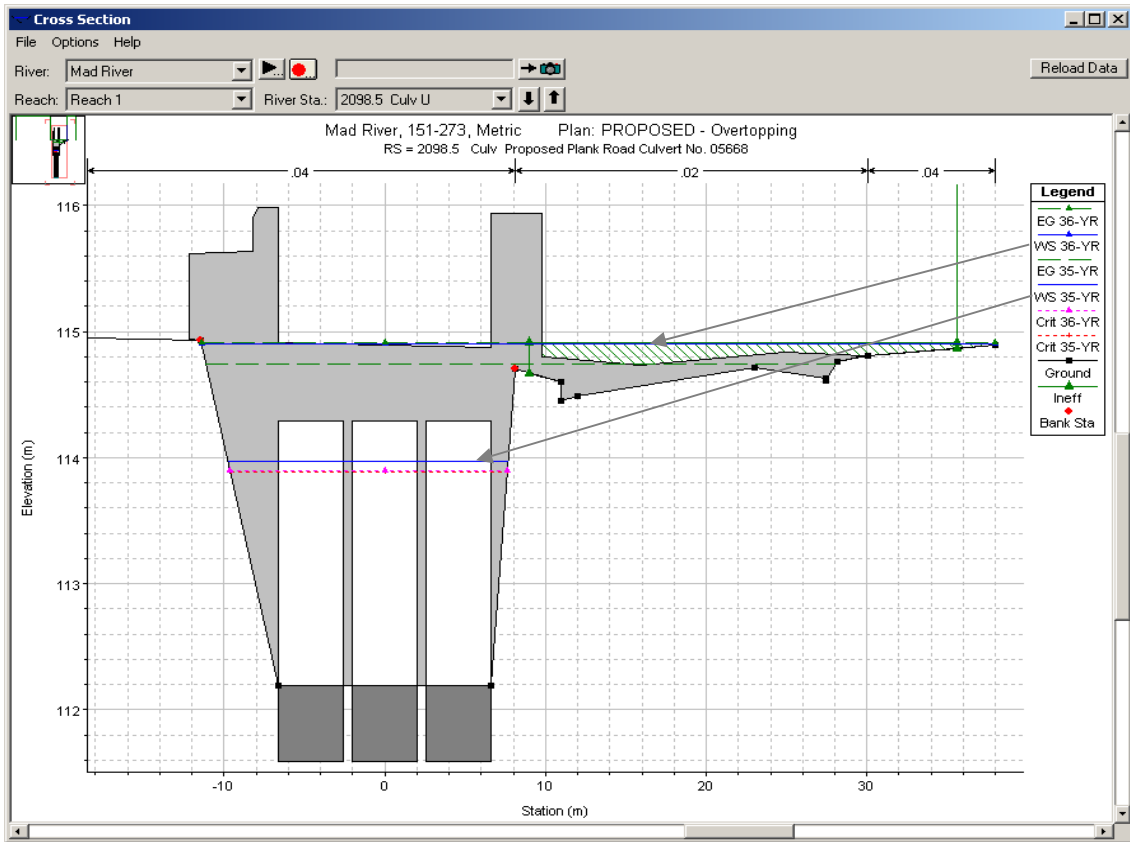
Upstream water surface elevation upstream of bridge, culvert or weir (specific to that opening, not necessarily the energy weighted average).

below Min. Weir Flow elevation

below inside top of the culvert (114.29m)



# Proposed Culvert No. 05668 (Plank Road) Overtopping Flow Based on Energy Grade HEC-RAS Output



**Culvert Output**

River: Mad River Profile: 35-YR Culv Group: Box Culvert

Reach: Reach 1 RS: 2098.5 Plan: PR\_DQT\_OVT

Plan: PR_DQT_OVT	Mad River	Reach 1	RS: 2098.5	Culv Group: Box Culvert	Profile: 35-YR
Q Culv Group (m3/s)			83.13	Culv Full Len (m)	
# Barrels			3	Culv Vel US (m/s)	3.89
Q Barrel (m3/s)			27.71	Culv Vel DS (m/s)	4.08
E.G. US. (m)			114.90	Culv Inv El Up (m)	111.59
W.S. US. (m)			114.65	Culv Inv El Dn (m)	111.41
E.G. DS (m)			114.00	Culv Frctn Ls (m)	0.19
W.S. DS (m)			113.65	Culv Exit Loss (m)	0.56
Delta EG (m)			0.90	Culv Entr Loss (m)	0.15
Delta WS (m)			1.00	Q Weir (m3/s)	
E.G. IC (m)			114.82	Weir Sta Lft (m)	
E.G. OC (m)			114.90	Weir Sta Rgt (m)	
Culvert Control			Outlet	Weir Submerg	
Culv WS Inlet (m)			113.97	Weir Max Depth (m)	
Culv WS Outlet (m)			113.71	Weir Avg Depth (m)	
Culv Nml Depth (m)			2.38	Weir Flow Area (m2)	
Culv Cit Depth (m)			2.30	Min El Weir Flow (m)	114.90

Errors, Warnings and Notes

Select Profile

**Culvert Output**

River: Mad River Profile: 36-YR Culv Group: Box Culvert

Reach: Reach 1 RS: 2098.5 Plan: PR\_DQT\_OVT

Plan: PR_DQT_OVT	Mad River	Reach 1	RS: 2098.5	Culv Group: Box Culvert	Profile: 36-YR
Q Culv Group (m3/s)			83.79	Culv Full Len (m)	
# Barrels			3	Culv Vel US (m/s)	3.91
Q Barrel (m3/s)			27.93	Culv Vel DS (m/s)	4.09
E.G. US. (m)			114.91	Culv Inv El Up (m)	111.59
W.S. US. (m)			114.66	Culv Inv El Dn (m)	111.41
E.G. DS (m)			114.01	Culv Frctn Ls (m)	0.19
W.S. DS (m)			113.67	Culv Exit Loss (m)	0.55
Delta EG (m)			0.90	Culv Entr Loss (m)	0.16
Delta WS (m)			1.00	Q Weir (m3/s)	1.48
E.G. IC (m)			114.84	Weir Sta Lft (m)	-6.60
E.G. OC (m)			114.91	Weir Sta Rgt (m)	35.60
Culvert Control			Outlet	Weir Submerg	0.00
Culv WS Inlet (m)			113.98	Weir Max Depth (m)	0.18
Culv WS Outlet (m)			113.72	Weir Avg Depth (m)	0.08
Culv Nml Depth (m)			2.39	Weir Flow Area (m2)	3.15
Culv Cit Depth (m)			2.31	Min El Weir Flow (m)	114.90

Errors, Warnings and Notes

**Warning:** During the culvert inlet computations, the program could not balance the culvert/weir flow. The reported inlet energy grade answer may not be valid.

Select Profile

## Existing Structure No. 05668 (Plank Road) Overtopping Flow

### KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
2			
10	0.1	1650	46.72
25	0.04	2500	70.79
50	0.02	3400	96.28
100	0.01	4400	124.59
500			

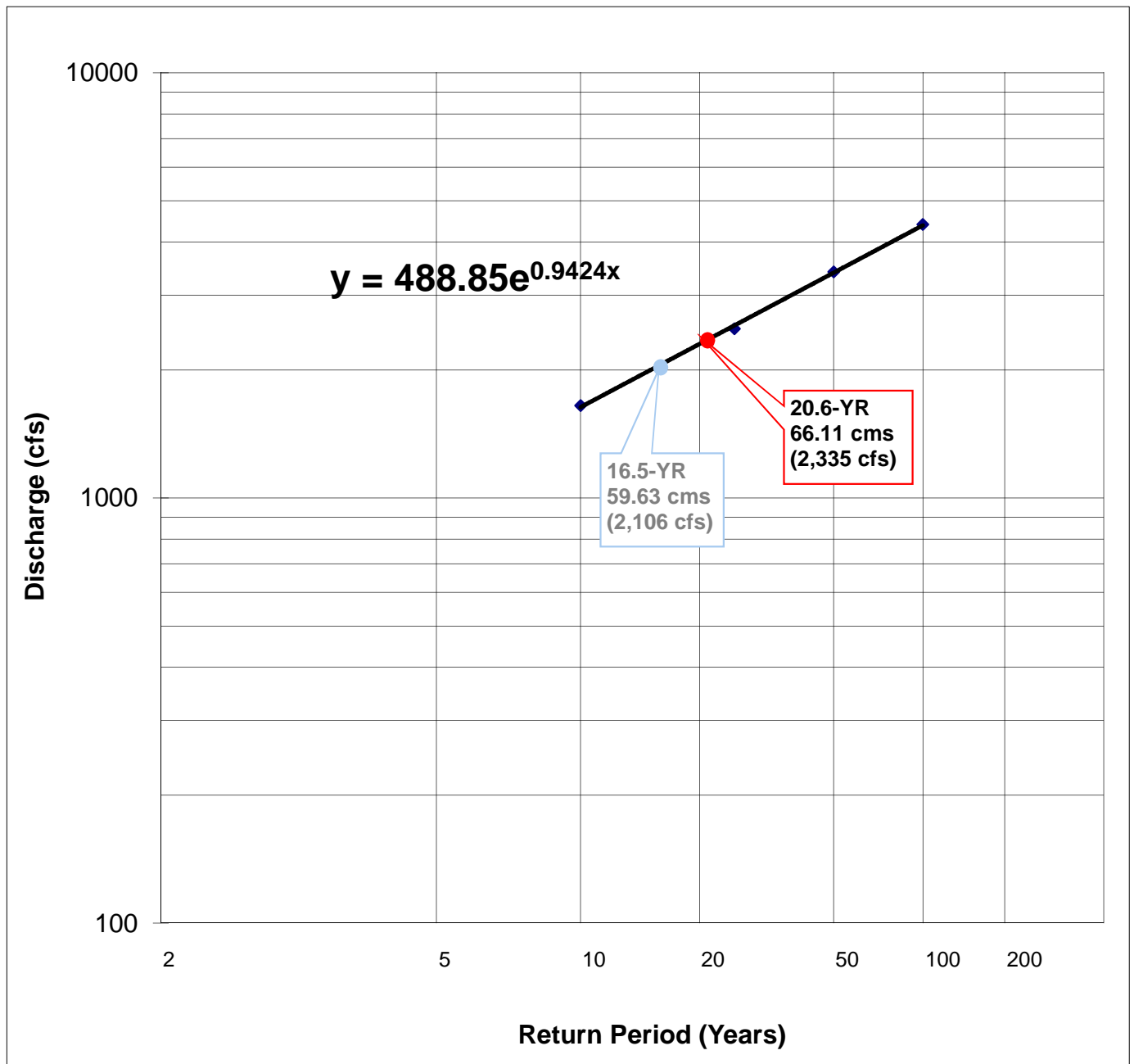
$$y = C \times \text{EXP}(p \times F) = 488.85e^{0.9424x}$$

$$= 2335 \text{ cfs}$$

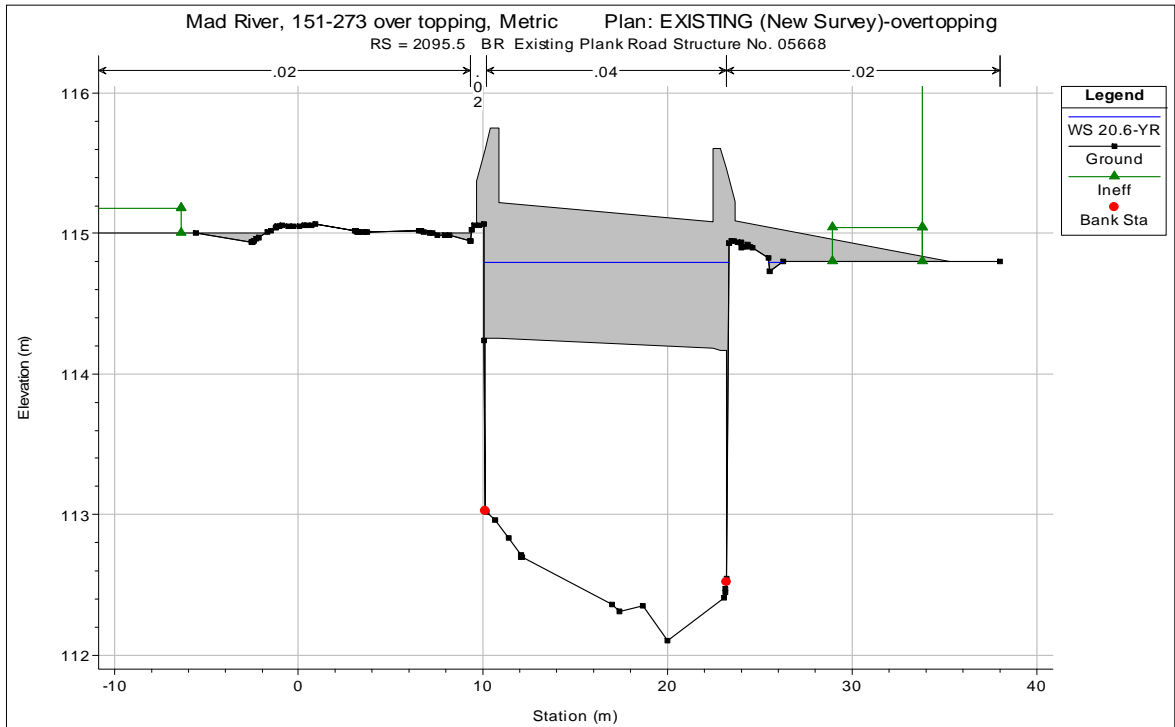
$$= 66.11 \text{ cms}$$

C =	488.85
p =	0.9424
y =	discharge
F =	x-axis value of return frequency
	= 1.6591

