Bridge Number 2934, Route 4 over Sandy River in Madrid

Final Design Hydrology and Hydraulics Report

Maine DOT WIN 22615.00

NORTHSTAR
HYDRO

For: Stantec

November 5, 2018

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STATE OF MAINE
ELLEN
KNIGHT O'BRIEN
No. 7945
LICENSED
PROFESSIONAL ENGINEER

Bridge Number 2934, Route 4 over Sandy River in Madrid, MaineDOT WIN 22615.00

Final Design Hydrology and Hydraulics Report

1.0 Introduction

The Weymouth Bridge in Madrid carries Route 4 over the Sandy River about 0.5 mile southeast of the Madrid Town Line. Figure 1 shows the site location.

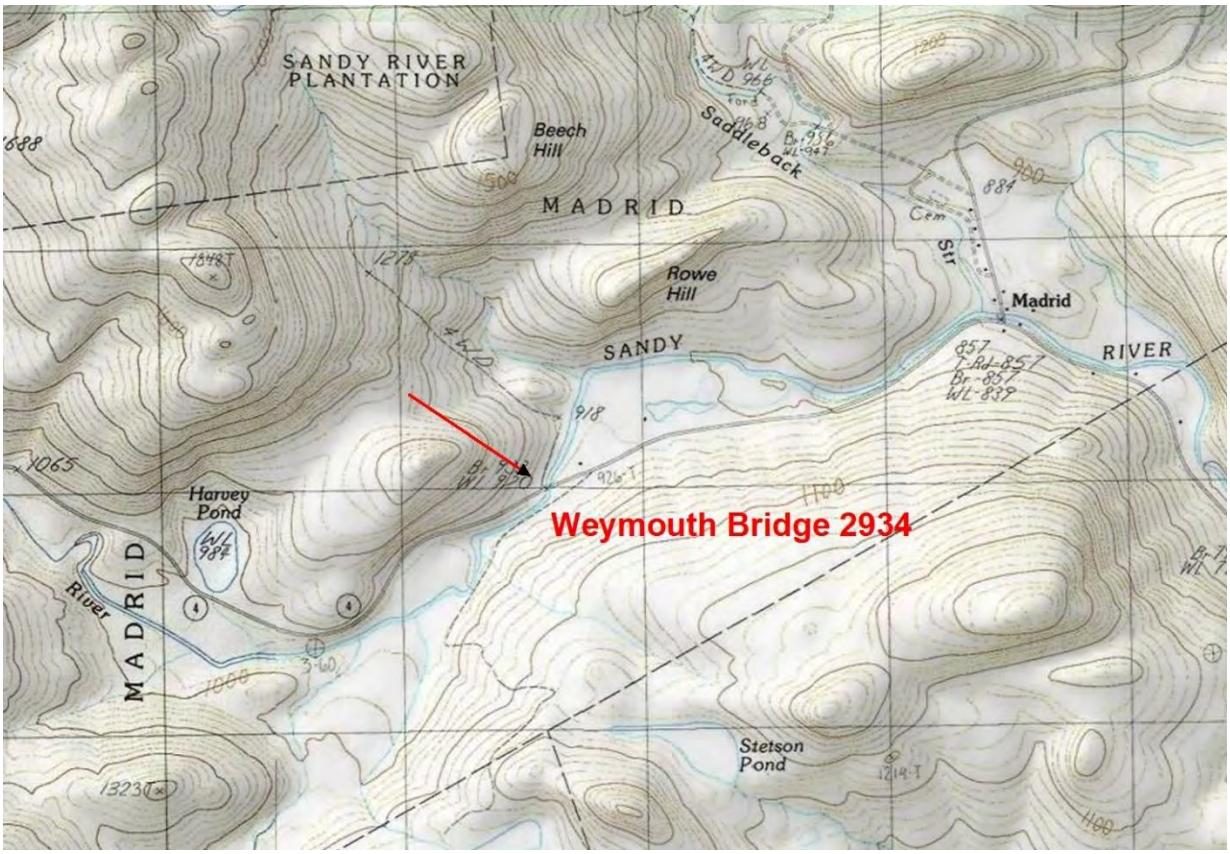

Figure 1. Project Location, Weymouth Bridge No. 2934 in Madrid over Sandy River.

The 45' single span bridge crosses a segment of river with rapid flows and steep gradient. The bridge crosses the river at approximately a 30-35 degree angle and Hurricane Irene in 2011 carved a scour hole downstream of the bridge. Figure 2 is an air photo that shows the bridge site.

This final design report details hydrologic, hydraulic, and scour analyses for existing conditions and for the final design bridge which includes a clear span of 104' and spans the Bank Full Width condition for facilitation of fish passage.

Stantec furnished plans dated February of 2017, and for the 90% submittal planned for May 14, 2018 showing the planned bridge profile and plan (Sheets 4 and 5).

Figure 2 shows the bridge on an aerial photo.

Figure 2. Air photo of bridge crossing showing scour hole downstream. Note skew of bridge structure to direction of flow.

The river segment contains a sharp bend and rapids upstream and a scour hole downstream. The left or westerly abutment projects into the river flow. Figure 3 is taken from the easterly upstream bank looking at the upstream western abutment face.

Figure 3. Looking upstream. Note steep gradient and bend upstream.

Figure 4 below is taken from Stantec's proposed plans of February, 2018 showing restored channel, bridge spanning natural channel, and preliminary design flood elevations. This same section is shown in the 90% submittal plans.

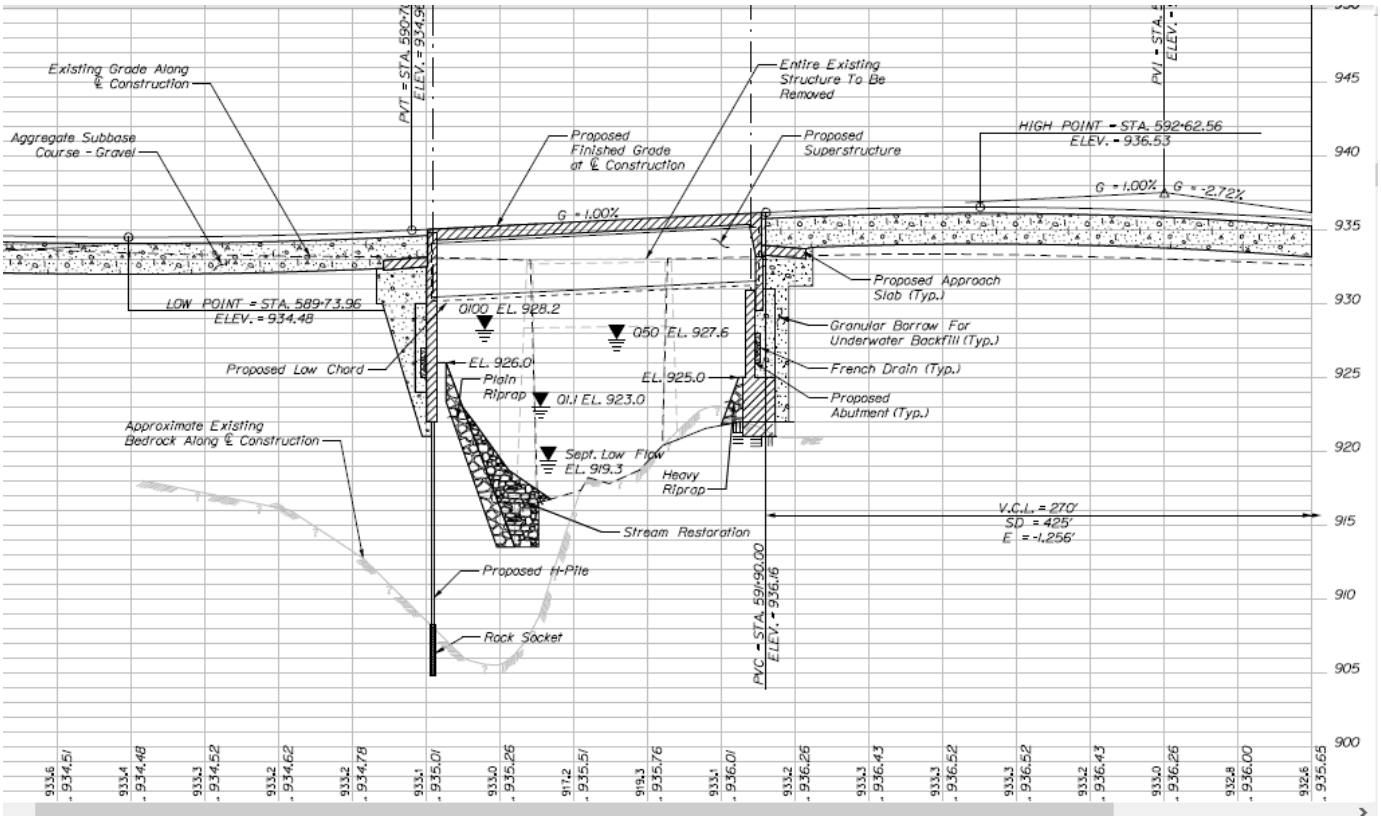

Figure 4. Proposed replacement bridge.

2.0 Existing Data Review

Existing data related to this bridge was reviewed, including but not limited to

- MDOT file information including
  - In 2010, a Bridge Scour Assesment Summary Report was issued by Maine DOT. The report is included in the appendix. The report notes concerns with ongoing scour on the left (westerly) abutment as well as a scour hole downstream. The bridge is rated "3" scour critical and scour protection is recommended for the left abutment. Note that this report was done prior to Hurricane Irene.
  - Structure Inventory and Appraisal Sheets from 2014 note scour as "4" stable but needs action.
- Historical Flood Information – No site specific flood information was found for this location. However, the 1987 flood in this area is estimated to be approximately a 150-year event. The 1936 hurricane is the next largest flood on the Sandy River. Information on Hurricane Irene in 2011 was recorded at Madrid (see below), and is likely the flood of record at this site.
- Surveyed channel cross sections and additional project survey were utilized for hydraulic modeling.

- Soil borings – material, depth, size and distribution of bottom materials.
- USGS gaging station records- the nearest long term USGS Gage on the Sandy River is near Mercer, Maine, about 40 miles downstream with a drainage area of 516 square miles. This gage record runs from 1928 to present (2017).
  http://waterdata.usgs.gov/nwis/inventory/?site_no=01048000&agency_cd=USGS
  A short term gage is located on the bridge, drains 25.3 square miles and has records from 2008 to present. Flood of record at this gage was 5200 cfs during Hurricane Irene on August 28, 2011. Other annual peaks have ranged from 1500 to 2800 cfs.
  http://waterdata.usgs.gov/nwis/inventory/?site_no=01047200&agency_cd=USGS

Figure 5. Left or westerly abutment with stream gage installation on downstream wing.