F of 1.6591 equals to Return Frequency of 20.6-YR



# Existing Structure No. 05668 (Plank Road) Overtopping Flow Based on Water Surface HEC-RAS Output



**Bridge Output**

File Type Options Help

River: Mad River Profile: 20.6-YR

Reach: Reach 1 RS: 2095.5 Plan: EX-DOT\_OT

Plan: EX-DOT\_OT Mad River Reach 1 RS: 2095.5 Profile: 20.6-YR

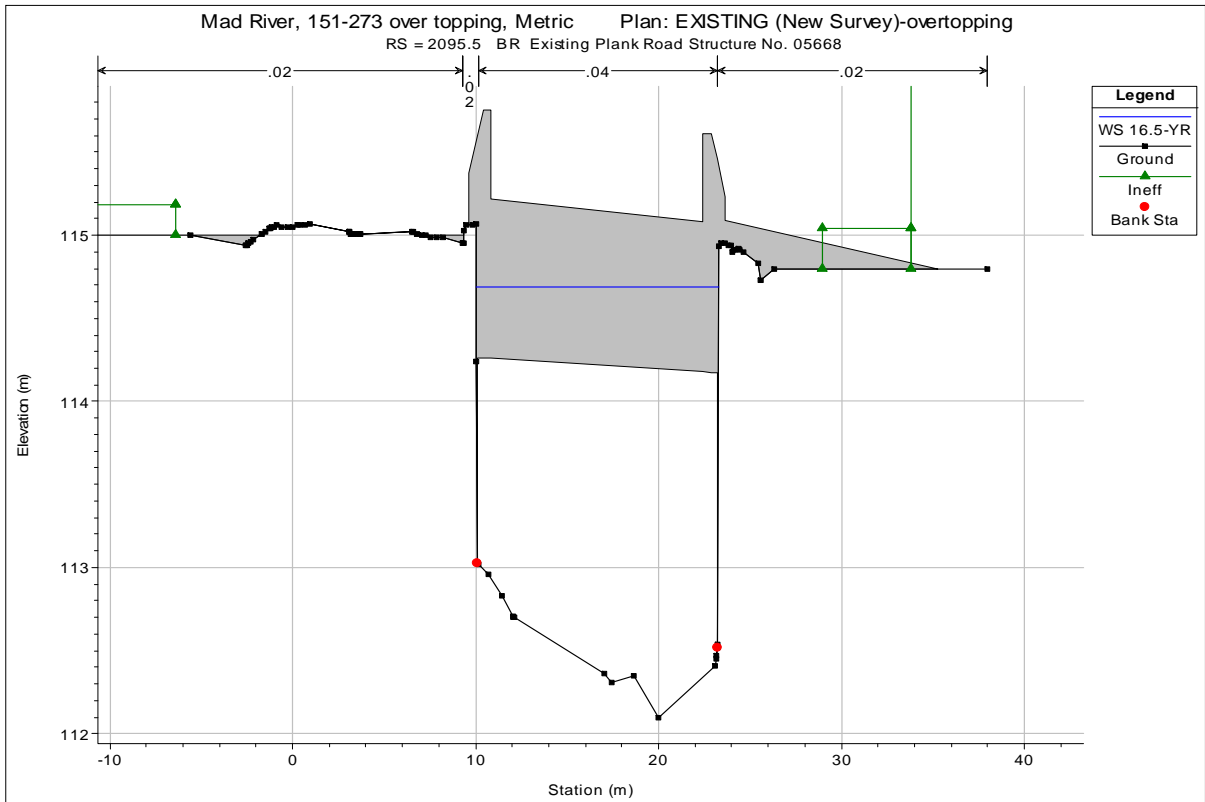
		Element	Inside BR US	Inside BR DS
E.G. US. (m)	115.13	E.G. Elev (m)	115.13	115.13
W.S. US. (m)	114.80	W.S. Elev (m)	114.80	114.80
Q Total (m3/s)	66.11	Crit W.S. (m)	113.84	113.62
Q Bridge (m3/s)	64.21	Max Chl Dpth (m)	2.70	2.96
Q Weir (m3/s)	1.90	Vel Total (m/s)	2.49	2.09
Weir Sta Lft (m)	-6.39	Flow Area (m2)	26.55	31.68
Weir Sta Rgt (m)	33.80	Froude # Chl	0.56	0.48
Weir Submerg	0.00	Specif Force (m3)	37.60	58.20
Weir Max Depth (m)	0.29	Hydr Depth (m)		
Min El Weir Flow (m)	114.96	W.P. Total (m)	29.21	29.96
Min El Prs (m)	114.26	Conv. Total (m3/s)		
Delta EG (m)	1.03	Top Width (m)		
Delta WS (m)	1.36	Frctn Loss (m)		
BR Open Area (m2)	23.03	C & E Loss (m)		
BR Open Vel (m/s)	2.79	Shear Total (N/m2)		
Coef of Q		Power Total (N/m s)	-1005.44	-1770.52
Br Sel Method	Press/Weir			

**Errors, Warnings and Notes**

- Note: Momentum answer is not valid if the water surface is above the low chord or if there is weir flow. The momentum answer has been disregarded.
- Note: The downstream water surface is below the minimum elevation for pressure flow. The sluice gate equations were used for pressure flow.
- Note: Multiple critical depths were found at this location. The critical depth with the lowest valid, water surface was used.
- Note: For the cross section inside the bridge at the upstream end, the water surface and energy have been projected from the

Select Profile

# Existing Structure No. 05668 (Plank Road) Overtopping Flow Based on Energy Grade HEC-RAS Output



**Bridge Output**

File Type Options Help

River: Mad River Profile: 16.5-YR

Reach: Reach 1 RS: 2095.5 Plan: EX-DOT\_OT

Plan: EX-DOT\_OT Mad River Reach 1 RS: 2095.5 Profile: 16.5-YR

		Element	Inside BR US	Inside BR DS
E.G. US. (m)	114.99	E.G. Elev (m)	114.99	114.92
W.S. US. (m)	114.69	W.S. Elev (m)	114.69	114.69
Q Total (m3/s)	59.63	Crit W.S. (m)	113.75	113.52
Q Bridge (m3/s)	59.63	Max Chl Dpth (m)	2.59	2.85
Q Weir (m3/s)	0.00	Vel Total (m/s)	0.00	0.00
Weir Sta Lft (m)	27.52	Flow Area (m2)		
Weir Sta Rgt (m)	28.93	Froude # Chl	0.51	0.44
Weir Submerg	0.00	Specif Force (m3)	47.06	52.15
Weir Max Depth (m)	0.04	Hydr Depth (m)		
Min El Weir Flow (m)	114.96	W.P. Total (m)	29.21	29.96
Min El Prs (m)	114.26	Conv. Total (m3/s)		
Delta EG (m)	1.03	Top Width (m)		
Delta WS (m)	1.35	Frctn Loss (m)		
BR Open Area (m2)	23.03	C & E Loss (m)		
BR Open Vel (m/s)	2.59	Shear Total (N/m2)		
Coef of Q		Power Total (N/m s)	-1005.44	-1770.52
Br Sel Method	Press/Weir			

**Errors, Warnings and Notes**

- Note: Momentum answer is not valid if the water surface is above the low chord or if there is weir flow. The momentum answer has been disregarded.
- Note: The downstream water surface is below the minimum elevation for pressure flow. The sluice gate equations were used for pressure flow.
- Note: Multiple critical depths were found at this location. The critical depth with the lowest valid, water surface was used.
- Note: For the cross section inside the bridge at the upstream end, the water surface and energy have been projected from the

Select Profile

## Proposed Pedestrian Bridge Overtopping Flow

### KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
0			
10	0.1	2350	66.54
25	0.04	3550	100.53
50	0.02	4850	137.34
100	0.01	6250	176.98
0			

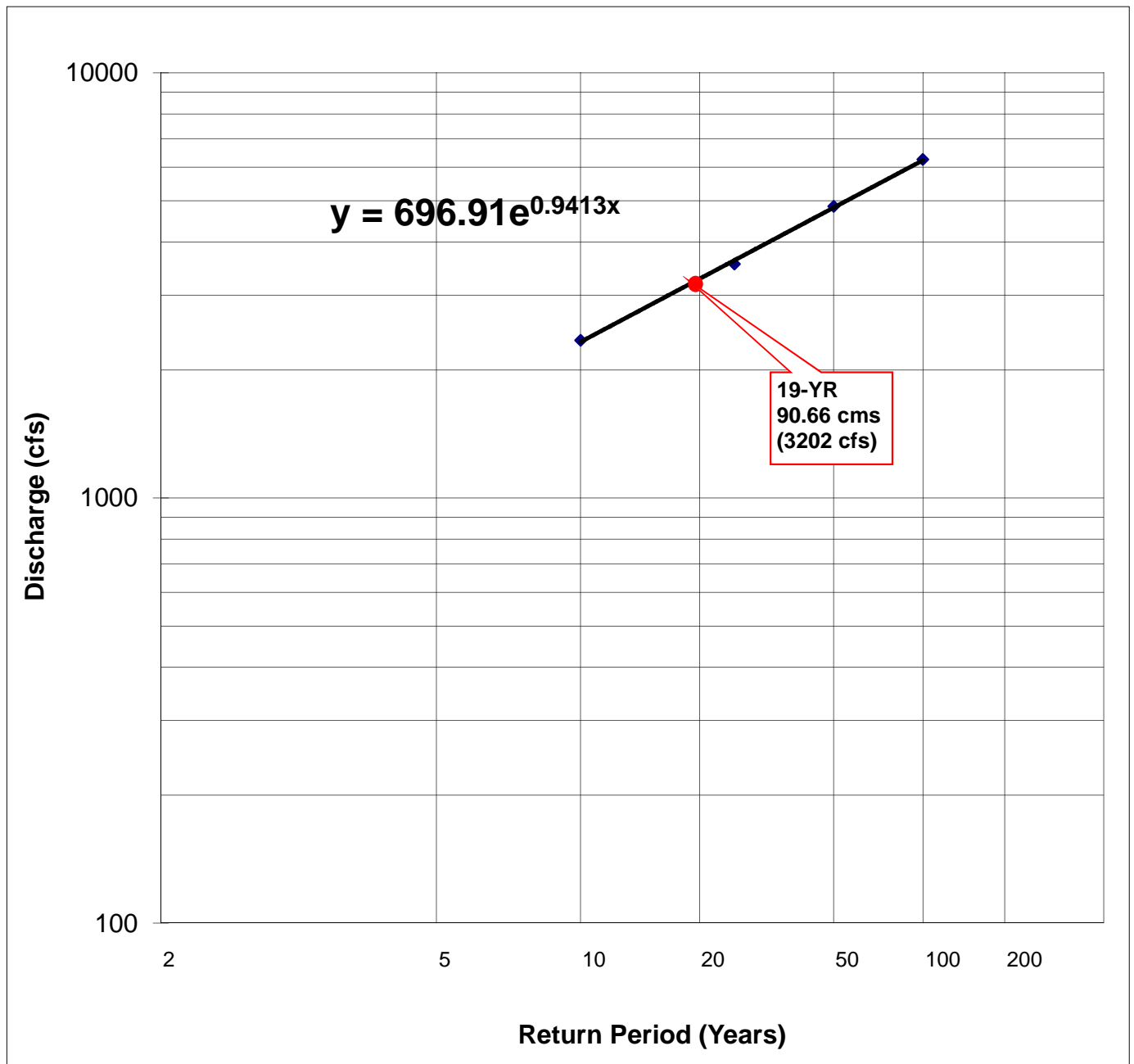
$$y = C \times \text{EXP}(p \times F) = 696.91e^{0.9413x}$$

$$= 3202 \text{ cfs}$$

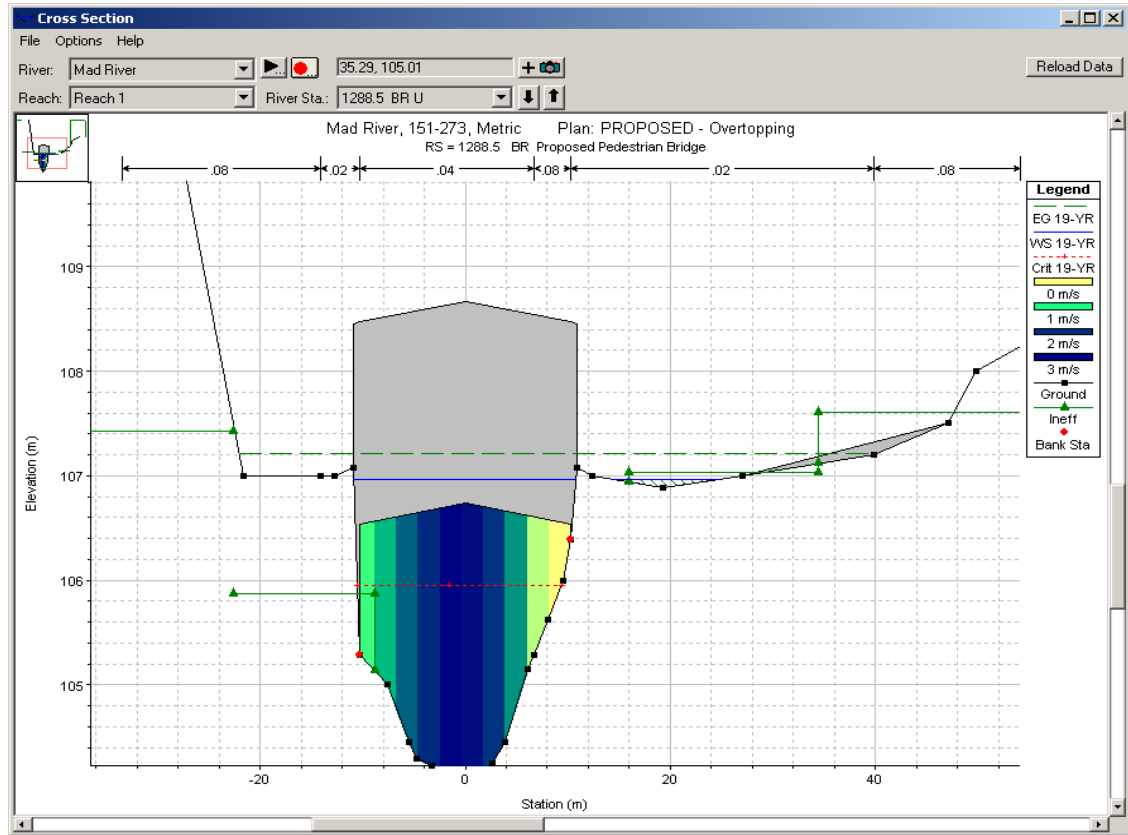
$$= 90.66 \text{ cms}$$

C =	696.91
p =	0.9413
y =	discharge
F =	x-axis value of return frequency
	= 1.6199

F of 1.6199 equals to Return Frequency of 19-YR



# Proposed Pedestrian Bridge Overtopping Flow HEC-RAS Output



Bridge Output				
File Type Options Help				
River:	Mad River	Profile:	19-YR	
Reach:	Reach 1	RS:	1288.5	Plan: PR_DOT_OVT
Plan: PR_DOT_OVT Mad River Reach 1 RS: 1288.5 Profile: 19-YR				
E.G. US. (m)	107.21	Element	Inside BR US	Inside BR DS
W.S. US. (m)	106.97	E.G. Elev (m)	107.21	107.21
Q Total (m3/s)	90.66	W.S. Elev (m)	106.97	106.97
Q Bridge (m3/s)	85.61	Crit W.S. (m)	105.95	105.96
Q Weir (m3/s)	5.05	Max Chl Dpth (m)	3.01	3.01
Weir Sta Lft (m)	-21.98	Vel Total (m/s)	2.30	2.30
Weir Sta Rgt (m)	34.47	Flow Area (m2)	39.43	39.41
Weir Submerg	0.00	Froude # Chl	0.49	0.49
Weir Max Depth (m)	0.32	Specif Force (m3)	75.86	75.86
Min El Weir Flow (m)	106.97	Hydr Depth (m)	24.11	
Min El Prs (m)	106.74	W.P. Total (m)	44.71	43.07
Delta EG (m)	0.24	Conv. Total (m3/s)		
Delta WS (m)	0.13	Top Width (m)	10.50	
BR Open Area (m2)	39.41	Frctn Loss (m)		
BR Open Vel (m/s)	2.17	C & E Loss (m)		
Coef of Q		Shear Total (N/m2)		
Br Sel Method	Press/Weir	Power Total (N/m s)		
Errors, Warnings and Notes				
Note:	The downstream water surface is above the minimum elevation required for orifice flow. The orifice flow equation was used for pressure flow.			
Note:	For the cross section inside the bridge at the upstream end, the water surface and energy have been projected from the upstream cross section. The selected bridge modeling method does not compute answers inside the bridge.			
Note:	Multiple critical depths were found at this location. The critical depth with the lowest valid			
Select Profile				