- FEMA Flood Maps and FIS report
  - FEMA has not studied this area in detail. The Flood Insurance Rate Map is of the "approximate study" type, published in 1985. Flood zone is listed as "A" with no flood elevations shown.
- Air photos
- Topographic Maps

3.0 Hydrologic Analysis

Maine DOT furnished peak discharges for floods of selected design intervals, including the 1.1-year, 10-, 25-, 50-, 100-, and 500-year flood based on the USGS Regression Equations. At the Weymouth Bridge, drainage area is 25.3 square miles and percent wetlands is 2.6. Table 1 below summarizes peak flood flows as computed by Maine DOT and as used for this bridge analysis. In addition to flow data calculated by Maine DOT, the record for the USGS gage at the bridge was used to identify a range of typical annual peak flows and the flow for Hurricane Irene. The flow data for specific frequencies were calculated by the Regression formula. Irene and peak flows are as recorded by the gage.

No specific historic data was found for the 1987 for 1936 floods. However, recent Hurricane Irene (August 28, 2011) dropped 8.5 in. of rain on the Carrabassett Valley area, washing out two bridges on Route 27 near the Sugarloaf Access Road. This storm was recorded by the gage on the Sandy River at Madrid. For the 25 sq mi. mile drainage basin, the 5,200 cfs recorded flow is about a 500-year event.

Summary of Available Hydrologic Data, Weymouth Bridge 2934, Madrid, Maine

Recurrence Interval	Maine DOT calculations at gage
Calculation Method	25.3 sq mi, 2.6 % wetlands
1.1	535
2	1,127
5	1,796
10	2,304
25	2,992
50	3,540
100	4,124
500	5,604
Hurricane Irene (~500 yr)	5,200
Gage Annual Peak Low	1,500
Gage Annual Peak High	2,800
September Mean Low	5.8
October Mean Low	9.9

Table 1. Flow frequency data for recurrence intervals, calculated by Maine DOT. Hurricane Irene, annual flows and mean flows recorded by the USGS gage.

Drainage Area	**25 sq mi.**
Q25	2,992 cfs
Design Discharge (Q50)	3,540 cfs
Check Discharge (Q100)	4,124 cfs
Scour Check Discharge (Q500)	5,604 cfs
Ordinary High Water (Q1.1)	535 cfs
Flood of Record (Hurricane Irene)	5,200 cfs

Table 2. Summary of Hydrologic Data for Bridge Analysis

Site Photographs: Figures 6-14 are photographs relative to site hydraulics.

Figure 6. Looking upstream from bridge. Note bend in river just upstream of bridge.

Figure 7. Looking at west upstream abutment. Note that abutment encroaches into main channel.

Figure 8. Looking downstream from bridge at scour hole.

Figure 9. Right or eastern abutment set on rock.

Figure 10. West abutment. Note cracking. Maine DOT inspection photos note cracking and rotation of abutment.

Figure 11. Looking downstream through bridge. Easterly or right abutment. Note scour hole downstream. Abutment founded on rock.

Figure 12. Right/East abutment looking upstream. Note abutment founded on rock.

Figure 13. Downstream left/westerly abutment. Note abutment projects into flow.

Figure 14. Upstream end of left/westerly abutment. Note projection into stream.

4.0 Hydraulic Analysis

The goal of the hydraulic analysis was to provide information on flood elevations and flow velocities under existing and proposed conditions. Model data was used by the design team to establish design parameters for a replacement bridge including: required alternative road profiles, structure depths, and substructure layout. The hydraulic model was also used to assess channel conditions related to fish passage.

Figure 15 shows project survey and layout of model cross sections used for the hydraulic analysis. These sections and modified sections were used to simulate channel conditions as the bridge exists now and under expected conditions for a replacement bridge.

Note that for the final design model, sections at each face of the proposed bridge were added to the model skewed 35 degrees to simulate the area perpendicular to stream flow. This section layout was somewhat different than the preliminary design hydraulic model due to final design

geometry. The modeled bridge reach has conditions of rapidly varying flow and the bridge is not perpendicular to flow. This layout results in challenges for 1-dimensional flow model simulation to perfectly capture bridge hydraulics. HECRAS calculates both water surface elevation and energy grade line, providing additional information to designers on expected water levels under flood conditions.

Figure 15. Channel cross sections.

The existing bridge crosses the river at approximately a 35 degree angle. While the existing bridge span is 48 ft, the channel width from abutment to abutment perpendicular to flow is approximately 40 ft. A large scour hole was created downstream of the bridge by flows

generated by Hurricane Irene. The existing abutments project somewhat into the natural channel. The channel has rapidly varying flow conditions, with a drop into the scour pool.

The hydraulic analysis calculates flood levels such that the bridge may be designed for passage of peak flood flows with sufficient clearance for selected flood events (typically 2 ft at Q50 for minor structures such as this bridge, 4 ft for major bridges). The analysis also provided variables used for projecting scour depths. In addition, pre- and post- condition flood elevations were determined and compared to assure that flood levels will not be raised by the new bridge. The hydraulic analysis also assisted with determining average Bank Full Width channel section for design related to fish passage.

Hydraulic analysis was performed in accordance with the procedures outlined in the Maine DOT Bridge Design Guide. Hydraulic analysis was be prepared using HECRAS, version 5.03 River Analysis System by the U.S. Army Corps of Engineers.

Modeled cross sections are shown in Figure 15 above. In addition to sections shown on this plan, two new sections at the bridge faces for each design option were included in the final model, and skewed 35 degrees to plot perpendicular to flow.

The proposed bridge layout is shown in Figure 16. The width of the proposed bridge perpendicular to flow increases from approximately 40 ft to 85 ft.

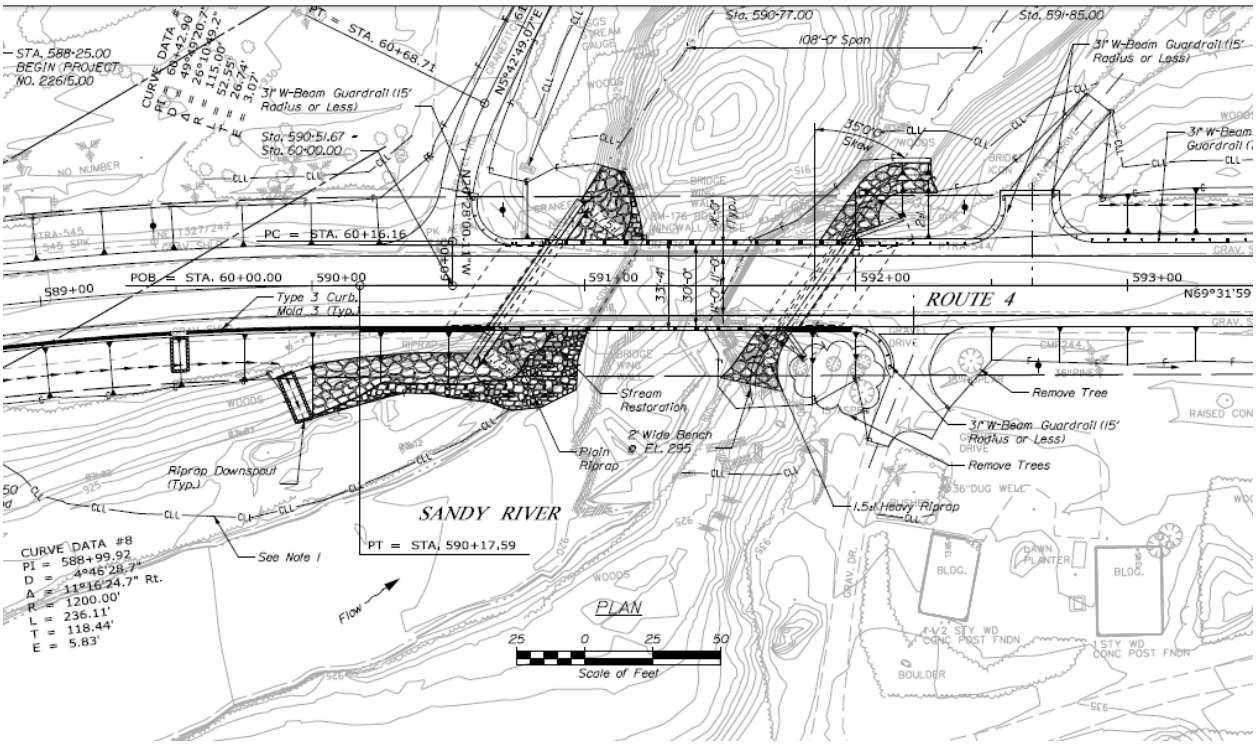

Figure 16. Final design bridge layout

The expanded width of the proposed bridge allows for improved flood passage. Figure 17 shows a comparison of the flood elevations under the existing condition (blue) and the proposed bridge (red). The narrower opening of the existing bridge caused backwater upstream of the bridge and

high velocities through the bridge. The wider proposed opening allows flows to pass without significant upstream impact and will mitigate scour by lowering discharge velocities.