## Existing Pedestrian Bridge Overtopping Flow

### KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
0			
10	0.1	2350	66.54
25	0.04	3550	100.53
50	0.02	4850	137.34
100	0.01	6250	176.98
0			

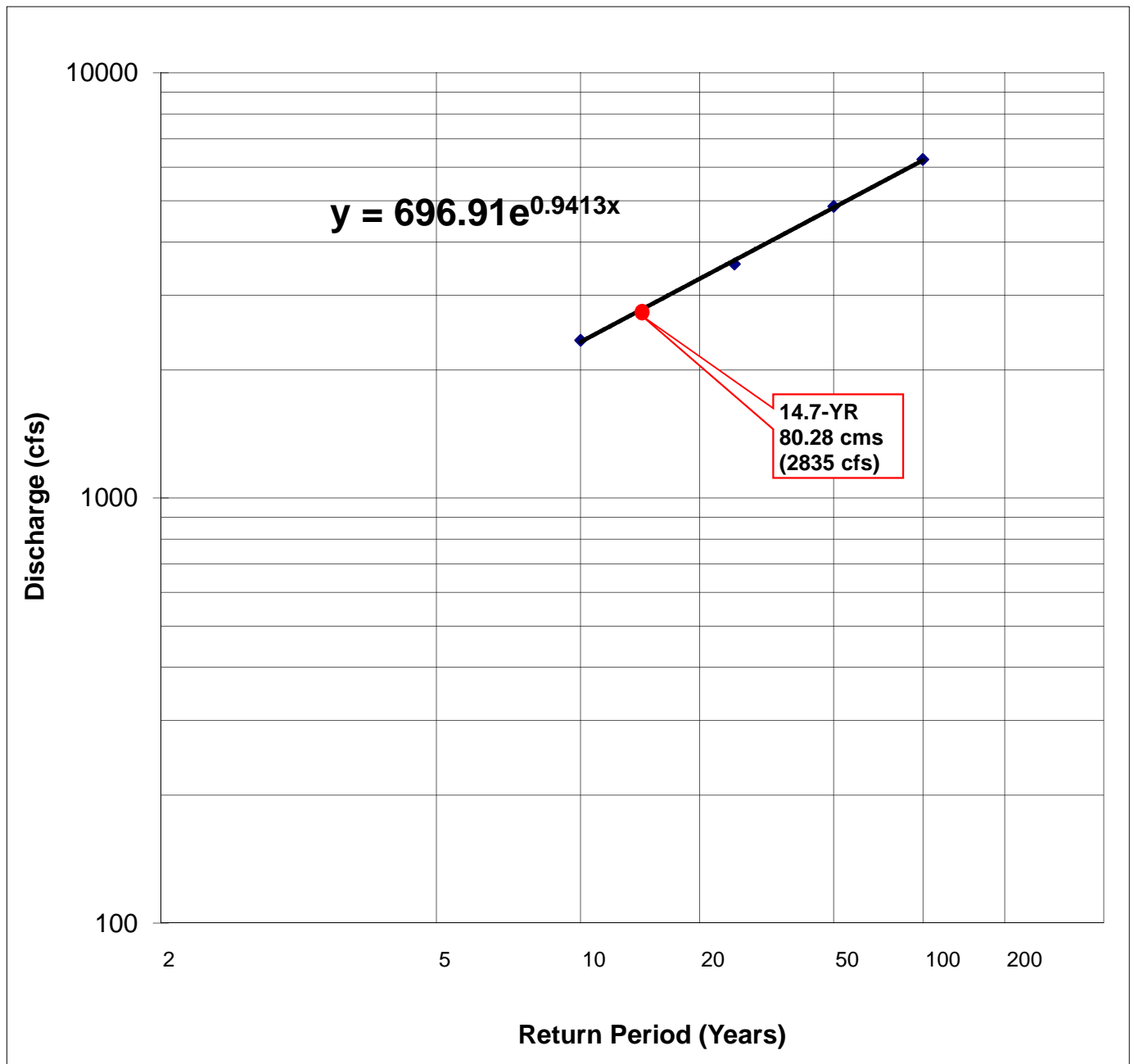
$$y = C \times \text{EXP}(p \times F) = 696.91e^{0.9413x}$$

$$= 2835 \text{ cfs}$$

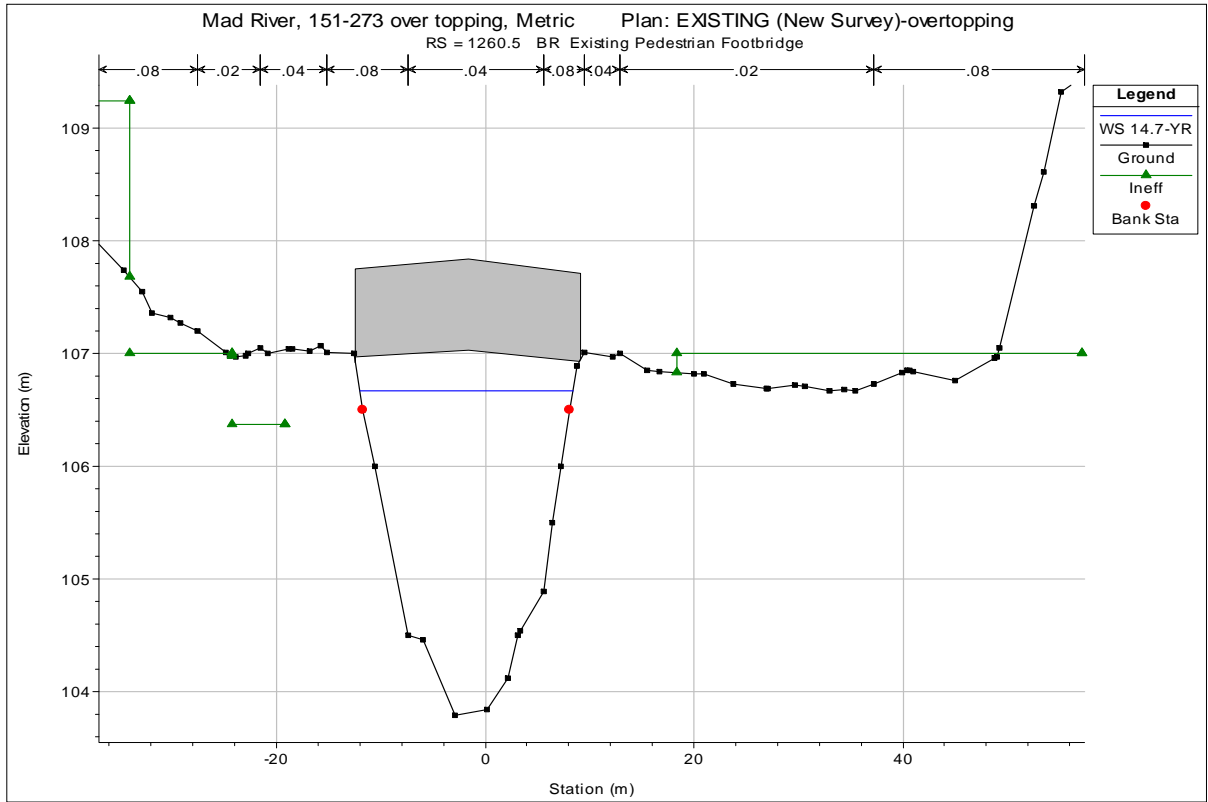
$$= 80.28 \text{ cms}$$

C =	696.91
p =	0.9413
y =	discharge
F =	x-axis value of return frequency
	= 1.4906

*F of 1.4906 equals to Return Frequency of 14.7-YR*



# Existing Pedestrian Bridge Overtopping Flow HEC-RAS Output



**Bridge Output**

File Type Options Help

River: Mad River Profile: 14.7-YR

Reach: Reach 1 RS: 1260.5 Plan: EX-DOT\_OT

Plan: EX-DOT\_OT Mad River Reach 1 RS: 1260.5 Profile: 14.7-YR

		Element	Inside BR US	Inside BR DS
E.G. US (m)	106.94	E.G. Elev (m)	106.88	106.87
W.S. US (m)	106.85	W.S. Elev (m)	106.67	106.66
Q Total (m3/s)	80.28	Crit W.S. (m)	105.74	105.74
Q Bridge (m3/s)	80.12	Max Chl Dpth (m)	2.88	2.87
Q Weir (m3/s)	0.16	Vel Total (m/s)	2.02	2.04
Weir Sta Lft (m)	-12.50	Flow Area (m2)	39.57	39.35
Weir Sta Rgt (m)	18.30	Froude # Chl	0.46	0.46
Weir Submerg	0.00	Specif Force (m3)	62.19	61.85
Weir Max Depth (m)	0.11	Hydr Depth (m)	1.94	1.94
Min El Weir Flow (m)	106.92	W.P. Total (m)	21.61	21.52
Min El Prs (m)	107.03	Conv. Total (m3/s)	1509.9	1496.3
Delta EG (m)	0.12	Top Width (m)	20.40	20.30
Delta WS (m)	0.20	Frctn Loss (m)	0.01	0.03
BR Open Area (m2)	46.31	C & E Loss (m)	0.00	0.02
BR Open Vel (m/s)	2.04	Shear Total (N/m2)	50.77	51.62
Coef of Q		Power Total (N/m s)	-2377.14	-2353.68
Br Sel Method	Energy/Weir			

**Errors, Warnings and Notes**

- Note: Manning's n values were composited to a single value in the main channel.
- Note: Multiple critical depths were found at this location. The critical depth with the lowest valid, water surface was used.
- Note: Notes(60): This is an inside cross section of a perched bridge that has energy, low flow inside of the bridge and weir flow over the embankment. The reported hydraulics are based on the flow and area inside of the bridge.
- Note: Manning's n values were composited to a single value in the main channel.
- Note: Multiple critical depths were found at this location. The critical depth with the lowest valid, water surface was used.

Select Profile



## Existing Downstream Private Bridge Overtopping Flow

### KNOWN DATA

Return Period (Years)	Probability of Exceedance	Discharge	
		(cfs)	(cms)
0			
10	0.1	2350	66.54
25	0.04	3550	100.53
50	0.02	4850	137.34
100	0.01	6250	176.98
0			

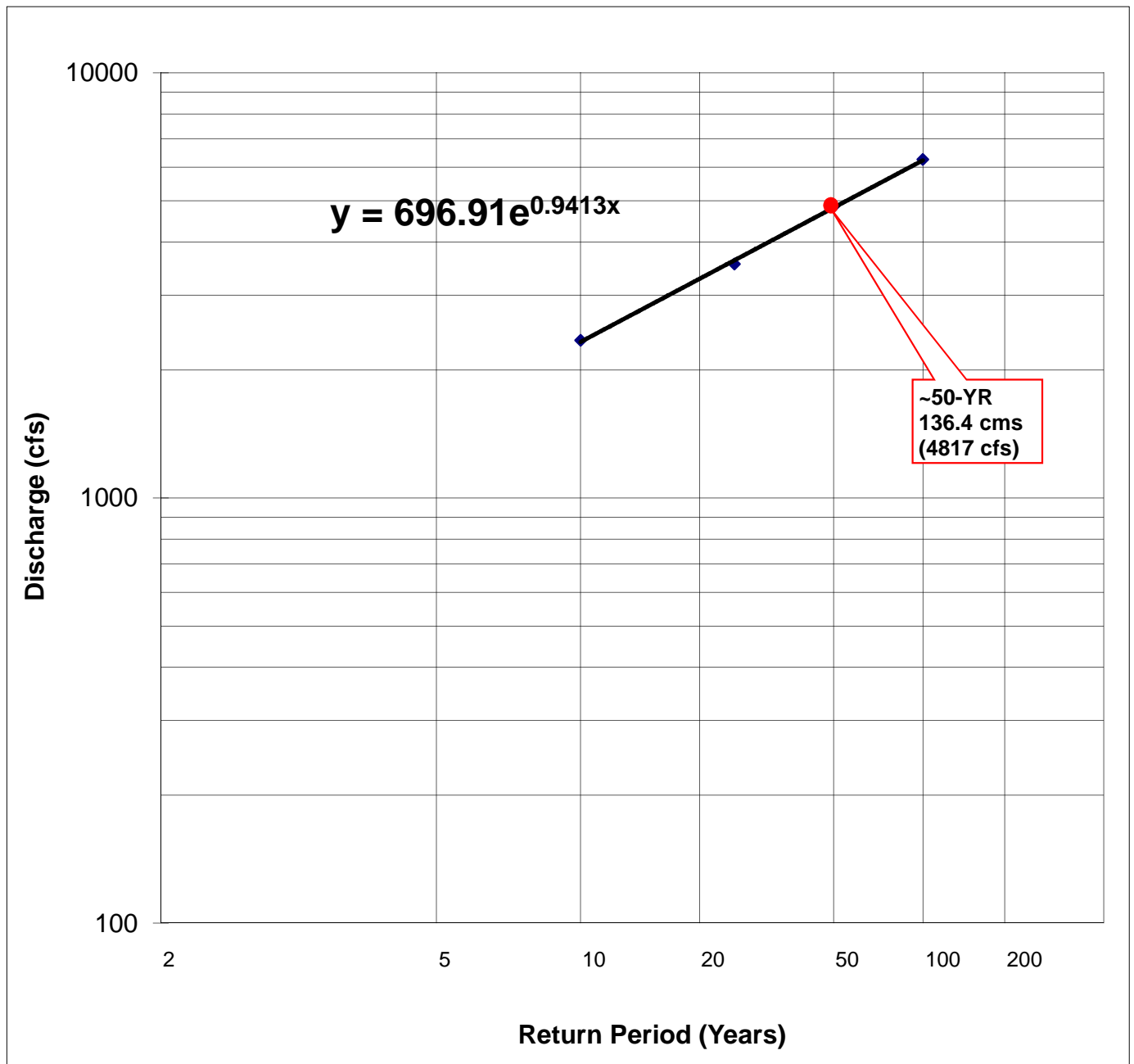
$$y = C \times \text{EXP}(p \times F) = 696.91e^{0.9413x}$$

$$= 4817 \text{ cfs}$$

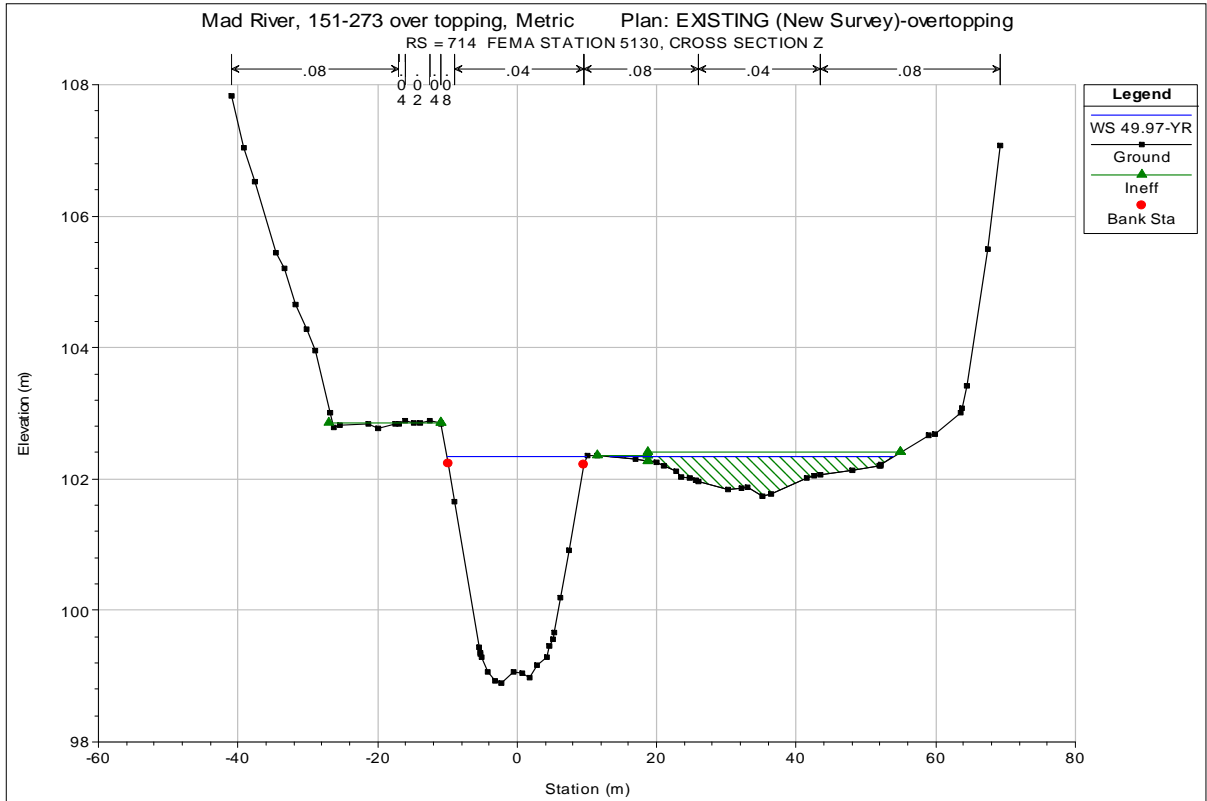
$$= 136.40 \text{ cms}$$

C =	696.91
p =	0.9413
y =	discharge
F =	x-axis value of return frequency
=	2.0537

F of 2.0537 equals to Return Frequency of 50-YR



# Existing Downstream Private Bridge Overtopping Flow HEC-RAS Output



**Cross Section Output**

File Type Options Help

River: Mad River Profile: 49.97-YR

Reach: Reach 1 RS: 714 Plan: EX-DOT\_OT

Plan: EX-DOT\_OT Mad River Reach 1 RS: 714 Profile: 49.97-YR

		Element	Left OB	Channel	Right OB
E.G. Elev (m)	102.76	Wt n-Val.	0.080	0.042	0.080
Vel Head (m)	0.42	Reach Len. (m)	11.40	11.50	11.60
W.S. Elev (m)	102.34	Flow Area (m <sup>2</sup> )	0.01	47.48	0.02
Crit W.S. (m)	101.49	Area (m <sup>2</sup> )	0.01	47.48	11.45
E.G. Slope (m/m)	0.005056	Flow (m <sup>3</sup> /s)	0.00	136.40	0.00
Q Total (m <sup>3</sup> /s)	136.40	Top Width (m)	0.17	19.51	41.04
Top Width (m)	60.71	Avg. Vel. (m/s)	0.11	2.87	0.13
Vel Total (m/s)	2.87	Hydr. Depth (m)	0.05	2.43	0.06
Max Chl Dpth (m)	3.45	Conv. (m <sup>3</sup> /s)	0.0	1918.1	0.0
Conv. Total (m <sup>3</sup> /s)	1918.2	Wetted Per. (m)	0.20	21.21	0.41
Length Wtd. (m)	11.50	Shear (N/m <sup>2</sup> )	2.24	110.99	2.79
Min Ch El (m)	98.89	Stream Power (N/m s)	3313.63	0.00	0.00
Alpha	1.00	Cum Volume (1000 m <sup>3</sup> )	0.01	2.21	0.17
Frctn Loss (m)	0.05	Cum SA (1000 m <sup>2</sup> )	0.05	1.26	0.57
C & E Loss (m)	0.04				

Errors, Warnings and Notes

**Warning:** Divided flow computed for this cross-section.

**Note:** Manning's n values were composited to a single value in the main channel.

**Note:** Multiple critical depths were found at this location. The critical depth with the lowest valid, energy was used.

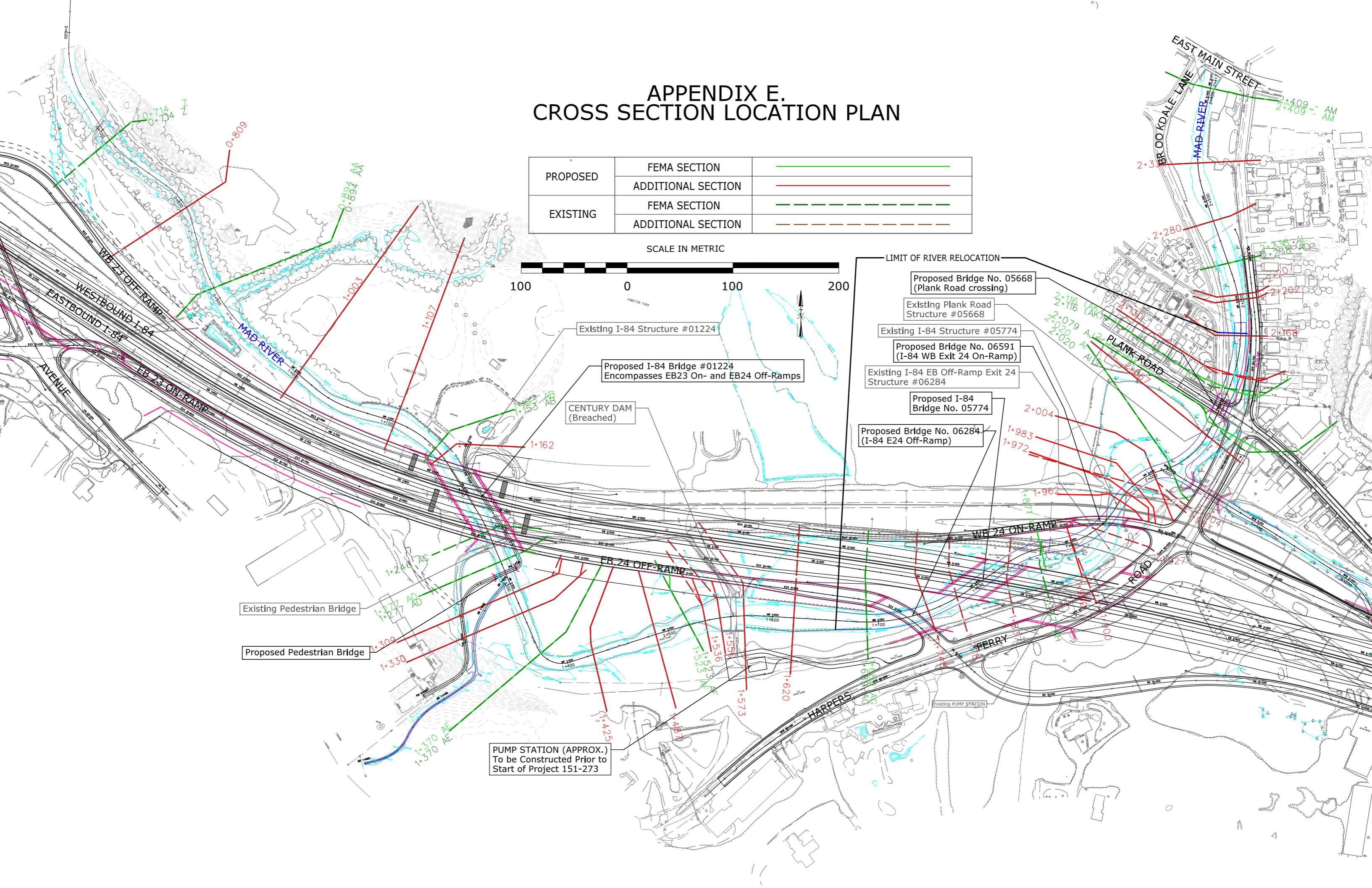
Select Profile

Flow begins to enter Right

# APPENDIX E. CROSS SECTION LOCATION PLAN

PROPOSED	FEMA SECTION	
	ADDITIONAL SECTION	
EXISTING	FEMA SECTION	
	ADDITIONAL SECTION	

SCALE IN METRIC



Existing I-84 Structure #01224

Proposed I-84 Bridge #01224  
Encompasses EB23 On- and EB24 Off-Ramps

CENTURY DAM  
(Breached)

LIMIT OF RIVER RELOCATION

Proposed Bridge No. 05668  
(Plank Road crossing)

Existing Plank Road  
Structure #05668

Existing I-84 Structure #05774

Proposed Bridge No. 06591  
(I-84 WB Exit 24 On-Ramp)

Existing I-84 EB Off-Ramp Exit 24  
Structure #06284

Proposed I-84  
Bridge No. 05774

Proposed Bridge No. 06284  
(I-84 E24 Off-Ramp)

Existing Pedestrian Bridge

Proposed Pedestrian Bridge

PUMP STATION (APPROX.)  
To be Constructed Prior to  
Start of Project 151-273

EAST MAIN STREET  
2+409 AM  
2+409 AM

BROOKDALE LANE  
2+300

PLANK ROAD  
2+116 (AK)  
2+079 A12  
2+020 A11

HARRIS ROAD  
1+983  
1+972  
1+962  
1+818  
1+800

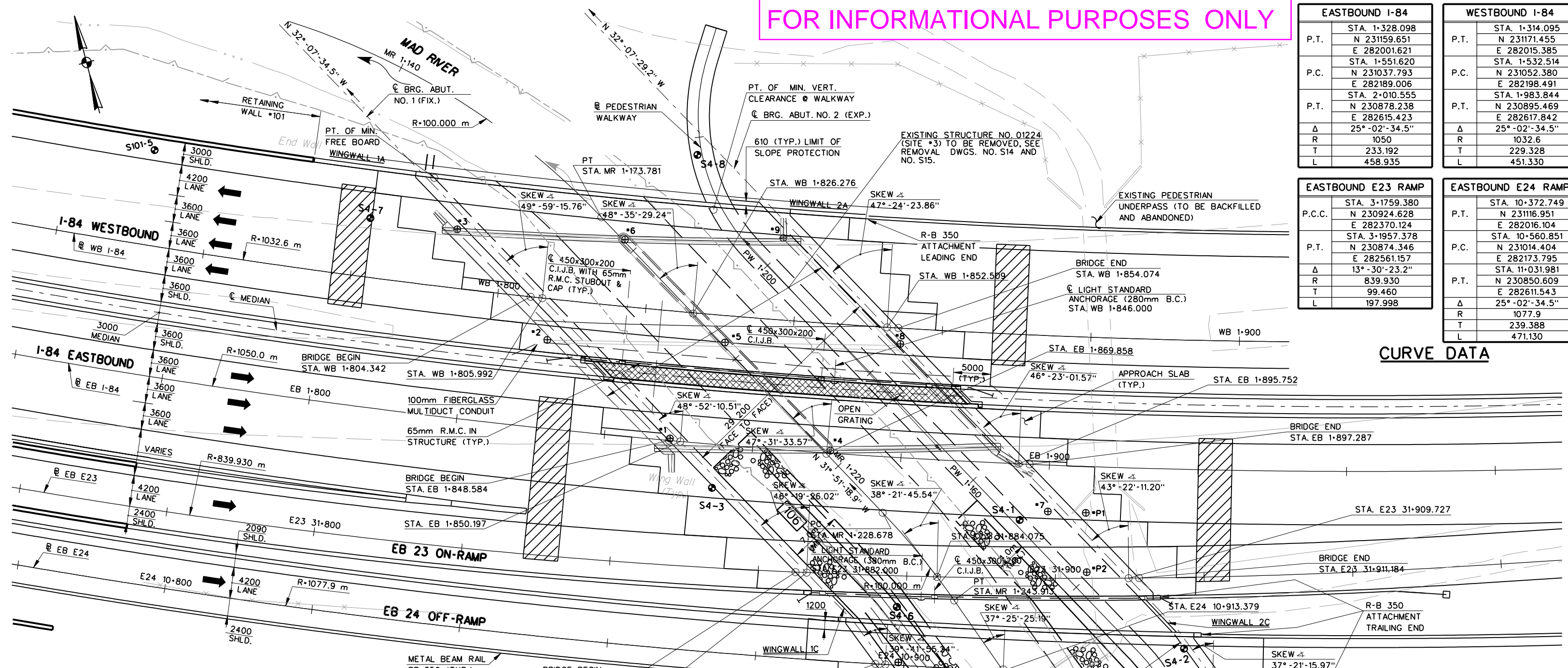
PERRY ROAD  
1+680  
1+670  
1+660  
1+650  
1+640  
1+630  
1+620  
1+610  
1+600

Existing PUMP STATION

## **Appendix F. Structure Plans**

- Bridge No. 01224: Westerly I-84 Crossing
- Pedestrian Bridge Crossing
- Bridge No. 06284: I-84 Eastbound Exit 24 Off-Ramp to Harpers Ferry Road
- Bridge No. 05774: Easterly I-84 Crossing
- Bridge No. 06591: I-84 Westbound Exit 24 On-Ramp from Harpers Ferry Rd
- Culvert No. 05668: Plank Road Crossing