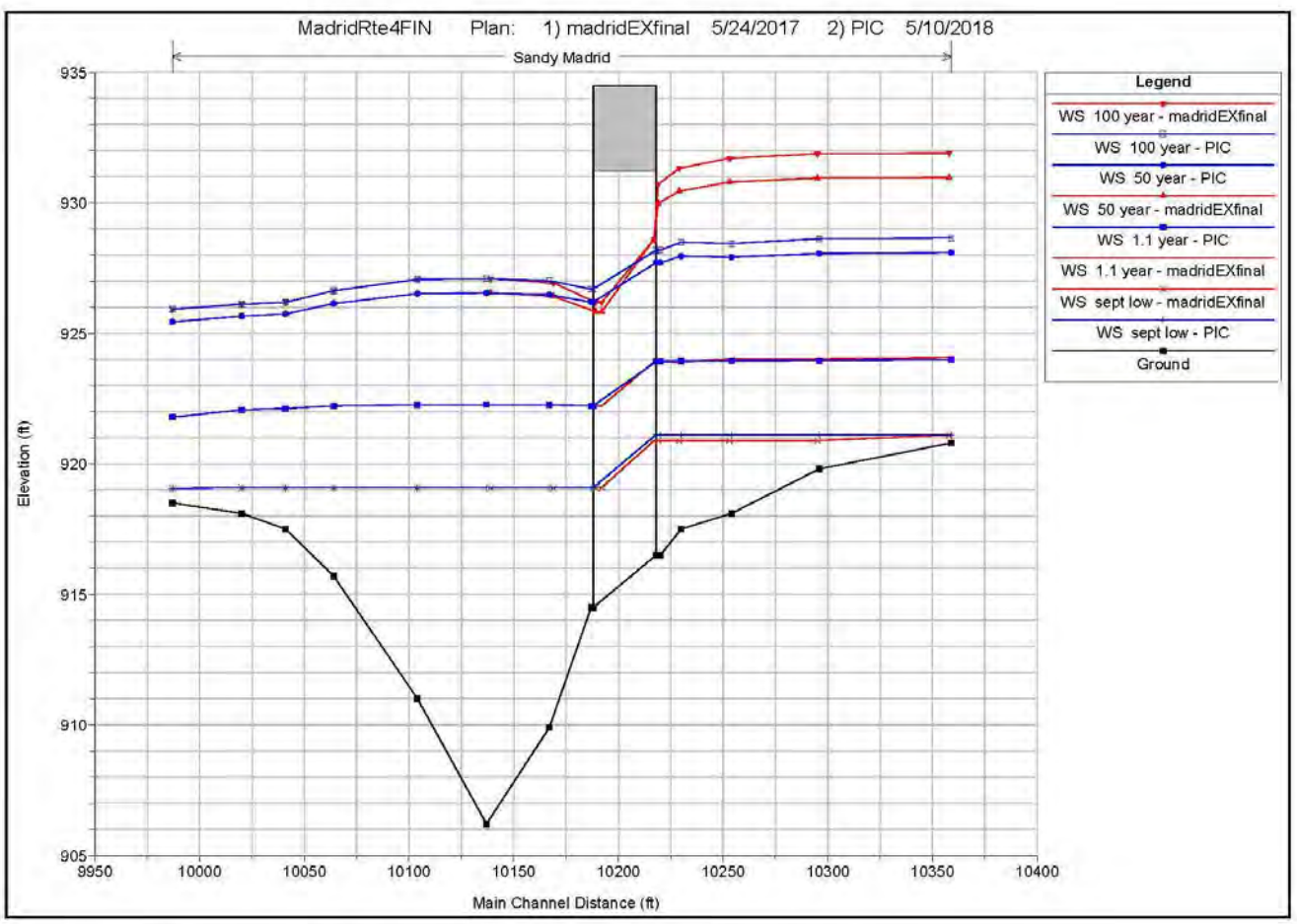

Figure 17. Channel bottom and existing and proposed flood profiles. September low flow, 1.1-year flow, 50- and 100-year flows.

Table 3 below summarizes hydraulic data for existing and proposed conditions.

Summary of Hydraulic Data	Existing Bridge	Proposed Bridge
Low Chord	928.6	930.1 (L) -931.2 (R)
Width at Q100 (perpendicular to flow)	39.7	85.3
Width at Banks (perpendicular to flow)	39.5	84.7
Headwater at Q25, ft, (at bridge face)	927.3	927.2
Energy Grade Line for Q25 at US face.	928.4	927.7
Headwater at Q50, ft, (at bridge face)	928.6	927.7
Energy Grade Line for Q50 at US face	930.9	928.3
Headwater at Q100, ft, (at bridge face)	928.6	928.2
Energy Grade Line for Q100 at US face	931.8	928.9
Discharge Velocity at Q25, fps	8.9	6.2
Discharge Velocity at Q50, fps	10.1	6.7
Discharge Velocity at Q100, fps	11.3	7.2
Ordinary High Water Elevation (Q1.1) (US face), ft	923.9	923.9
Discharge Velocity at Q1.1, fps	2.5	2.2
Clearance @ Q25, ft	0.2	2.9-4.0
Clearance @ Q50, ft	EGL 2.3 above low cord, pressure flow	2.4-3.5
Clearance @ Q100, ft	EGL 3.2 above low chord, pressure flow	1.9-3.0
Bridge Opening Area, ft^2	400.5	864.7
Flow Area at Q100, ft^2 (US Face)	400.5	629.1

Table 3. Summary of Hydraulic Data.

5.0 Scour Computations

The existing bridge shows evidence of scour by contraction (scour hole) and at the west abutment. The right or easterly abutment will be founded on rock. The west or left abutment will require scour protection. Contraction scour potential decreases significantly due to the proposed bridge section being wider than bank full width. Because abutments will not be subject to scour due to presence of rock or scour protection, only contraction scour was computed.

Scour analysis for the proposed 104 ft span at a thirty five degree angle to flow yielded the following results:

Proposed Bridge	100-year		500-year	
	Left	center	left	center
D50 (assumed)	1mm		1 mm	
Contraction Scour	0.0’	0.80	0.0’	1.4’
Abutment Scour Depth	N/A scour protection		NA scour protection	
Total Scour	0.0	0.8’	0.0’	1.4’
Channel Elev. Before scour	921.9	916.0	921.9	916.0
Est. Channel Elevation after scour	921.9	915.2	921.9	914.6

Table 4. Scour Calculations

The project site was checked for susceptibility to rock scour, but rock scour is generally thought to apply only to scour at piers. Critical stream power was computed based on logged rock qualities, but calculation of actual stream power can only be done at piers.

Fish Passage:

The Sandy River flows into the Kennebec River and is thus part of the Atlantic Salmon Restoration Initiative. Improved fish passage allowance is required for the new bridge. The existing bridge constricts the natural channel as do the old abutments downstream. Bank full width was estimated to be 73 ft perpendicular to the channel based on several estimation methods, including examination of surveyed sections, calculations with HECRAS, sketches of main channel banks and field examination. Detail is included in the appendix. For the proposed bridge design including proposed channel reconstruction, channel width at the 1.1-yr event will be 69 ft perpendicular to the channel. Note that this design has a total bridge span of 104 ft which translates to an approximately 85 foot span abutment to abutment in the direction perpendicular to flow. Sloped embankments, bedrock and scour protection make the channel narrower at the 1.1-year flood level.

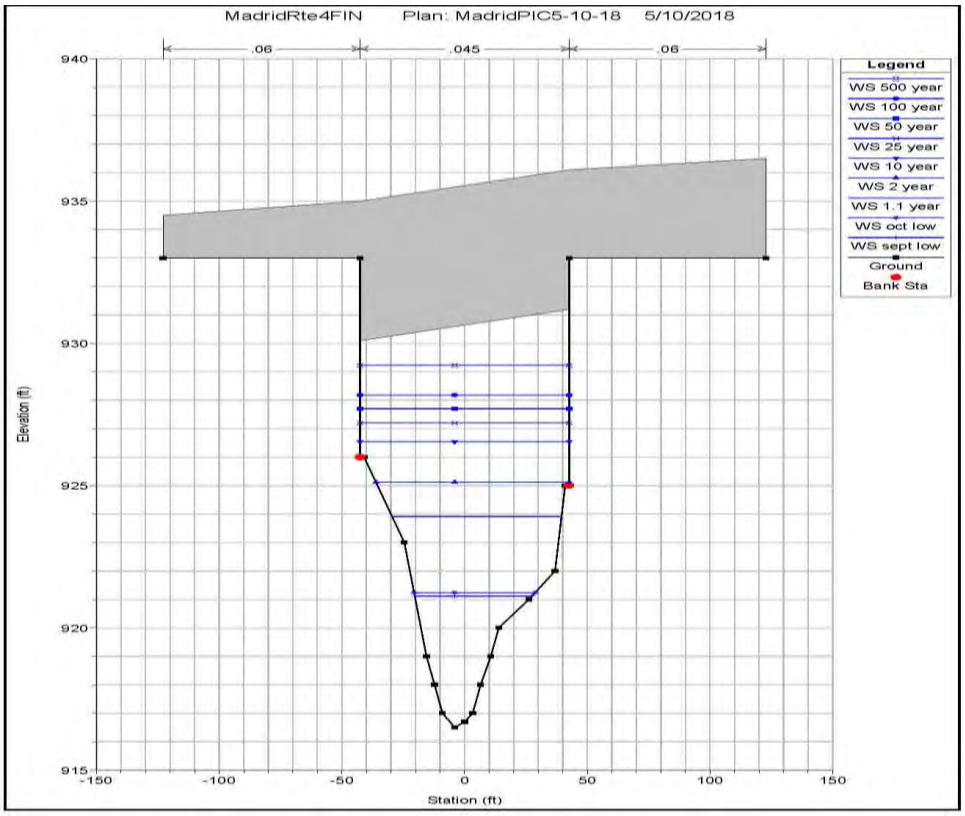

Figure 18. Bridge cross section, HECRAS model. – US section.

6.0 Summary of Findings

- The bridge crosses the channel at an approximately 35 degree angle.
- The existing bridge constricts the channel to narrower than natural bank full width.

- The Flood Insurance Study does not provide a 100-year elevation at this location.
- Model results indicate that in a 50-year flood event, the existing bridge is likely to have flood water above the low chord.
- The drainage area is 25.3 square miles and a short term recording gage installed and maintained by USGS is located on the downstream side of the bridge.
- The hydraulic characteristics of the bridge site indicate rapid flow upstream of and through the bridge. The stream flows into a scour pool below the bridge.
- Starting water levels for the hydraulic model were based on calculated stream gradient and normal depth.
- For the proposed bridge, 50-year clearance is 2.4-3.5 ft, and 100-year clearance is predicted to be 1.9-3.0 ft according to the hydraulic model.
- The East abutment is to be founded on rock, and the west abutment is subject to scour unless protected with scour protection. The west abutment will be protected with scour protection.
- Predicted contraction scour is limited to less than 1.1' for the new bridge due to the wider span. Rock scour is limited to piers, so is not a factor at this site.
- Improvements in fish passage will be provided by widening the bridge opening to slightly narrower than bank full width, or 69 ft perpendicular to flow direction.
- The wider bridge will result in less likelihood of backwater during flood events.

References

Federal Emergency Management Agency. Flood Insurance Rate Map, Town of Madrid, Maine. 1985

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Maine Dept. of Transportation. Bridge Scour Assessment Summary Report. Weymouth Bridge, Madrid, Maine. Bridge # 2934. 1/29/10

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http://waterdata.usgs.gov/nwis/inventory/?site_no=01048000&agency_cd=USGS

USGS Gage on Sandy River near Madrid, Maine #
http://waterdata.usgs.gov/nwis/inventory/?site_no=01047200&agency_cd=USGS

Stantec for MaineDOT,. Madrid Franklin County, Weymouth Bridge over Sandy River. Route 4 Federal Aid Project No. STP-226(500), Bridge Number 2934. 90% Submission. 5/14/2018

Weymouth Bridge, Sandy River, Madrid, Maine

Final Design Hydrologic and Hydraulics Report

Appendix

Project Name:	Madrid - Weymouth Br	**PIN:**	22615
Stream Name:	Sandy River	**Town:**	Madrid
Bridge Name:	Weymouth Bridge	**Bridge No.**	2934
Route No.	ME 4	**USGS Quad:**	
Analysis by:	CSH	**Date:**	3/19/2014

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999)

Enter data in blue cells only!

	km²	mi²	ac	
A	65.79	25.40	16256.0	Watershed Area
W	1.71	0.66	423.0	Wetlands area (by NWI)
P_c	378070	4968047		watershed centroid (E, N; UTM 19N; meters)
County	Franklin			*choose county from drop-down menu*
pptA	45.6			mean annual precipitation (inches; by look-up)
SG	0.00			sand & gravel aquifer as decimal fraction of watershed A

Enter data in [mi²]

A (km²) 65.79 **Conf Lvl** 0.67
W (%) 2.60

Worksheet prepared by:
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Maine Dept. Transportation
Augusta, ME 04333-0016
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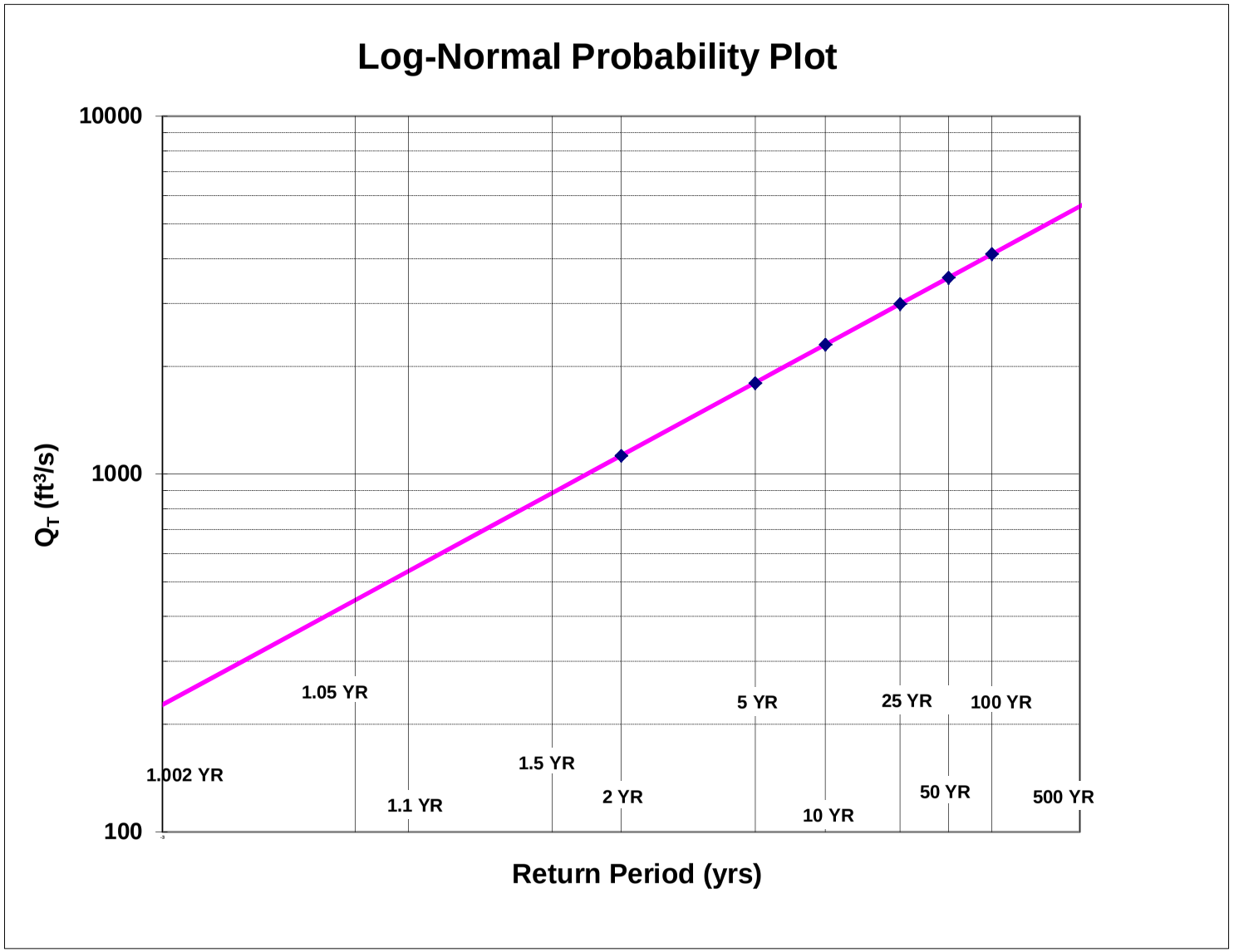
Charles.Hebson@maine.gov

Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m³/s)	Upper	Q_T (ft³/s)
1.1		15.16		535.4
2	22.75	31.91	44.76	1126.9
5	36.08	50.86	71.71	1796.0
10	45.86	65.24	92.81	2303.6
25	58.70	84.72	122.28	2991.6
50	68.64	100.26	146.44	3540.1
100	78.97	116.78	172.70	4123.6
500	103.89	158.70	242.45	5603.8

Reference:

Hodgkins, G., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
Water-Resources Investigations Report 99-4008
US Geological Survey, Augusta, Maine

$Q_T = b \times A^a \times 10^{-WW}$


Log-Normal Probability Plot
10000
1000
100
Q_T (ft³/s)
1.002 YR
1.05 YR
1.1 YR
1.5 YR
2 YR
5 YR
10 YR
25 YR
50 YR
100 YR
500 YR
Return Period (yrs)

Project Name:	Madrid - Weymouth Br	**PIN:**	22615
Stream Name:	Sandy River	**Town:**	Madrid
Bridge Name:	Weymouth Bridge	**Bridge No.**	2934
Route No.	ME 4	**USGS Quad:**	
Analysis by:	CSH	**Date:**	3/19/2014

DO NOT ENTER ANY DATA ON THIS PAGE; EVERYTHING IS CALCULATED

MAINE MONTHLY MEDIAN FLOWS BY USGS REGRESSION EQUATIONS (2004)

Worksheet prepared by:
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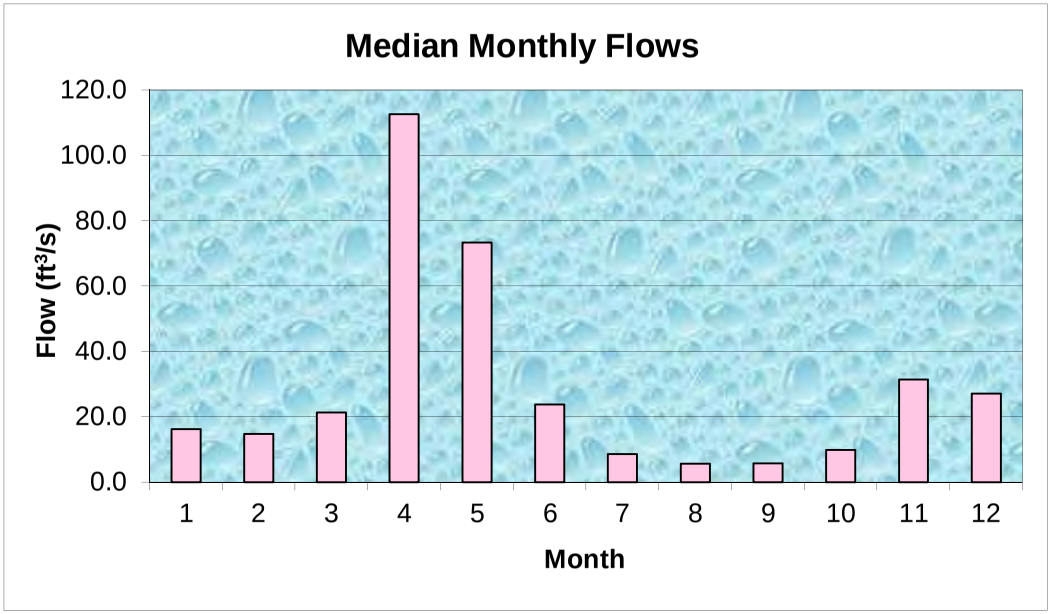
Chief Hydrologist
Maine Dept. Transportation
Augusta, ME 04333-0016
207-624-3073
Charles.Hebson@maine.gov

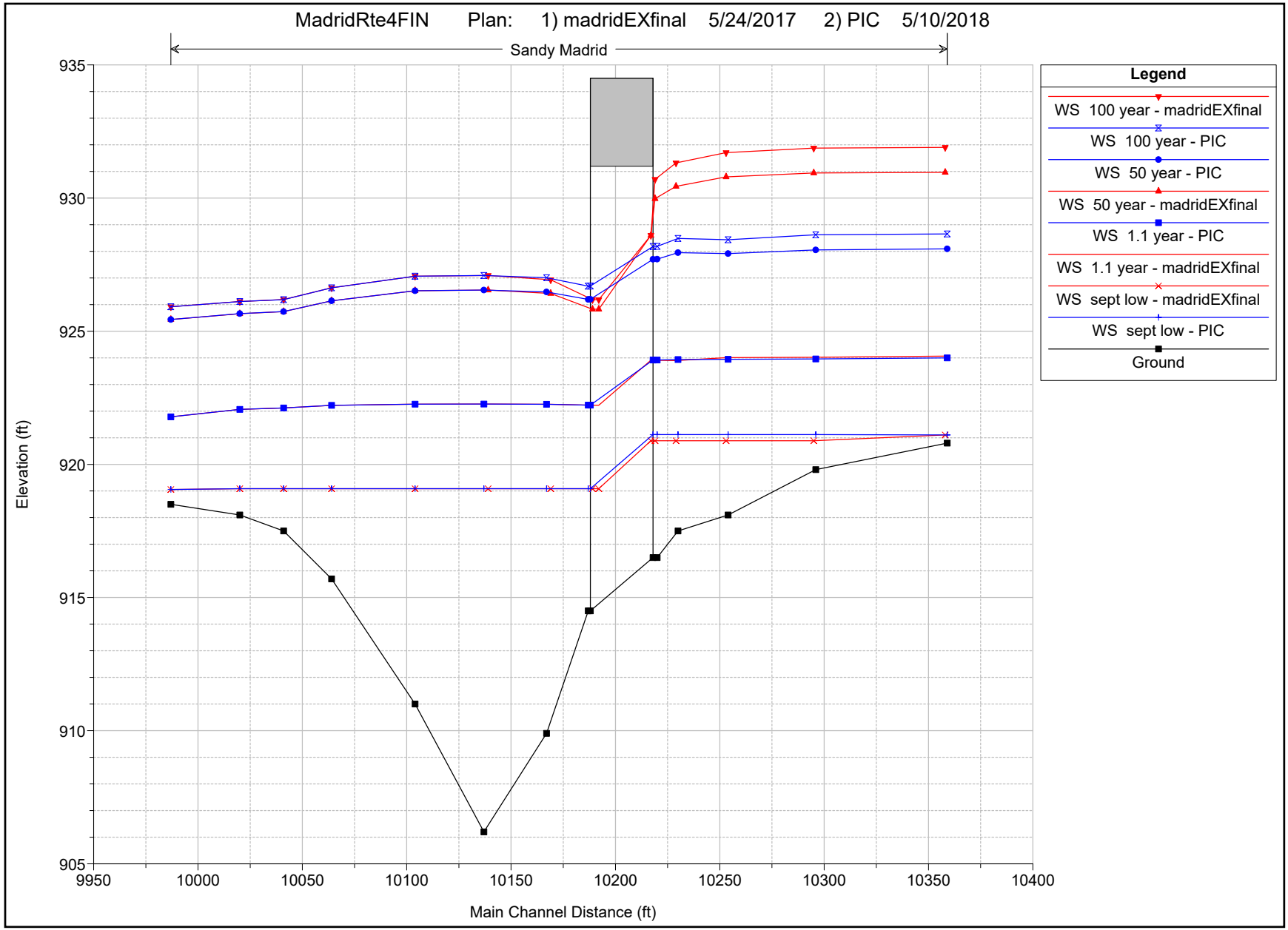
	Value	Variable	Explanation
	25.400	*A*	Area (mi^2)
378070	4968047	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	111.68	*DIST*	Distance from Coastal reference line (mi)
	45.6	*pptA*	Mean Annual Precipitation (inches)
	0.00	*SG*	Sand & Gravel Aquifer (decimal fraction of watershed area)

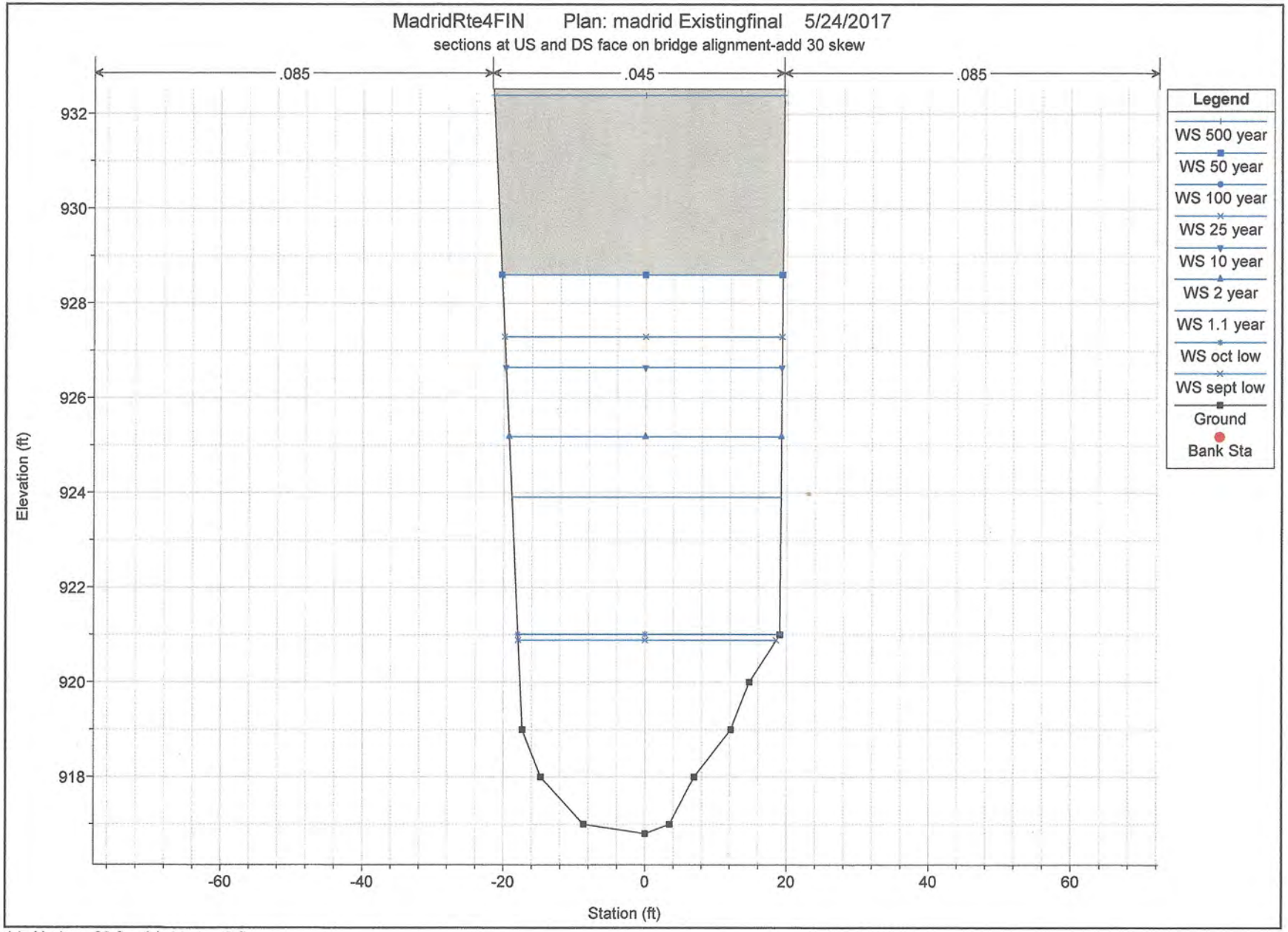
Month	Q_{median} (ft3/s)	(m^3/s)
Jan	**16.26**	0.4607
Feb	**14.75**	0.4180
Mar	**21.32**	0.6041
Apr	**112.64**	3.1922
May	**73.38**	2.0795
Jun	**23.84**	0.6756
Jul	**8.64**	0.2448
Aug	**5.69**	0.1613
Sep	**5.80**	0.1643
Oct	**9.91**	0.2807
Nov	**31.44**	0.8911
Dec	**27.13**	0.7688

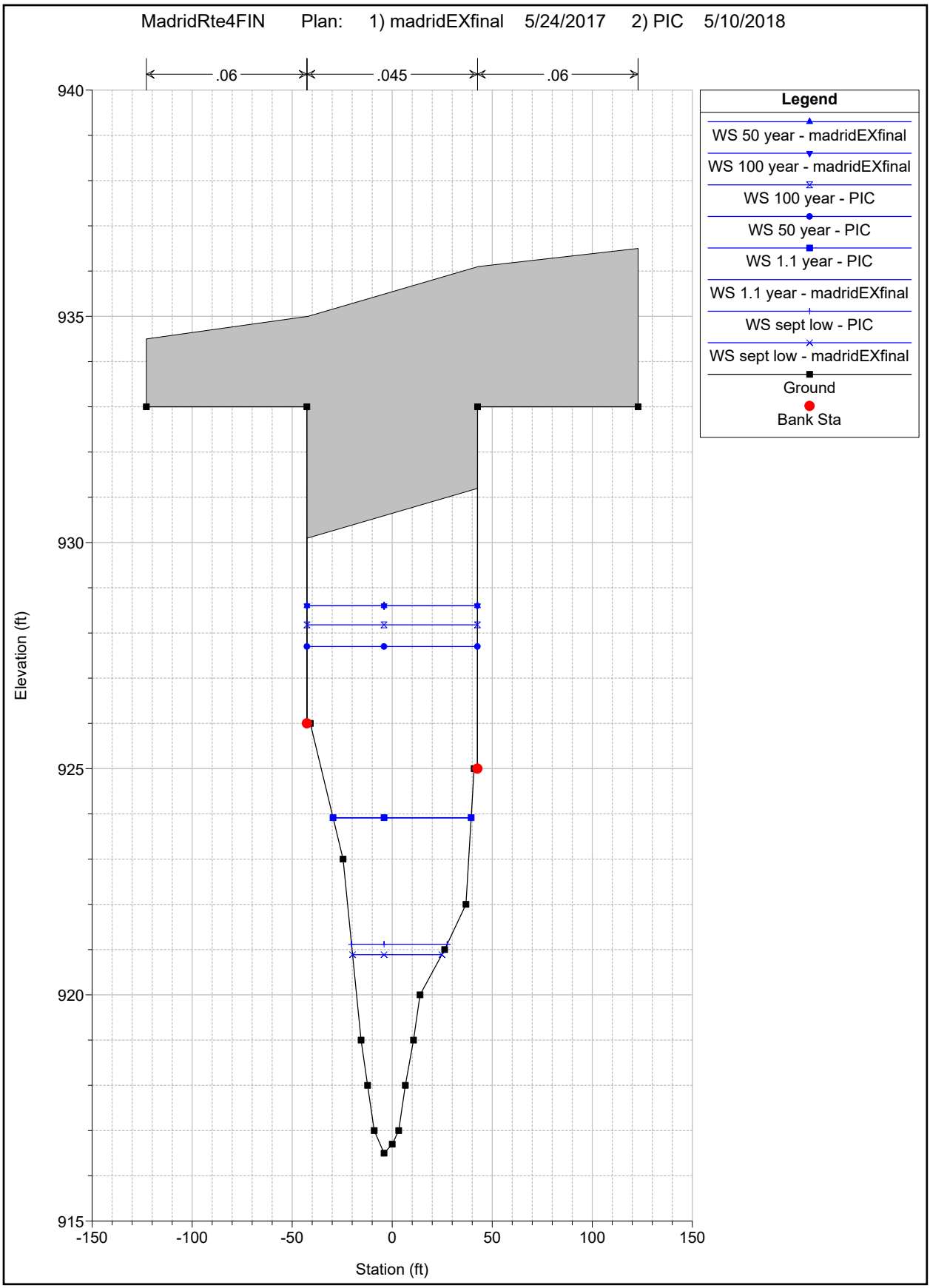


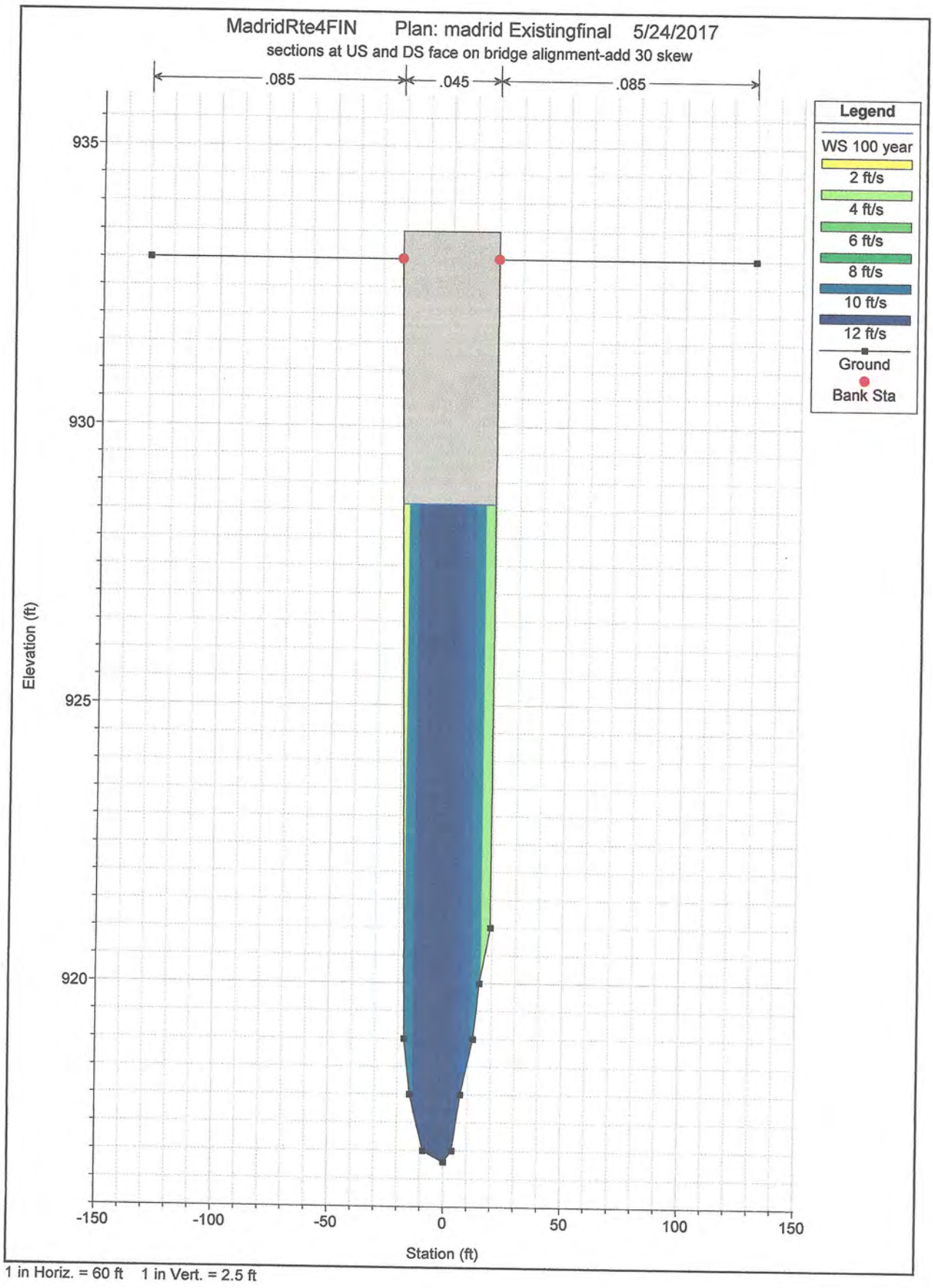
Q_{bf}	**155.0**
ann avg	**51.9**
ann med	**27.6**
$Q_{1.002}$	**226.3**
$Q_{1.01}$	307.3
$Q_{1.05}$	444.4

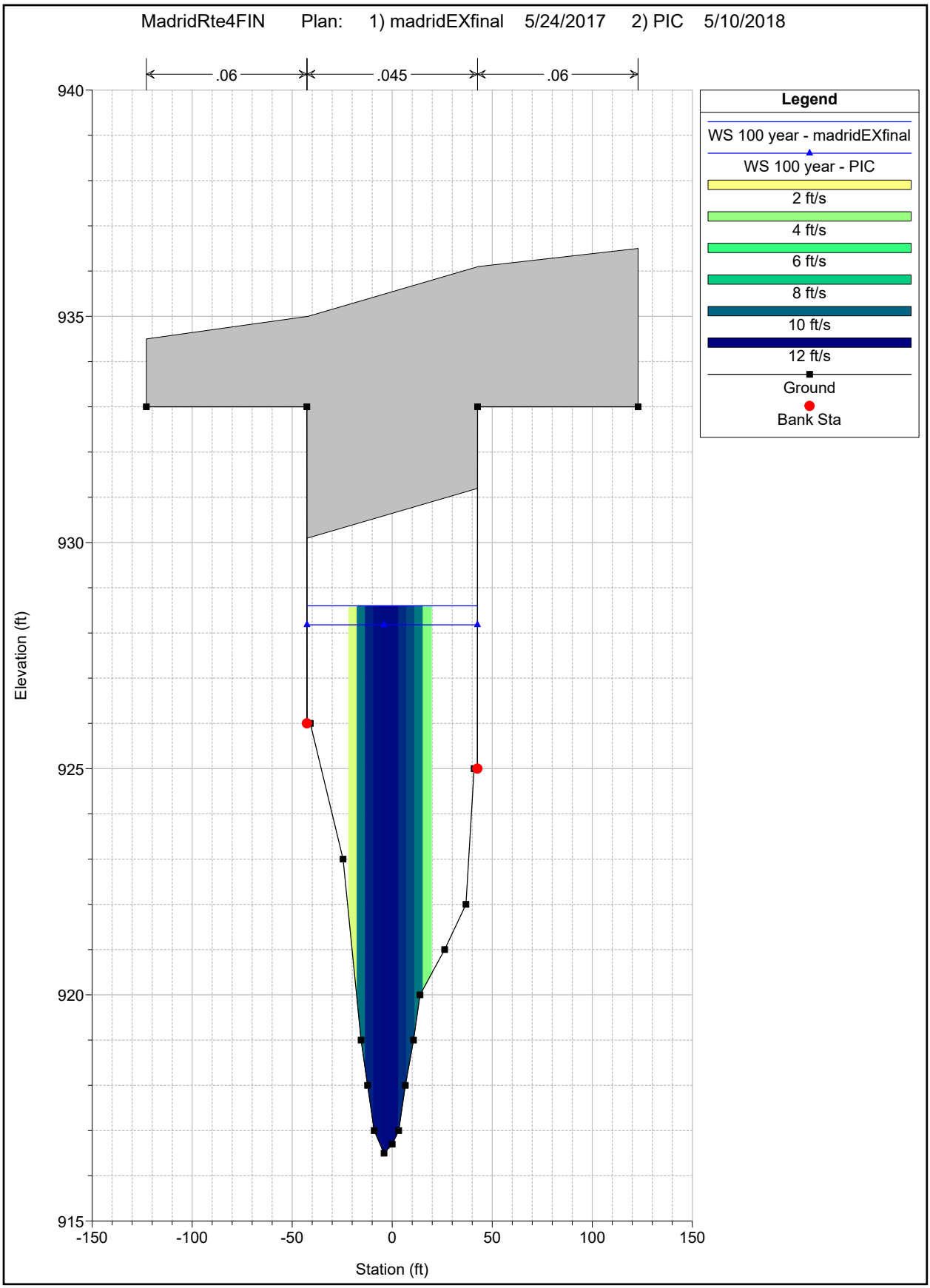
W_{bf}	41.0	
d_{bf}	3.2	
Q_{bf}	523.4	assume v = 4ft/s


MadridRte4FIN Plan: 1) madridEXfinal 5/24/2017 2) PIC 5/10/2018
Sandy Madrid
Elevation (ft)
Main Channel Distance (ft)
935
930
925
920
915
910
905
9950
10000
10050
10100
10150
10200
10250
10300
10350
10400
Legend
WS 100 year - madridEXfinal
WS 100 year - PIC
WS 50 year - PIC
WS 50 year - madridEXfinal
WS 1.1 year - PIC
WS 1.1 year - madridEXfinal
WS sept low - madridEXfinal
WS sept low - PIC
Ground


MadridRte4FIN Plan: madrid Existingfinal 5/24/2017
sections at US and DS face on bridge alignment-add 30 skew
.085
.045
.085
Legend
WS 500 year
WS 50 year
WS 100 year
WS 25 year
WS 10 year
WS 2 year
WS 1.1 year
WS oct low
WS sept low
Ground
Bank Sta
Elevation (ft)
932
930
928
926
924
922
920
918
-60
-40
-20
0
20
40
60
Station (ft)
1 in Horiz. = 20 ft 1 in Vert. = 3 ft


MadridRte4FIN Plan: 1) madridEXfinal 5/24/2017 2) PIC 5/10/2018
.06
.045
.06
940
935
930
925
920
915
Elevation (ft)
-150
-100
-50
0
50
100
150
Station (ft)
Legend
WS 50 year - madridEXfinal
WS 100 year - madridEXfinal
WS 100 year - PIC
WS 50 year - PIC
WS 1.1 year - PIC
WS 1.1 year - madridEXfinal
WS sept low - PIC
WS sept low - madridEXfinal
Ground
Bank Sta


MadridRte4FIN Plan: madrid Existingfinal 5/24/2017
sections at US and DS face on bridge alignment-add 30 skew
.085
.045
.085
Legend
WS 100 year
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
935
930
925
920
Elevation (ft)
-150
-100
-50
0
50
100
150
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 2.5 ft


MadridRte4FIN Plan: 1) madridEXfinal 5/24/2017 2) PIC 5/10/2018
.06
.045
.06
940
935
930
925
920
915
Elevation (ft)
-150
-100
-50
0
50
100
150
Station (ft)
Legend
WS 100 year - madridEXfinal
WS 100 year - PIC
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

proposed

HEC-RAS Plan: PIC River: Sandy Reach: Madrid

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Madrid	10362	1.1 year	535.00	920.80	924.00	922.48	924.13	0.002141	2.95	201.49	97.61	0.32
Madrid	10362	2 year	1127.00	920.80	925.25	923.32	925.49	0.002435	4.05	326.55	104.02	0.36
Madrid	10362	10 year	2304.00	920.80	926.80	924.67	927.25	0.003105	5.69	504.03	124.18	0.43
Madrid	10362	25 year	2992.00	920.80	927.53	925.21	928.09	0.003330	6.41	597.66	134.05	0.45
Madrid	10362	50 year	3540.00	920.80	928.09	925.66	928.73	0.003403	6.86	676.51	146.15	0.46
Madrid	10362	100 year	4124.00	920.80	928.65	926.08	929.35	0.003432	7.26	760.08	152.38	0.47
Madrid	10362	500 year	5604.00	920.80	929.93	927.08	930.78	0.003461	8.11	963.62	166.58	0.49
Madrid	10362	sept low	5.80	920.80	921.10	921.10	921.14	0.066456	1.56	3.71	47.19	0.98
Madrid	10362	oct low	9.90	920.80	921.24	921.13	921.25	0.006894	0.96	10.35	50.17	0.37
Madrid	10299	1.1 year	535.00	919.80	923.96		924.03	0.000914	2.09	259.26	89.65	0.21
Madrid	10299	2 year	1127.00	919.80	925.21		925.35	0.001283	3.11	375.44	96.68	0.26
Madrid	10299	10 year	2304.00	919.80	926.75		927.06	0.001866	4.60	564.25	145.42	0.33
Madrid	10299	25 year	2992.00	919.80	927.48		927.88	0.002041	5.20	675.71	157.49	0.36
Madrid	10299	50 year	3540.00	919.80	928.05		928.51	0.002098	5.57	768.30	166.31	0.37
Madrid	10299	100 year	4124.00	919.80	928.62		929.12	0.002127	5.91	864.24	169.74	0.37
Madrid	10299	500 year	5604.00	919.80	929.93		930.53	0.002168	6.62	1090.51	177.56	0.39
Madrid	10299	sept low	5.80	919.80	921.12	920.10	921.12	0.000011	0.11	52.90	53.91	0.02
Madrid	10299	oct low	9.90	919.80	921.24		921.24	0.000023	0.17	59.70	54.76	0.03
Madrid	10257	1.1 year	535.00	918.10	923.94		923.99	0.000473	1.81	297.94	76.91	0.16
Madrid	10257	2 year	1127.00	918.10	925.18		925.30	0.000857	2.90	404.43	92.92	0.22
Madrid	10257	10 year	2304.00	918.10	926.68		926.99	0.001501	4.53	552.70	102.68	0.31
Madrid	10257	25 year	2992.00	918.10	927.38		927.80	0.001793	5.29	625.18	104.63	0.34
Madrid	10257	50 year	3540.00	918.10	927.91		928.42	0.001970	5.80	681.33	106.12	0.36
Madrid	10257	100 year	4124.00	918.10	928.43		929.03	0.002141	6.31	737.08	107.57	0.38
Madrid	10257	500 year	5604.00	918.10	929.60		930.42	0.002518	7.45	864.34	110.78	0.42
Madrid	10257	sept low	5.80	918.10	921.12		921.12	0.000001	0.05	110.69	55.16	0.01
Madrid	10257	oct low	9.90	918.10	921.24		921.24	0.000002	0.08	117.66	56.25	0.01
Madrid	10233	1.1 year	535.00	917.50	923.94		923.98	0.000391	1.68	339.66	101.30	0.14
Madrid	10233	2 year	1127.00	917.50	925.17		925.28	0.000704	2.67	475.24	116.94	0.20
Madrid	10233	10 year	2304.00	917.50	926.69		926.94	0.001209	4.13	658.20	122.43	0.28
Madrid	10233	25 year	2992.00	917.50	927.41		927.73	0.001433	4.79	745.43	122.62	0.30
Madrid	10233	50 year	3540.00	917.50	927.95		928.34	0.001567	5.24	812.15	122.77	0.32
Madrid	10233	100 year	4124.00	917.50	928.48		928.94	0.001696	5.69	877.72	122.91	0.34
Madrid	10233	500 year	5604.00	917.50	929.68		930.30	0.001984	6.70	1024.98	123.22	0.37
Madrid	10233	sept low	5.80	917.50	921.12		921.12	0.000002	0.05	107.21	67.82	0.01
Madrid	10233	oct low	9.90	917.50	921.24		921.24	0.000003	0.09	115.75	68.70	0.01
Madrid	10221	1.1 year	535.00	916.50	923.92	919.81	923.97	0.000519	1.89	283.68	69.07	0.16
Madrid	10221	2 year	1127.00	916.50	925.12	921.33	925.26	0.001118	3.03	371.54	78.73	0.25
Madrid	10221	10 year	2304.00	916.50	926.55	922.90	926.89	0.002056	4.70	490.21	85.21	0.35
Madrid	10221	25 year	2992.00	916.50	927.21	923.62	927.67	0.002421	5.48	546.03	85.23	0.38
Madrid	10221	50 year	3540.00	916.50	927.70	924.15	928.27	0.002641	6.02	588.47	85.24	0.40
Madrid	10221	100 year	4124.00	916.50	928.19	924.67	928.85	0.002862	6.55	629.57	85.25	0.42
Madrid	10221	500 year	5604.00	916.50	929.24	925.86	930.18	0.003391	7.79	719.31	85.27	0.47
Madrid	10221	sept low	5.80	916.50	921.12	916.89	921.12	0.000001	0.05	114.97	47.80	0.01
Madrid	10221	oct low	9.90	916.50	921.24	917.00	921.24	0.000002	0.08	121.05	49.41	0.01
Madrid	10200		Bridge									
Madrid	10197	1.1 year	535.00	914.50	922.22		922.29	0.000688	2.15	249.02	59.10	0.18
Madrid	10197	2 year	1127.00	914.50	923.52		923.70	0.001381	3.43	328.20	64.66	0.27
Madrid	10197	10 year	2304.00	914.50	925.00		925.44	0.002909	5.33	432.29	77.42	0.40
Madrid	10197	25 year	2992.00	914.50	925.68		926.27	0.003541	6.15	486.16	81.59	0.44
Madrid	10197	50 year	3540.00	914.50	926.20		926.89	0.003942	6.69	529.29	85.21	0.47
Madrid	10197	100 year	4124.00	914.50	926.69		927.50	0.004140	7.21	571.62	85.22	0.49
Madrid	10197	500 year	5604.00	914.50	927.75		928.87	0.004688	8.47	661.97	85.24	0.54
Madrid	10197	sept low	5.80	914.50	919.09		919.09	0.000001	0.05	108.27	34.41	0.01
Madrid	10197	oct low	9.90	914.50	919.22		919.22	0.000002	0.09	112.89	34.73	0.01
Madrid	10166	1.1 year	535.00	909.90	922.26		922.27	0.000085	1.03	523.82	82.96	0.07
Madrid	10166	2 year	1127.00	909.90	923.60		923.65	0.000207	1.79	637.60	85.98	0.11
Madrid	10166	10 year	2304.00	909.90	925.19		925.33	0.000488	3.03	777.24	91.28	0.18
Madrid	10166	25 year	2992.00	909.90	925.92		926.13	0.000631	3.63	844.28	91.95	0.21
Madrid	10166	50 year	3540.00	909.90	926.48		926.73	0.000733	4.06	895.11	92.46	0.22
Madrid	10166	100 year	4124.00	909.90	927.01		927.32	0.000838	4.49	944.56	92.95	0.24
Madrid	10166	500 year	5604.00	909.90	928.17		928.63	0.001095	5.49	1053.43	102.62	0.28
Madrid	10166	sept low	5.80	909.90	919.09		919.09	0.000000	0.02	298.55	59.93	0.00
Madrid	10166	oct low	9.90	909.90	919.22		919.22	0.000000	0.03	306.62	60.82	0.00
Madrid	10136	1.1 year	535.00	906.20	922.26		922.27	0.000017	0.64	857.05	89.11	0.03
Madrid	10136	2 year	1127.00	906.20	923.62		923.64	0.000050	1.20	981.88	94.79	0.06
Madrid	10136	10 year	2304.00	906.20	925.23		925.31	0.000136	2.15	1140.23	101.78	0.10
Madrid	10136	25 year	2992.00	906.20	925.98		926.09	0.000192	2.64	1217.77	105.66	0.12
Madrid	10136	50 year	3540.00	906.20	926.55		926.68	0.000236	3.00	1278.11	108.58	0.14
Madrid	10136	100 year	4124.00	906.20	927.09		927.26	0.000284	3.37	1340.19	119.84	0.15

HEC-RAS Plan: PIC River: Sandy Reach: Madrid (Continued)

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Madrid	10136	500 year	5604.00	906.20	928.28		928.55	0.000408	4.25	1500.43	170.91	0.18
Madrid	10136	sept low	5.80	906.20	919.09		919.09	0.000000	0.01	589.07	79.98	0.00
Madrid	10136	oct low	9.90	906.20	919.22		919.22	0.000000	0.02	599.78	80.35	0.00
Madrid	10103	1.1 year	535.00	911.00	922.26		922.27	0.000035	0.76	729.10	109.45	0.05
Madrid	10103	2 year	1127.00	911.00	923.61		923.64	0.000093	1.36	878.54	111.56	0.08
Madrid	10103	10 year	2304.00	911.00	925.22		925.30	0.000232	2.34	1059.30	114.08	0.12
Madrid	10103	25 year	2992.00	911.00	925.96		926.08	0.000316	2.83	1145.00	116.69	0.15
Madrid	10103	50 year	3540.00	911.00	926.52		926.67	0.000386	3.19	1211.48	125.16	0.16
Madrid	10103	100 year	4124.00	911.00	927.06		927.25	0.000455	3.53	1286.57	145.93	0.18
Madrid	10103	500 year	5604.00	911.00	928.26		928.54	0.000605	4.34	1482.56	199.45	0.21
Madrid	10103	sept low	5.80	911.00	919.09		919.09	0.000000	0.01	442.19	78.59	0.00
Madrid	10103	oct low	9.90	911.00	919.22		919.22	0.000000	0.02	452.72	79.05	0.00
Madrid	10064	1.1 year	535.00	915.70	922.21		922.26	0.000374	1.78	320.35	84.58	0.14
Madrid	10064	2 year	1127.00	915.70	923.50		923.62	0.000722	2.88	456.04	116.70	0.20
Madrid	10064	10 year	2304.00	915.70	924.97		925.26	0.001341	4.52	631.56	122.55	0.29
Madrid	10064	25 year	2992.00	915.70	925.63		926.03	0.001642	5.29	714.19	125.05	0.32
Madrid	10064	50 year	3540.00	915.70	926.14		926.61	0.001834	5.82	778.00	127.08	0.35
Madrid	10064	100 year	4124.00	915.70	926.63		927.18	0.002029	6.34	841.90	150.37	0.37
Madrid	10064	500 year	5604.00	915.70	927.70		928.45	0.002447	7.49	1035.76	190.44	0.41
Madrid	10064	sept low	5.80	915.70	919.09		919.09	0.000001	0.05	120.33	51.25	0.01
Madrid	10064	oct low	9.90	915.70	919.22		919.22	0.000002	0.08	127.20	51.73	0.01
Madrid	10041	1.1 year	535.00	917.50	922.12		922.24	0.001280	2.87	211.23	90.26	0.26
Madrid	10041	2 year	1127.00	917.50	923.31		923.58	0.002070	4.37	339.94	134.03	0.34
Madrid	10041	10 year	2304.00	917.50	924.66		925.19	0.003170	6.35	524.51	138.54	0.44
Madrid	10041	25 year	2992.00	917.50	925.27		925.94	0.003686	7.27	610.05	144.46	0.49
Madrid	10041	50 year	3540.00	917.50	925.73		926.52	0.004004	7.91	679.07	154.09	0.51
Madrid	10041	100 year	4124.00	917.50	926.19		927.08	0.004297	8.52	751.06	164.86	0.54
Madrid	10041	500 year	5604.00	917.50	927.22		928.33	0.004758	9.74	958.48	239.01	0.57
Madrid	10041	sept low	5.80	917.50	919.09		919.09	0.000014	0.14	42.28	35.51	0.02
Madrid	10041	oct low	9.90	917.50	919.22		919.22	0.000030	0.21	47.10	36.91	0.03
Madrid	10020	1.1 year	535.00	918.10	922.07		922.21	0.001982	3.08	202.80	89.06	0.31
Madrid	10020	2 year	1127.00	918.10	923.23		923.53	0.002875	4.59	319.55	132.33	0.39
Madrid	10020	10 year	2304.00	918.10	924.57		925.11	0.003956	6.45	499.85	137.00	0.48
Madrid	10020	25 year	2992.00	918.10	925.19		925.86	0.004381	7.28	585.13	139.30	0.51
Madrid	10020	50 year	3540.00	918.10	925.66		926.42	0.004585	7.82	651.99	144.27	0.53
Madrid	10020	100 year	4124.00	918.10	926.11		926.98	0.004808	8.37	719.38	152.27	0.55
Madrid	10020	500 year	5604.00	918.10	927.11		928.22	0.005352	9.63	900.47	213.90	0.59
Madrid	10020	sept low	5.80	918.10	919.09		919.09	0.000135	0.29	19.95	30.09	0.06
Madrid	10020	oct low	9.90	918.10	919.22		919.22	0.000235	0.41	24.03	32.63	0.08
Madrid	9987	1.1 year	535.00	918.50	921.79	920.98	922.08	0.006009	4.42	130.00	70.83	0.51
Madrid	9987	2 year	1127.00	918.50	922.91	921.95	923.38	0.006001	5.76	264.62	148.74	0.55
Madrid	9987	10 year	2304.00	918.50	924.30	923.44	924.94	0.006007	7.22	475.16	155.59	0.58
Madrid	9987	25 year	2992.00	918.50	924.95	923.94	925.68	0.005999	7.86	577.82	160.13	0.59
Madrid	9987	50 year	3540.00	918.50	925.44	924.30	926.25	0.006003	8.32	658.34	169.64	0.60
Madrid	9987	100 year	4124.00	918.50	925.92	924.63	926.80	0.006002	8.76	742.43	179.55	0.61
Madrid	9987	500 year	5604.00	918.50	926.98	925.37	928.01	0.006003	9.70	961.18	232.11	0.62
Madrid	9987	sept low	5.80	918.50	919.05	918.82	919.07	0.006002	1.08	5.35	19.30	0.36
Madrid	9987	oct low	9.90	918.50	919.17	918.92	919.20	0.005999	1.28	7.75	21.78	0.38

Proposed

HEC-RAS Plan: PIC River: Sandy Reach: Madrid

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
Madrid	10233	1.1 year	923.98	923.94		0.00	0.00	101.30	2.33	526.12	6.55	1.68
Madrid	10233	2 year	925.28	925.17		0.01	0.01	116.94	11.64	1081.71	33.65	2.67
Madrid	10233	10 year	926.94	926.69		0.02	0.03	122.43	44.18	2133.65	126.18	4.13
Madrid	10233	25 year	927.73	927.41		0.02	0.04	122.62	71.65	2730.32	190.03	4.79
Madrid	10233	50 year	928.34	927.95		0.02	0.05	122.77	95.75	3199.22	245.03	5.24
Madrid	10233	100 year	928.94	928.48		0.02	0.06	122.91	122.44	3695.89	305.67	5.69
Madrid	10233	500 year	930.30	929.68		0.03	0.10	123.22	192.78	4945.50	465.72	6.70
Madrid	10233	sept low	921.12	921.12		0.00	0.00	67.82		5.80		0.05
Madrid	10233	oct low	921.24	921.24		0.00	0.00	68.70		9.90		0.09
Madrid	10221	1.1 year	923.97	923.92	919.81			69.07		535.00		1.89
Madrid	10221	2 year	925.26	925.12	921.33			78.73		1127.00		3.03
Madrid	10221	10 year	926.89	926.55	922.90			85.21	0.00	2304.00	0.00	4.70
Madrid	10221	25 year	927.67	927.21	923.62			85.23	0.00	2992.00	0.00	5.48
Madrid	10221	50 year	928.27	927.70	924.15			85.24	0.00	3540.00	0.00	6.02
Madrid	10221	100 year	928.85	928.19	924.67			85.25	0.00	4124.00	0.00	6.55
Madrid	10221	500 year	930.18	929.24	925.86			85.27	0.00	5603.99	0.01	7.79
Madrid	10221	sept low	921.12	921.12	916.89			47.80		5.80		0.05
Madrid	10221	oct low	921.24	921.24	917.00			49.41		9.90		0.08
Madrid	10200 BR U	1.1 year	923.97	923.92	919.83			69.06		535.00		1.89
Madrid	10200 BR U	2 year	925.26	925.12	921.34			78.73		1127.00		3.03
Madrid	10200 BR U	10 year	926.89	926.54	922.92			85.21	0.00	2304.00	0.00	4.71
Madrid	10200 BR U	25 year	927.67	927.20	923.65			85.23	0.00	2992.00	0.00	5.48
Madrid	10200 BR U	50 year	928.26	927.70	924.19			85.24	0.00	3540.00	0.00	6.02
Madrid	10200 BR U	100 year	928.85	928.18	924.71			85.25	0.00	4123.99	0.01	6.56
Madrid	10200 BR U	500 year	930.17	929.23	925.87			85.27	0.01	5603.98	0.01	7.80
Madrid	10200 BR U	sept low	921.12	921.12	916.90			47.80		5.80		0.05
Madrid	10200 BR U	oct low	921.24	921.24	917.00			49.41		9.90		0.08
Madrid	10200 BR D	1.1 year	922.30	922.22	917.73			59.10		535.00		2.15
Madrid	10200 BR D	2 year	923.70	923.52	919.16			64.67		1127.00		3.43
Madrid	10200 BR D	10 year	925.45	925.01	921.46			77.44		2304.00		5.33
Madrid	10200 BR D	25 year	926.27	925.68	922.31			81.62		2992.00	0.00	6.15
Madrid	10200 BR D	50 year	926.89	926.20	922.86			85.21		3540.00	0.00	6.68
Madrid	10200 BR D	100 year	927.51	926.70	923.44			85.22	0.00	4124.00	0.00	7.21
Madrid	10200 BR D	500 year	928.87	927.76	924.81			85.24	0.00	5603.99	0.01	8.46
Madrid	10200 BR D	sept low	919.09	919.09	914.91			34.41		5.80		0.05
Madrid	10200 BR D	oct low	919.22	919.22	915.01			34.73		9.90		0.09
Madrid	10197	1.1 year	922.29	922.22		0.00	0.02	59.10		535.00		2.15
Madrid	10197	2 year	923.70	923.52		0.01	0.04	64.66		1127.00		3.43
Madrid	10197	10 year	925.44	925.00		0.02	0.09	77.42		2304.00		5.33
Madrid	10197	25 year	926.27	925.68		0.03	0.12	81.59		2992.00	0.00	6.15
Madrid	10197	50 year	926.89	926.20		0.03	0.13	85.21		3540.00	0.00	6.69
Madrid	10197	100 year	927.50	926.69		0.03	0.15	85.22	0.00	4124.00	0.00	7.21
Madrid	10197	500 year	928.87	927.75		0.04	0.19	85.24	0.00	5604.00	0.00	8.47
Madrid	10197	sept low	919.09	919.09		0.00	0.00	34.41		5.80		0.05
Madrid	10197	oct low	919.22	919.22		0.00	0.00	34.73		9.90		0.09
Madrid	10166	1.1 year	922.27	922.26		0.00	0.00	82.96	1.21	533.79		1.03
Madrid	10166	2 year	923.65	923.60		0.00	0.01	85.98	4.27	1122.73		1.79
Madrid	10166	10 year	925.33	925.19		0.01	0.02	91.28	13.49	2290.51		3.03
Madrid	10166	25 year	926.13	925.92		0.01	0.03	91.95	20.23	2971.77	0.00	3.63
Madrid	10166	50 year	926.73	926.48		0.01	0.04	92.46	26.38	3513.62	0.00	4.06
Madrid	10166	100 year	927.32	927.01		0.01	0.04	92.95	33.52	4090.48	0.00	4.49
Madrid	10166	500 year	928.63	928.17		0.02	0.06	102.62	53.92	5550.08	0.00	5.49
Madrid	10166	sept low	919.09	919.09		0.00	0.00	59.93	0.00	5.80		0.02
Madrid	10166	oct low	919.22	919.22		0.00	0.00	60.82	0.00	9.90		0.03

Proposed

Plan: PIC Sandy Madrid RS: 10200 Profile: 100 year

E.G. US. (ft)	928.85	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	928.19	E.G. Elev (ft)	928.85	927.51
Q Total (cfs)	4124.00	W.S. Elev (ft)	928.18	926.70
Q Bridge (cfs)	4124.00	Crit W.S. (ft)	924.71	923.44
Q Weir (cfs)		Max Chl Dpth (ft)	11.68	12.20
Weir Sta Lft (ft)		Vel Total (ft/s)	6.56	7.21
Weir Sta Rgt (ft)		Flow Area (sq ft)	629.09	572.01
Weir Submerg		Froude # Chl	0.43	0.49
Weir Max Depth (ft