FOR INFORMATIONAL PURPOSES ONLY



EASTBOUND I-84		WESTBOUND I-84	
P.T.	STA. 1-328.098	P.T.	STA. 1-314.095
	N 231159.651		N 231171.455
	E 282001.621		E 282015.385
P.C.	STA. 1-551.620	P.C.	STA. 1-532.514
	N 231037.793		N 231052.380
	E 282189.006		E 282198.491
P.T.	STA. 2-010.555	P.T.	STA. 1-983.844
	N 230878.238		N 230895.469
	E 282615.423		E 282617.842
Δ	25°-02'-34.5"	Δ	25°-02'-34.5"
R	1050	R	1032.6
T	233.192	T	229.328
L	458.935	L	451.330

EASTBOUND E23 RAMP		EASTBOUND E24 RAMP	
P.C.C.	STA. 3-1759.380	P.T.	STA. 10-372.749
	N 230924.628		N 231116.951
	E 282370.124		E 282016.104
P.T.	STA. 3-1957.378	P.C.	STA. 10-560.851
	N 230874.346		N 231014.404
	E 282561.157		E 282173.795
Δ	13°-30'-23.2"	P.T.	STA. 11-031.981
R	839.930		N 230850.609
T	99.460		E 282611.543
L	197.998	Δ	25°-02'-34.5"
		R	1077.9
		T	239.388
		L	471.130

CURVE DATA

MEMBER	MAX. SHIPPING LENGTH	MAX. SHIPPING HEIGHT	MAX. SHIPPING WIDTH	MAX. SHIPPING MASS
G-1	34 075 mm	2121 mm	500 mm	16,500 kg

**NOTICE TO BRIDGE INSPECTORS**

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COMPONENT OR DETAIL	STRUCTURE SHEET REFERENCE

ITEM	TOTAL
SUPERSTRUCTURE	1450 m <sup>3</sup>
SUBSTRUCTURE	1550 m <sup>3</sup>
FOOTINGS	1550 m <sup>3</sup>
TOTAL	4550 m <sup>3</sup>

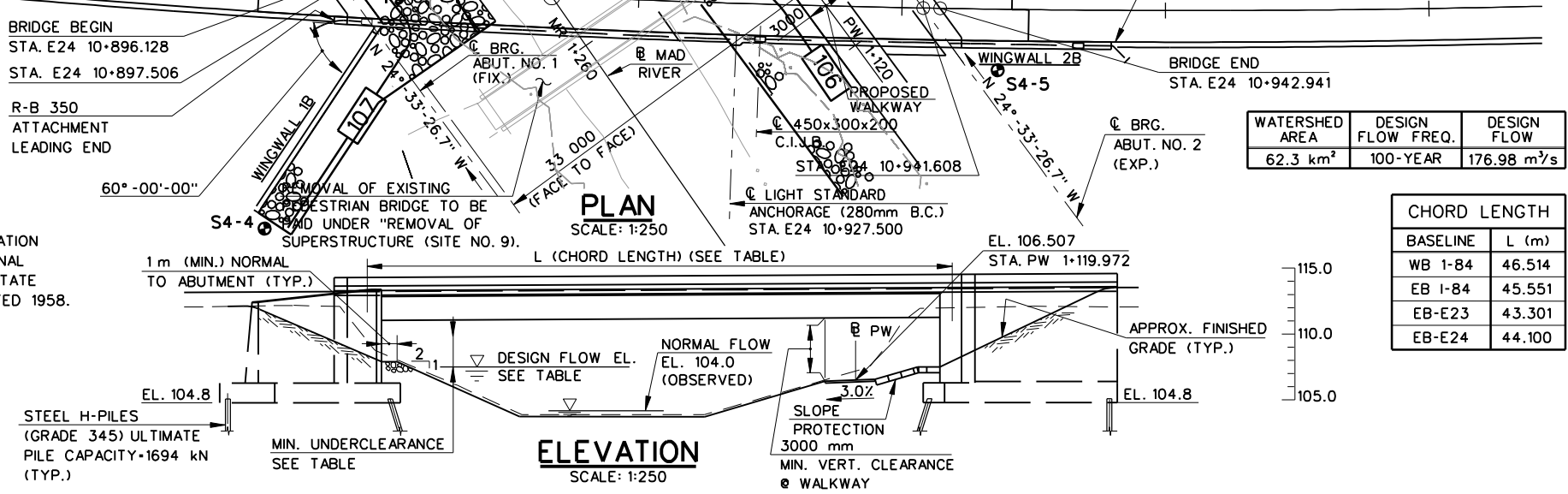
METHOD	UNIT	QUAN.
ULTRASONIC	mm	-
MAGNETIC PARTICLE	mm	-

	UPSTREAM FASCIA GIRDER	DOWNSTREAM FASCIA GIRDER
DESIGN FLOW ELEVATION	107.43	106.69
MIN. UNDERCLEARANCE (m)	3.2	1.6

**BORING LEGEND**

- ⊙ - 2001 BORING
- ⊕ - 1957 BORING.

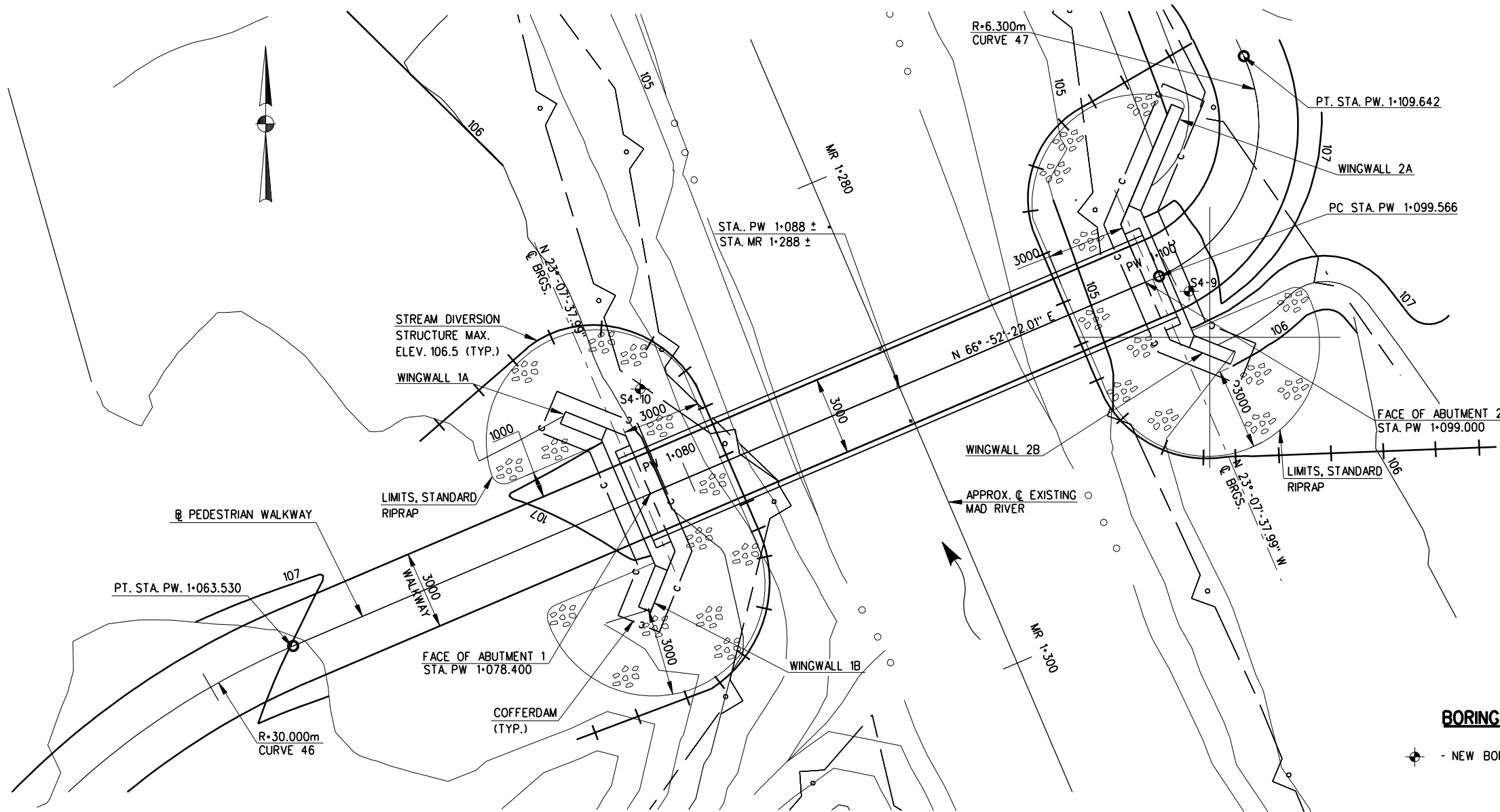
NOTE: EXISTING BORING INFORMATION REFERENCED FROM ORIGINAL CONTRACT PLANS FOR STATE PROJECT NO. 182-20, DATED 1958.



WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
62.3 km <sup>2</sup>	100-YEAR	176.98 m <sup>3</sup> /s

BASELINE	L (m)
WB I-84	46.514
EB I-84	45.551
EB-E23	43.301
EB-E24	44.100

CADD: \02730401.brg PLOTTED: 1/13/2010 SCALE AS NOTED	DESIGNER: R. LOPUSNY DRAFTER: A. PRESS CHECKED BY: N. VYAS DATE CHECKED:	STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION BERGER LEHMAN ASSOCIATES, P.C.	PROJECT TITLE: RECONSTRUCTION OF I-84 WATERBURY I-84 OVER MAD RIVER STRUCTURE NO. 151-273-01224	TOWN: WATERBURY DRAWING TITLE: GENERAL PLAN & ELEVATION	PROJECT NO.: 151-273 DRAWING NO.: S1 SHEET NO.:
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PLAN  
SCALE 1:100

PEDESTRIAN WALKWAY-CURVE 46	
P.C.	STA. PW 1-024.350
	N 230801.452
C.C.	E 282467.089
	N 230805.605
P.T.	E 282496.800
	STA. PW 1-063.530
△	N 230833.194
	E 282485.017
R	74°-49'-44.97"
T	30.000 m
L	22.949 m
	39.181 m

PEDESTRIAN WALKWAY-CURVE 47	
P.C.	STA. PW 1-099.566
	N 230847.348
C.C.	E 282518.156
	N 230853.141
P.T.	E 282515.682
	STA. PW 1-109.642
△	N 230855.781
	E 282521.402
R	91°-38'-24.26" L
T	6.300 m
L	6.483 m
	10.076 m

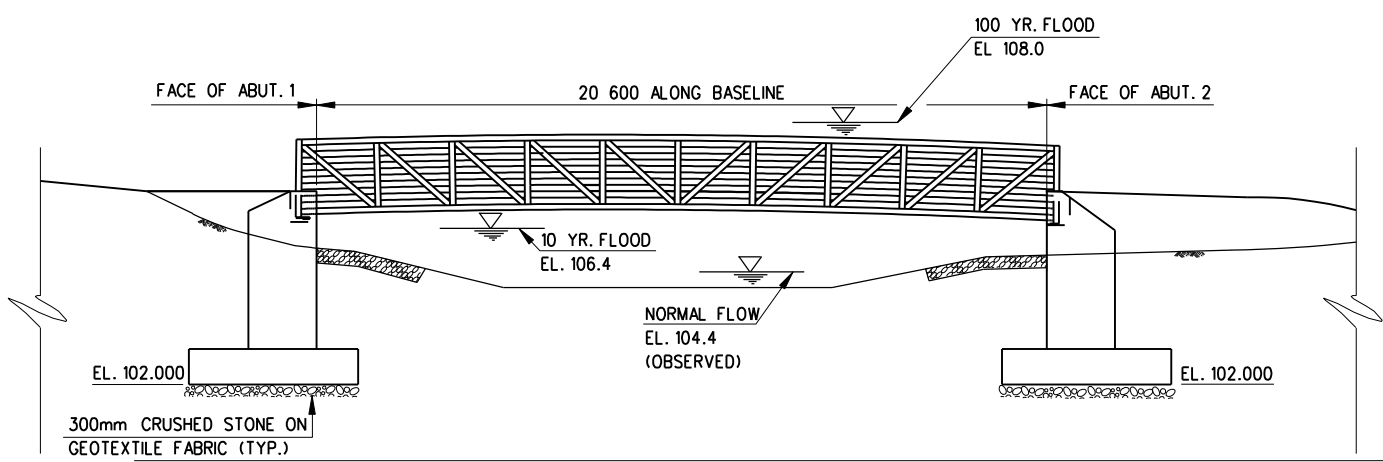
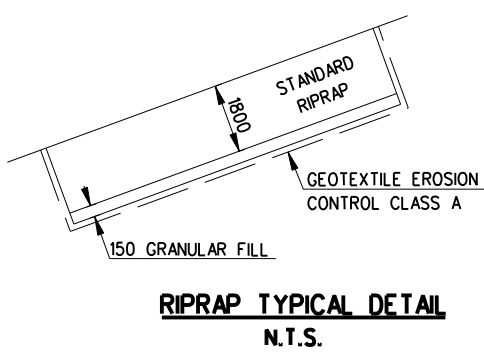
CURVE DATA

**BORING LEGEND**

◆ - NEW BORING (2002)

WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
62.3 Km <sup>2</sup>	100-YEAR	176.98 m <sup>3</sup> /s

FOR INFORMATIONAL PURPOSES ONLY

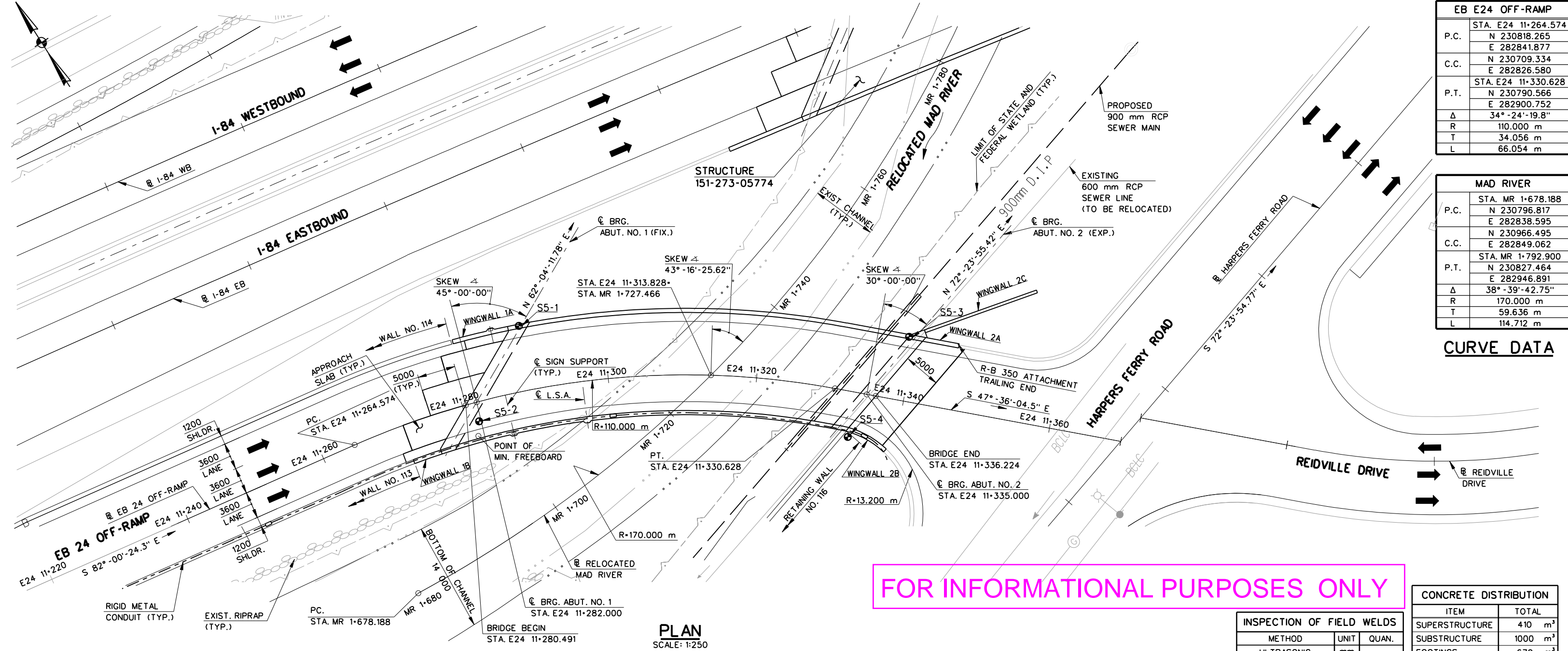


ELEVATION  
SCALE 1:100

**WATER HANDLING NOTES:**

1. THE TOP OF THE STREAM DIVERSION STRUCTURE AND COFFERDAMS SHALL BE INSTALLED TO AN ELEVATION NOT TO EXCEED 106.5m \* AND IN THE GENERAL LOCATION DEPICTED ON THE PLANS. ABOVE THIS ELEVATION THE FLOW OF THE RIVER SHALL BE CAPABLE OF OVERTOPPING THE STREAM DIVERSION STRUCTURE. THE CONTRACTOR IS ADVISED THAT SUCH OVERTOPPING WILL OCCUR FOR ANY EVENT WITH A DISCHARGE GREATER THAN A STORM WITH APPROXIMATELY A TWO YEAR FREQUENCY OF OCCURRENCE. THE CONTRACTOR SHALL EITHER ACCEPT THE RISK FOR DAMAGE TO UNCOMPLETED WORK DUE TO SUCH AN OCCURRENCE OR OBTAIN AT HIS OWN EXPENSE INSURANCE PROTECTING AGAINST SAME.
  2. ANY ALTERNATIVE CONSTRUCTION PROCEDURE PROPOSED BY THE CONTRACTOR MUST PROVIDE AT ALL TIMES A HYDRAULIC CONVEYANCE CAPACITY EQUAL TO OR GREATER THAN THAT PROVIDED BY THE STAGING SHOWN ON THE PLANS.
  3. PAYMENT FOR STREAM DIVERSION STRUCTURES AND DEWATERING FOR RIPRAP INSTALLATION ARE INCLUDED IN THE ITEM "HANDLING WATER."
  4. STAGING OF CONSTRUCTION IN THE WATERWAY MUST BE COORDINATED WITH CONSTRUCTION FOR STRUCTURE NO. 151-273-01224. SEE PERMIT APPLICATION.
- \* TOP OF COFFERDAM MAY EXCEED THIS ELEVATION WHERE NECESSARY TO RETAIN EXISTING GROUND.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE TRUE CONDITIONS OR THE ACTUAL QUANTITIES OR DISTRIBUTION OF QUANTITIES OF WORK WHICH WILL BE REQUIRED		CADD ...0273012001.brg PLOTTED 1/4/2010	DESIGNER: Z. RUBIN DRAFTER: A. BETANCOURT CHECKED BY: W. SCHMITZ DATE CHECKED: 4/30/03	STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION ENGINEER: BERGER LEHMAN ASSOCIATES, P.C. APPROVED BY: _____ DATE: _____	PROJECT TITLE: RECONSTRUCTION OF I-84 WATERBURY PEDESTRIAN WALKWAY OVER MAD RIVER	TOWN: WATERBURY DRAWING TITLE: GENERAL PLAN AND ELEVATION	PROJECT NO.: 151-273 DRAWING NO.: S1 SHEET NO.:
REV.	DATE	DESCRIPTION	SHEET NO.				



EB E24 OFF-RAMP	
P.C.	STA. E24 11+264.574
	N 230818.265
	E 282841.877
C.C.	N 230709.334
	E 282826.580
P.T.	STA. E24 11+330.628
	N 230790.566
	E 282900.752
Δ	34°-24'-19.8"
R	110.000 m
T	34.056 m
L	66.054 m

MAD RIVER	
P.C.	STA. MR 1+678.188
	N 230796.817
	E 282838.595
C.C.	N 230966.495
	E 282849.062
P.T.	STA. MR 1+792.900
	N 230827.464
	E 282946.891
Δ	38°-39'-42.75"
R	170.000 m
T	59.636 m
L	114.712 m

**CURVE DATA**

FOR INFORMATIONAL PURPOSES ONLY

**PLAN**  
SCALE: 1:250

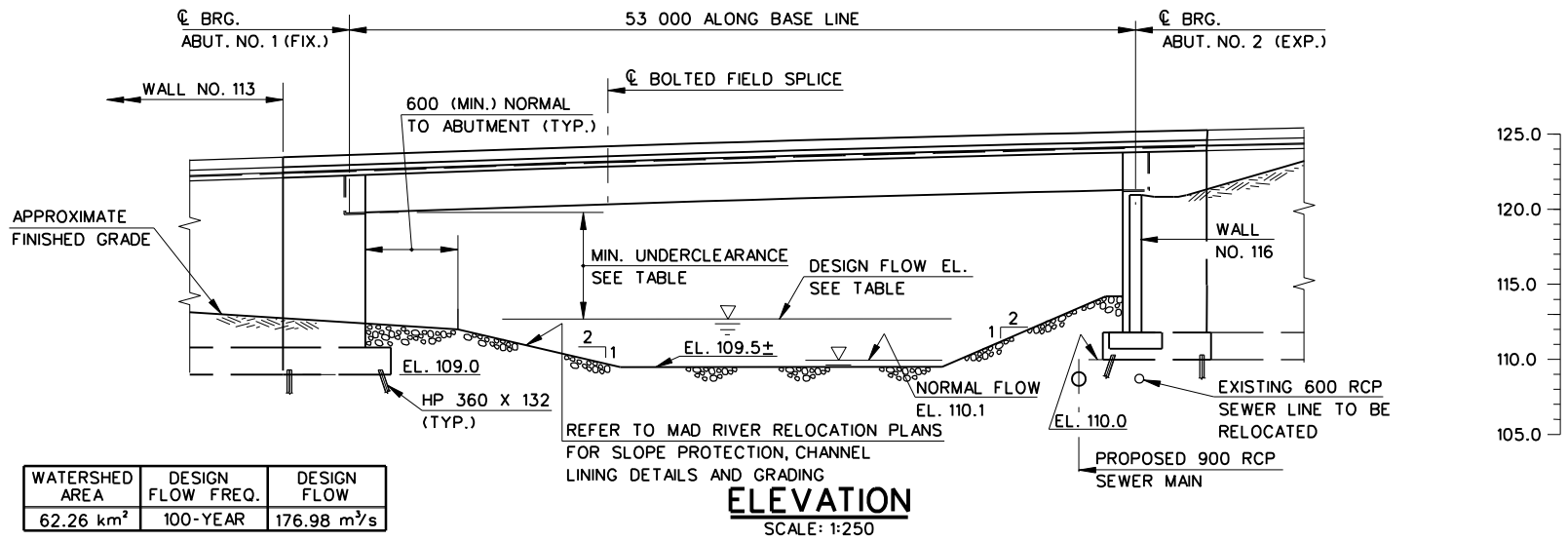
CONCRETE DISTRIBUTION	
ITEM	TOTAL
SUPERSTRUCTURE	410 m <sup>3</sup>
SUBSTRUCTURE	1000 m <sup>3</sup>
FOOTINGS	670 m <sup>3</sup>
<b>TOTAL</b>	<b>2080 m<sup>3</sup></b>

INSPECTION OF FIELD WELDS		
METHOD	UNIT	QUAN.
ULTRASONIC	mm	-
MAGNETIC PARTICLE	m	-

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COMPONENT OR DETAIL	STRUCTURE SHEET REFERENCE



**ELEVATION**  
SCALE: 1:250

TRANSPORTATION DIMENSION AND MASS				
MEMBER	SHIPPING LENGTH	SHIPPING HEIGHT	SHIPPING WIDTH	SHIPPING MASS
G1	35.500	2590	2192	39.450 kg

**BORING LEGEND**

⊙ - 2001 BORING

	UPSTREAM FACE	DOWNSTREAM FACE
DESIGN FLOW ELEVATION	112.65	112.56
MIN. UNDERCLEARANCE (m)	7.1	6.5

WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
62.26 km <sup>2</sup>	100-YEAR	176.98 m <sup>3</sup> /s

CADD ..\02730501.brg

PLOTTED 11/3/2010

SCALE AS NOTED

DESIGNER  
H. J. DIERKS

DRAFTER  
M. MOSLEY

CHECKED BY: E. CONNELL

DATE CHECKED: 1-27-03

**STATE OF CONNECTICUT**  
DEPARTMENT OF TRANSPORTATION

ENGINEER: BERGER LEHMAN ASSOCIATES, P.C.

APPROVED BY: \_\_\_\_\_ DATE: \_\_\_\_\_



PROJECT TITLE:  
**RECONSTRUCTION OF I-84 WATERBURY**  
EB 24 OFF-RAMP OVER RELOCATED MAD RIVER  
STRUCTURE NO. 151-273-06284

TOWN:  
**WATERBURY**

DRAWING TITLE:  
**GENERAL PLAN AND ELEVATION**

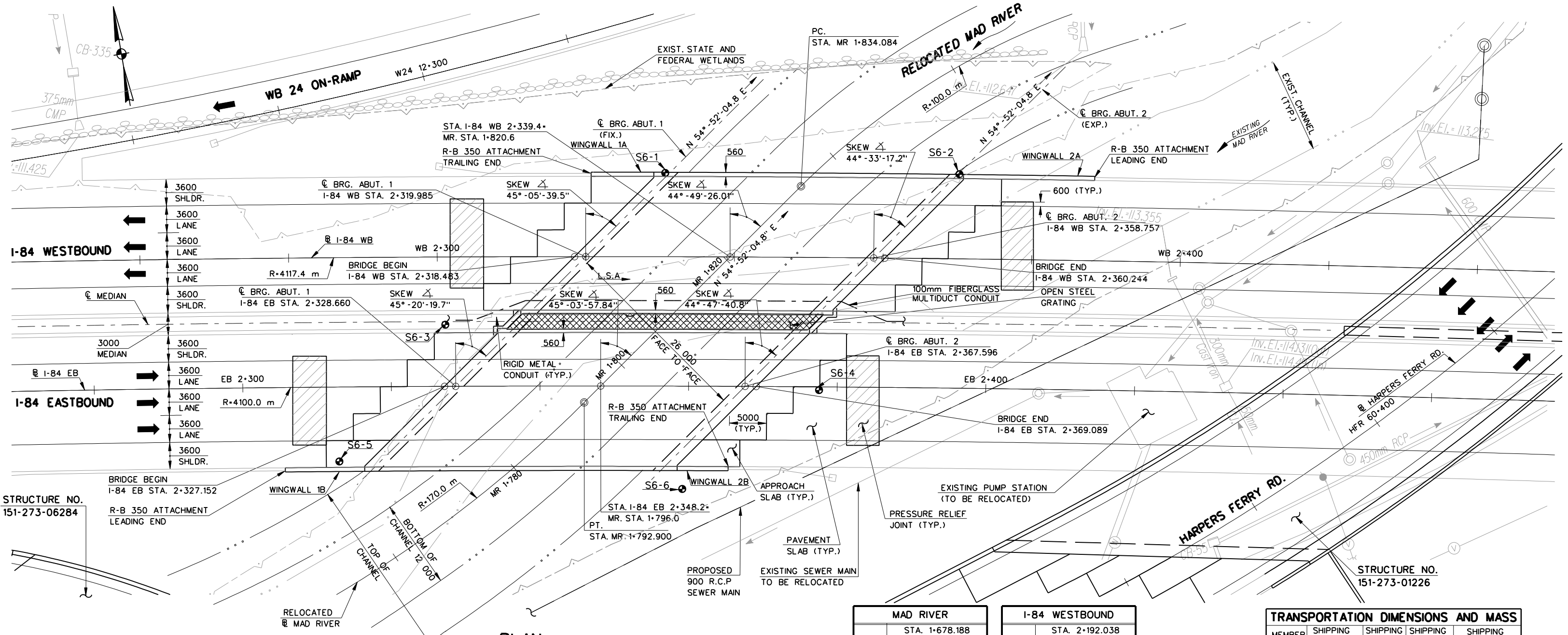
PROJECT NO.:  
**151-273**

DRAWING NO.:  
**S1**

SHEET NO.: \_\_\_\_\_

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE TRUE CONDITIONS OR THE ACTUAL QUANTITIES OR DISTRIBUTION OF QUANTITIES OF WORK WHICH WILL BE REQUIRED

REV.	DATE	DESCRIPTION	SHEET NO.



**PLAN**  
SCALE: 1:250

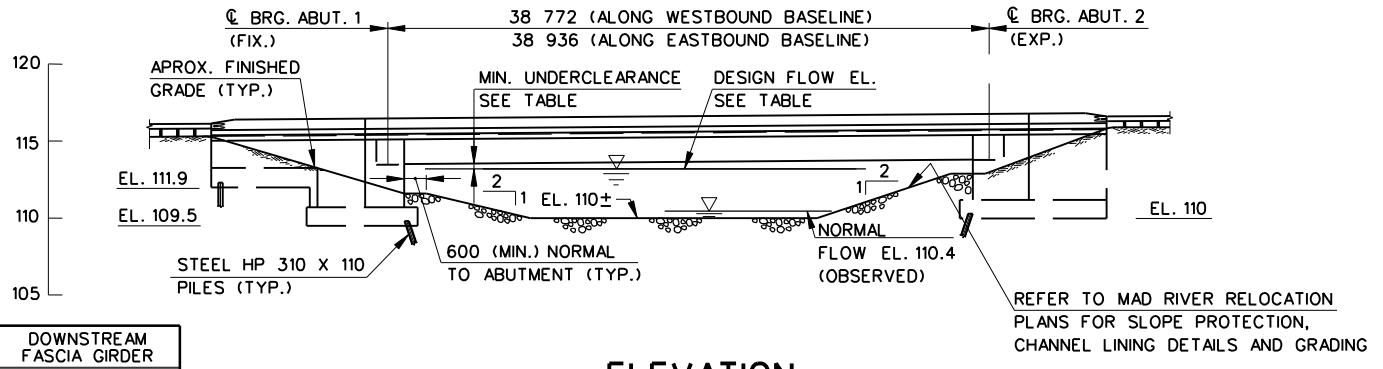
**BORING LEGEND**  
 (B) - BORING (2001)

FOR INFORMATIONAL PURPOSES ONLY

CONCRETE DISTRIBUTION	
SUPERSTRUCTURE	650 m <sup>3</sup>
SUBSTRUCTURE	940 m <sup>3</sup>
FOOTINGS	840 m <sup>3</sup>
<b>TOTAL</b>	<b>2430 m<sup>3</sup></b>

INSPECTION OF FIELD WELDS		
METHOD	UNIT	QUAN.
ULTRASONIC	mm	-
MAGNETIC PARTICLE	m	-

	UPSTREAM FASCIA GIRDER	DOWNSTREAM FASCIA GIRDER
DESIGN FLOW ELEVATION	113.2	112.9
MIN. UNDERCLEARANCE (m)	0.8	0.7



**ELEVATION**  
SCALE: 1:250

WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
62.26 km <sup>2</sup>	100-YEAR	176.98 m <sup>3</sup> /s

MAD RIVER	
P.C.	STA. 1+678.188
	N 230796.817
	E 282838.595
C.C.	N 230966.495
	E 282849.062
	STA. 1+792.900
P.T.	N 230827.464
	E 282946.891
Δ	38°-39'-42.75"
R	170.0 m
T	59.636 m
L	114.712 m

MAD RIVER	
P.C.	STA. 1+834.084
	N 230851.164
	E 282980.572
C.C.	N 230769.381
	E 283038.118
	STA. 1+882.517
P.T.	N 230868.552
	E 283025.269
Δ	27°-44'-59.37"
R	100.0 m
T	24.701 m
L	48.433 m

I-84 WESTBOUND	
P.C.	STA. 2+192.038
	N 230866.518
	E 282824.014
C.C.	N 226789.121
	E 282251.463
	STA. 2+753.408
P.T.	N 230750.859
	E 283372.895
Δ	7°-48'-42.30"
R	417.4 m
T	281.120 m
L	561.370 m

I-84 EASTBOUND	
P.C.	STA. 2+218.750
	N 230849.287
	E 282821.594
C.C.	N 226789.121
	E 282251.463
	STA. 2+777.747
P.T.	N 230734.117
	E 283368.156
Δ	7°-48'-42.30"
R	4100.0 m
T	279.932 m
L	558.997 m

**CURVE DATA**

TRANSPORTATION DIMENSIONS AND MASS				
MEMBER	SHIPPING LENGTH	SHIPPING HEIGHT	SHIPPING WIDTH	SHIPPING MASS
ALL	39 453 mm	1470 mm	400 mm	16 200 KG

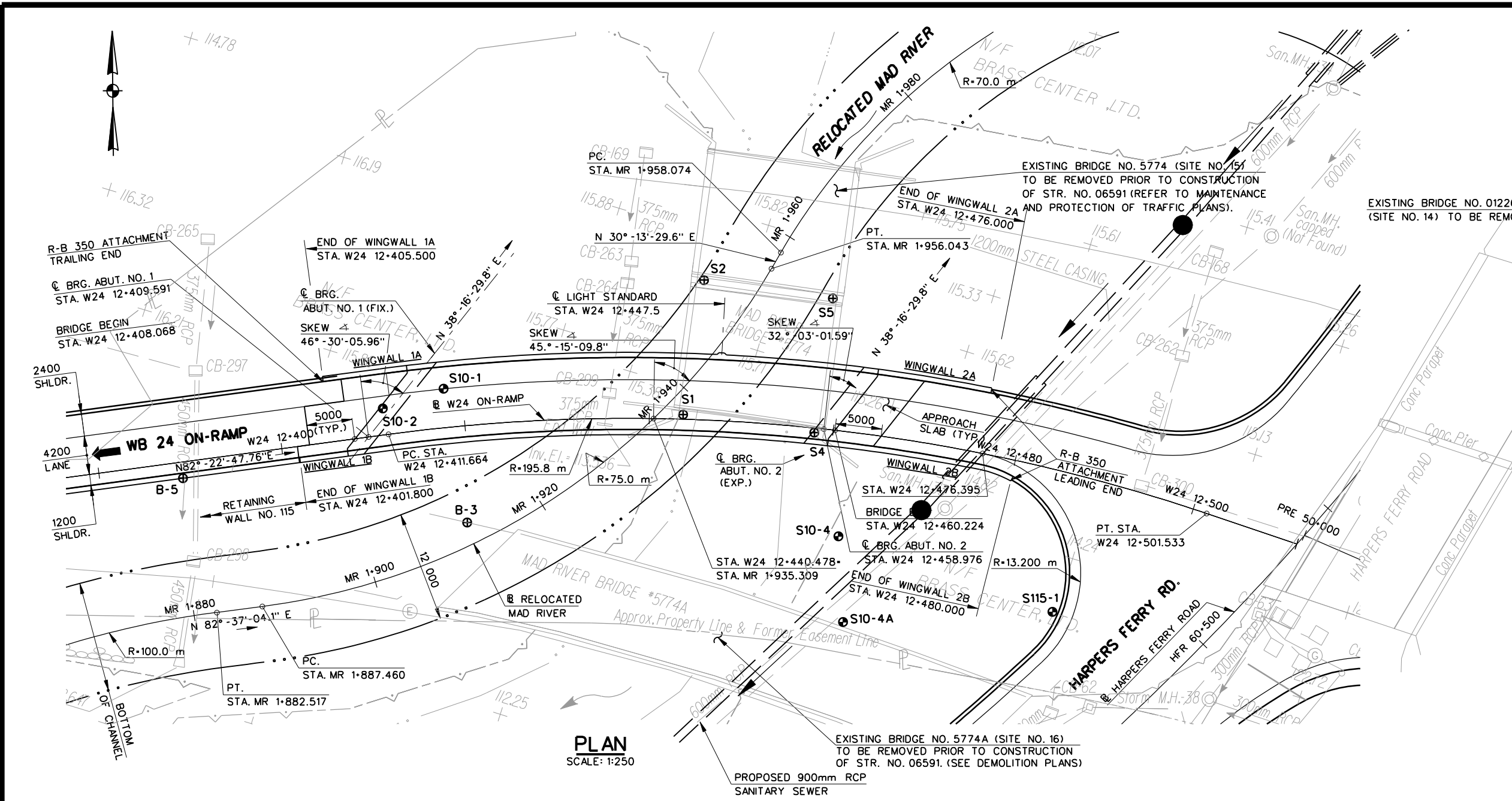
**NOTICE TO BRIDGE INSPECTORS**

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COMPONENT OR DETAIL	STRUCTURE SHEET REFERENCE

<table border="1" style="width: 100%;"> <thead> <tr> <th>REV.</th> <th>DATE</th> <th>DESCRIPTION</th> <th>SHEET NO.</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	REV.	DATE	DESCRIPTION	SHEET NO.					CADD: 102730601.brg PLOTTED: 11/20/10 SCALE AS NOTED	DESIGNER: Z. RUBIN DRAFTER: M. MOSLEY CHECKED BY: E. CONNELL DATE CHECKED: 1-20-03	<p><b>STATE OF CONNECTICUT</b> DEPARTMENT OF TRANSPORTATION</p>	PROJECT TITLE: <b>RECONSTRUCTION OF I-84 WATERBURY</b> <b>I-84 OVER MAD RIVER</b> <b>STRUCTURE NO. 151-273-05774</b>	TOWN: <b>WATERBURY</b> DRAWING TITLE: <b>GENERAL PLAN AND ELEVATION</b>	PROJECT NO.: <b>151-273</b> DRAWING NO.: <b>S1</b> SHEET NO.:
REV.	DATE	DESCRIPTION	SHEET NO.											





W24 ON-RAMP		MAD RIVER	
P.C.	STA. W24 12+411.664	P.C.	STA. MR 1+887.460
	N 230887.847		N 230869.187
	E 283043.838		E 283030.172
P.T.	STA. W24 12+501.533	P.T.	STA. MR 1+956.043
	N 230879.264		N 230905.811
	E 283132.506		E 283085.340
Δ	26°-17'-52.6"	Δ	52°-23'-34.6"
R	195.800 m	R	75.000 m
T	45.741 m	T	36.899 m
L	89.869 m	L	68.582 m

**CURVE DATA**

INSPECTION OF FIELD WELDS		
METHODS	UNIT	QUAN.
ULTRASONIC	mm	0
MAGNETIC PARTICLE	m	6200

CONCRETE DISTRIBUTION	
ITEMS	QUANTITY
SUPERSTRUCTURE	220 m <sup>3</sup>
SUBSTRUCTURE	600 m <sup>3</sup>
FOOTINGS	315 m <sup>3</sup>
<b>TOTAL</b>	<b>1135 m<sup>3</sup></b>

TRANSPORTATION DIMENSION AND MASS				
MEMBER	MAX. SHIPPING LENGTH	MAX. SHIPPING HEIGHT	MAX. SHIPPING WIDTH	MAX. SHIPPING MASS
G-4	36 200 mm	2400 mm	1500 mm	25 900 kg

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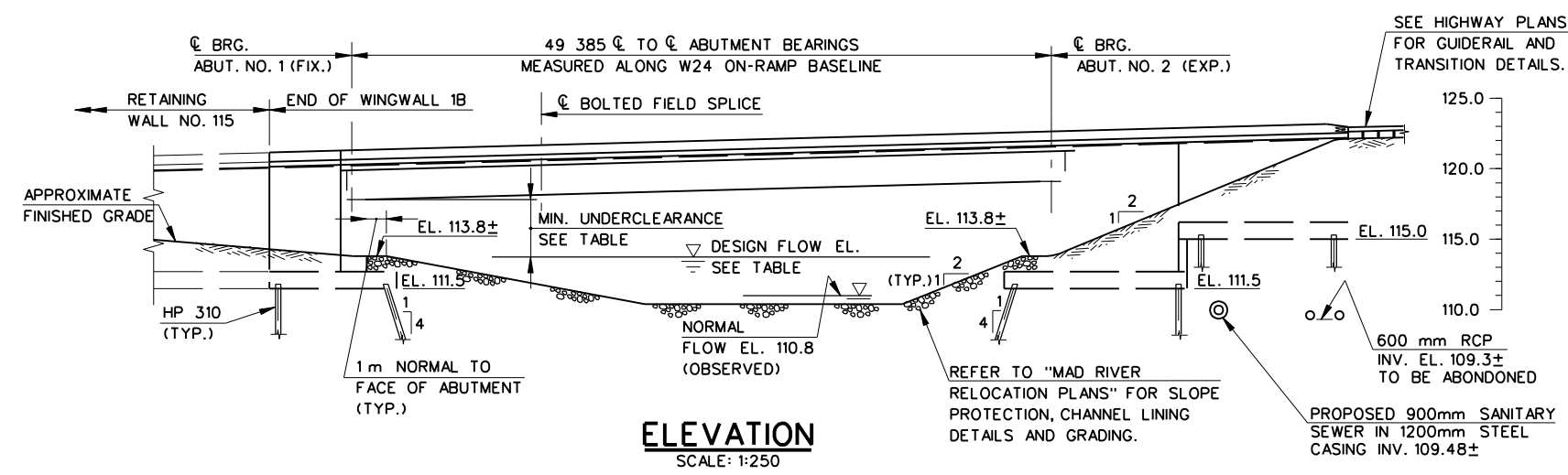
COMPONENT OR DETAIL	STRUCTURE SHEET REFERENCE

**BORING LEGEND**

- ⊙ - NEW BORING (2001)
- ⊕ - EXISTING BORING (1957 AND 1991)

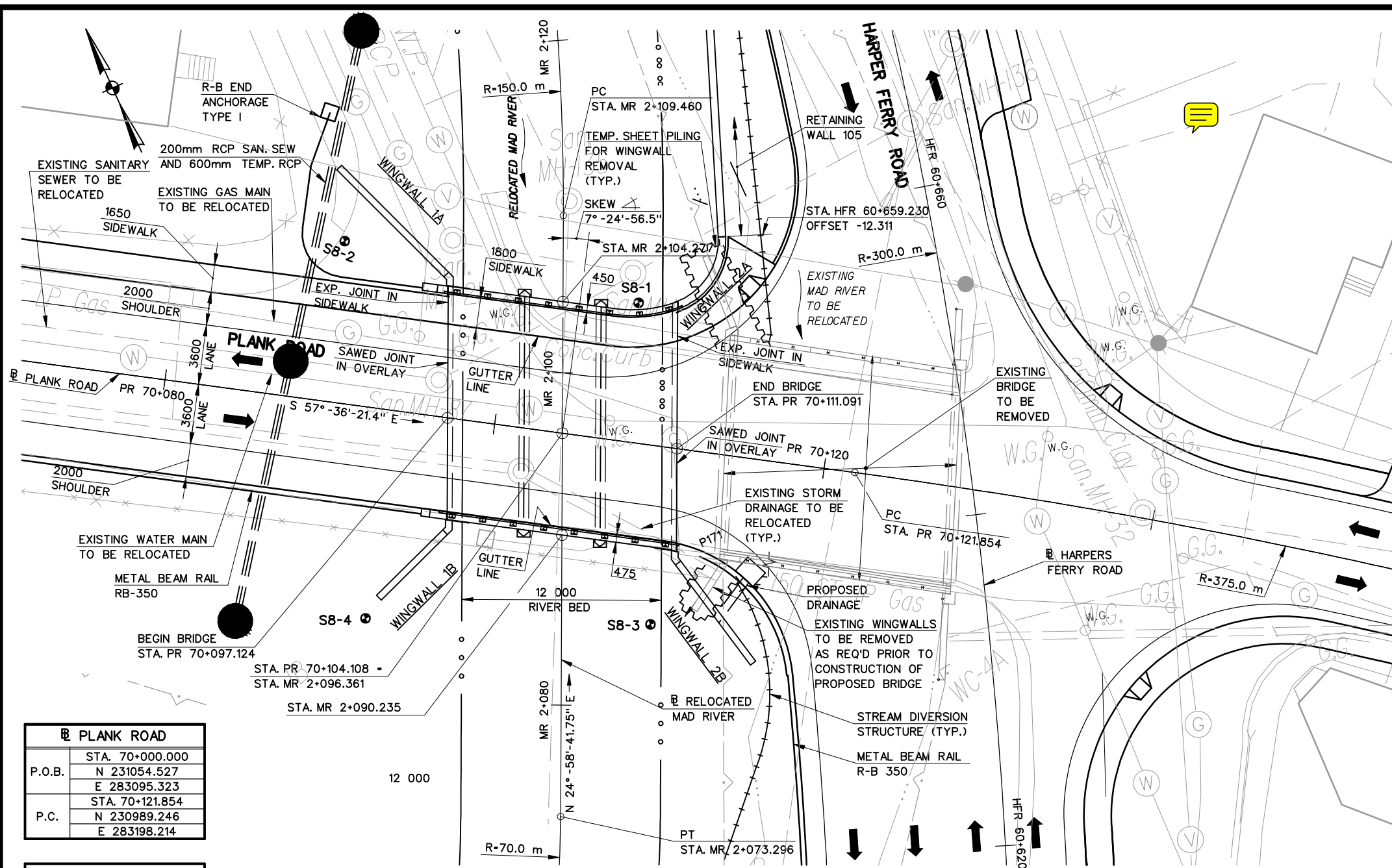
	UPSTREAM FASCIA GIRDER	DOWNSTREAM FASCIA GIRDER
DESIGN FLOW ELEVATION	113.83	113.78
MIN. UNDERCLEARANCE (m)	4.8	4.8

WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
62.3 km <sup>2</sup>	100-YEAR	176.98 m <sup>3</sup> /s



FOR INFORMATIONAL PURPOSES ONLY

<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>REV.</th> <th>DATE</th> <th>DESCRIPTION</th> <th>SHEET NO.</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	REV.	DATE	DESCRIPTION	SHEET NO.					<p>THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE TRUE CONDITIONS OR THE ACTUAL QUANTITIES OR DISTRIBUTION OF QUANTITIES OF WORK WHICH WILL BE REQUIRED</p>	<p>CADD ...02731001.brg PLOTTED 11/20/10 SCALE AS NOTED</p>	<p>DESIGNER: N. VYAS DRAFTER: A. PRESS CHECKED BY: E. CONNELL / N. VYAS DATE CHECKED: 2/25/03</p>	<p><b>STATE OF CONNECTICUT</b> DEPARTMENT OF TRANSPORTATION</p> <p>BERGER LEHMAN ASSOCIATES, P.C.</p>	<p>PROJECT TITLE: <b>RECONSTRUCTION OF I-84 WATERBURY WB W24 ON-RAMP OVER MAD RIVER STRUCTURE NO. 151-273-06591</b></p>	<p>TOWN: <b>WATERBURY</b></p> <p>DRAWING TITLE: <b>GENERAL PLAN AND ELEVATION</b></p>	<p>PROJECT NO.: <b>151-273</b></p> <p>DRAWING NO.: <b>S1</b></p> <p>SHEET NO.:</p>
REV.	DATE	DESCRIPTION	SHEET NO.												



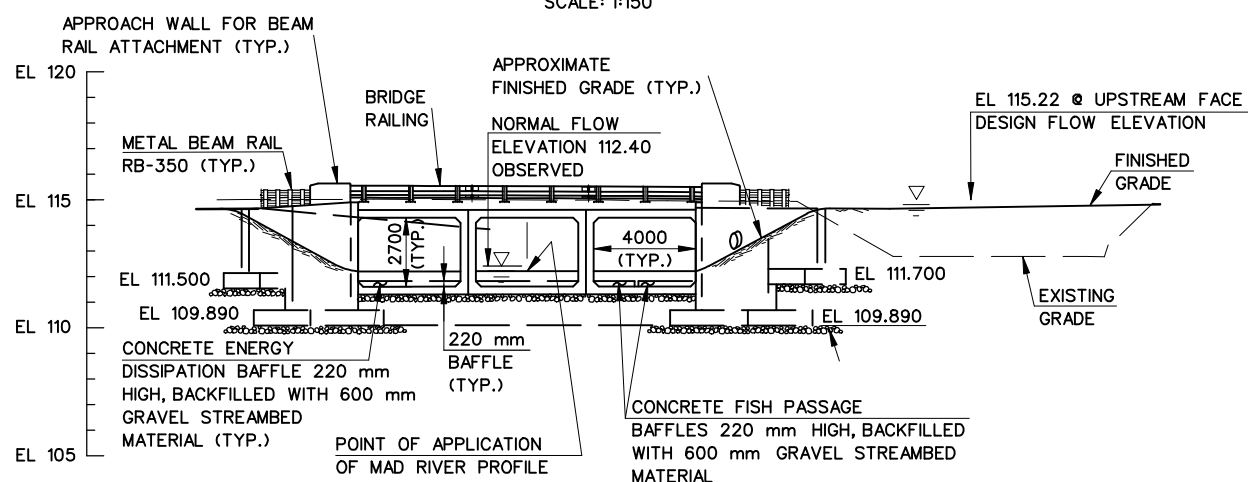
PLANK ROAD	
P.O.B.	STA. 70+000.000 N 231054.527 E 283095.323
P.C.	STA. 70+121.854 N 230989.246 E 283198.214

HARPERS FERRY ROAD	
P.T.	STA. 60+244.053 N 230756.116 E 282904.193
P.C.	STA. 60+353.733 N 230789.282 E 283008.738
P.C.C.	STA. 60+684.068 N 231026.708 E 283214.070
Δ	63°-05'-21.6"
R	300.0
T	184.162
L	330.335

MAD RIVER	
P.T.	STA. 2+073.296 N 230977.846 E 283173.491
P.C.	STA. 2+109.460 N 231010.627 E 283188.762

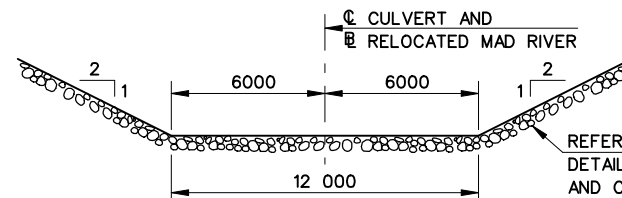
**CURVE DATA**

WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
47.8 km <sup>2</sup>	100-YEAR	124.59 m <sup>3</sup> /s



**ELEVATION**  
SCALE: 1:150

**FOR INFORMATIONAL PURPOSES ONLY**



**TYPICAL MAD RIVER SECTION**  
SCALE: 1:150

**BORING LEGEND**

● - 2000 BORING

INSPECTION OF FIELD WELDS		
METHOD	UNIT	QUAN.
ULTRASONIC	mm	-
MAGNETIC PARTICLE	mm	-

WATERSHED AREA	DESIGN FLOW FREQ.	DESIGN FLOW
47.8 km <sup>2</sup>	100-YEAR	124.59 m <sup>3</sup> /s

	UPSTREAM CULVERT FASCIA	DOWNSTREAM CULVERT FASCIA
DESIGN FLOW ELEVATION	115.22	114.37
AVERAGE FREEBOARD (m)	OVERTOPS	OVERTOPS

**NOTICE TO BRIDGE INSPECTORS**

THE DEPARTMENT'S BRIDGE SAFETY PROCEDURES REQUIRE THIS BRIDGE TO BE INSPECTED FOR, BUT NOT LIMITED TO ALL APPROPRIATE COMPONENTS INDICATED IN THE GOVERNING MANUALS FOR BRIDGE INSPECTION. ATTENTION MUST BE GIVEN TO INSPECTING THE FOLLOWING SPECIAL COMPONENTS AND DETAILS. (THE LISTING OF COMPONENTS FOR SPECIFIC ATTENTION SHALL NOT BE CONSTRUED TO REDUCE THE IMPORTANCE OF INSPECTION OF ANY OTHER COMPONENT OF THE STRUCTURE.) THE FREQUENCY OF INSPECTION OF THIS STRUCTURE SHALL BE IN ACCORDANCE WITH THE GOVERNING MANUALS FOR BRIDGE INSPECTION, UNLESS OTHERWISE DIRECTED BY THE MANAGER OF BRIDGE SAFETY AND EVALUATION.

COMPONENT OR DETAIL	STRUCTURE SHEET REFERENCE
N/A	N/A

**GENERAL NOTES**

**SPECIFICATIONS:** CONNECTICUT DEPARTMENT OF TRANSPORTATION FORM 816 (2004), SUPPLEMENTAL SPECIFICATION DATED ( - / - ) AND SPECIAL PROVISIONS.

**DESIGN STRENGTH:** STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES (AASHTO-1996) BY THE STRENGTH METHOD (LOAD FACTOR DESIGN) WITH THE INTERIM SPECIFICATIONS UP TO AND INCLUDING 2000 AS SUPPLEMENTED BY THE CONNECTICUT DEPARTMENT OF TRANSPORTATION BRIDGE DESIGN MANUAL (1997).

**DESIGN STRENGTH:**

CLASS "A" CONCRETE  
CLASS "F" CONCRETE  
REINFORCEMENT (ASTM A615M GRADE 420)

BASED ON  $f'c = 21 \text{ MPa}$   
BASED ON  $f'c = 28 \text{ MPa}$   
 $f_y = 414 \text{ MPa}$

**LIVE LOAD:** HS20.

**FUTURE PAVING ALLOWANCE:** NONE

**SUPERPAVE OVERLAY:** THIS SHALL CONSIST OF TWO LIFTS. THE FIRST SHALL BE SUPERPAVE 9.5 mm (25 mm THICK) AND THE SECOND SHALL BE SUPERPAVE 12.5 mm (40 mm THICK MINIMUM).

**FOUNDATION PRESSURES:** THE VARIOUS GROUP LOADINGS NOTED ON THE SUBSTRUCTURE PLAN SHEETS REFER TO THE GROUP LOADS AS GIVEN IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS.

**ELEVATIONS:** ALL ELEVATIONS ARE GIVEN IN METERS (m).

**DIMENSIONS:** ALL DIMENSIONS ARE GIVEN IN MILLIMETERS (mm), EXCEPT IF NOTED OTHERWISE.

**STATIONING:** STATIONS ARE GIVEN IN METERS (m).

**DECIMAL DIMENSIONS:** WHEN DIMENSIONS ARE GIVEN TO LESS THAN THREE DECIMAL PLACES, THE OMITTED DIGITS SHALL BE ASSUMED TO BE ZEROS.

**EXISTING PLANS:** BRIDGE NO. 05668 WAS ORIGINALLY CONSTRUCTED UNDER CONTRACT NO. MEWB2, DATED JUNE 1987. PLANS FOR THE EXISTING STRUCTURE TO BE REMOVED ARE AVAILABLE TO THE CONTRACTOR AT THE CONNECTICUT DEPARTMENT OF TRANSPORTATION MAP ROOM, 160 PASCOE PLACE, NEWINGTON, CT 06111.

**TRAFFIC:** ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE SPECIAL PROVISIONS "MAINTENANCE AND PROTECTION OF TRAFFIC" AND "SECTION 1.08 - PROSECUTION AND PROGRESS".

**CONSTRUCTION STAGING:** REFER TO "MAINTENANCE AND PROTECTION OF TRAFFIC" AND "MAD RIVER RELOCATION" PLANS FOR GRADING, CONSTRUCTION STAGING AND STREAM DIVERSION STRUCTURES.

**CONCRETE NOTES**

**CLASS "A" CONCRETE:** CLASS "A" CONCRETE SHALL BE USED THROUGHOUT, UNLESS NOTED OTHERWISE.

**CLASS "F" CONCRETE:** CLASS "F" CONCRETE SHALL BE USED ON THE SIDEWALKS AND PARAPETS.

**JOINT SEAL:** SEE SPECIAL PROVISIONS.

**EXPOSED EDGES:** EXPOSED EDGES OF CONCRETE SHALL BE BEVELED 25 mm x 25 mm UNLESS DIMENSIONED OTHERWISE.

**CONCRETE COVER:** ALL REINFORCEMENT SHALL HAVE 50 mm COVER UNLESS DIMENSIONED OTHERWISE.

**REINFORCEMENT:** ALL REINFORCEMENT SHALL BE ASTM A615M GRADE 420.

**EPOXY COATED REINFORCING BARS:** ALL REINFORCEMENT IN THE SUPERSTRUCTURE INCLUDING SIDEWALK AND CURBS SHALL BE EPOXY COATED UNLESS OTHERWISE NOTED. THESE BARS SHALL BE INCLUDED IN THE PAY ITEM FOR "DEFORMED STEEL BARS (EPOXY COATED)".

**PREFORMED EXPANSION JOINT FILLER:** THE COST OF FURNISHING AND INSTALLING PREFORMED EXPANSION JOINT FILLER SHALL BE INCLUDED IN THE COST OF THE ITEM "CLASS 'A' CONCRETE".

**CONSTRUCTION JOINTS:** CONSTRUCTION JOINTS, OTHER THAN THOSE SHOWN ON THE PLANS, WILL NOT BE PERMITTED WITHOUT THE PRIOR APPROVAL OF THE ENGINEER.

FOR ADDITIONAL NOTES, SEE DRAWINGS NOS. S7, S9 AND S11.

REV.	DATE	DESCRIPTION	SHEET NO.

THE INFORMATION, INCLUDING ESTIMATED QUANTITIES OF WORK SHOWN ON THESE SHEETS IS BASED ON LIMITED INVESTIGATIONS BY THE STATE AND IS IN NO WAY WARRANTED TO INDICATE THE TRUE CONDITIONS OR THE ACTUAL QUANTITIES OR DISTRIBUTION OF QUANTITIES OF WORK WHICH WILL BE REQUIRED

CADD ...027308001.brg	DESIGNER N. VYAS
PLOTTED 7/17/2013	DRAFTER A. PRESS
SCALE AS NOTED	CHECKED BY: E. CONNELL
	DATE CHECKED: 2/20/03

STATE OF CONNECTICUT DEPARTMENT OF TRANSPORTATION
ENGINEER: BERGER LEHMAN ASSOCIATES, P.C.
APPROVED BY: _____ DATE: _____

PROJECT TITLE: RECONSTRUCTION OF I-84 WATERBURY PLANK ROAD OVER MAD RIVER STRUCTURE NO. 151-273-05668	TOWN: WATERBURY	PROJECT NO.: 151-273
DRAWING TITLE: GENERAL PLAN & ELEVATION	DRAWING NO.: S1	SHEET NO.: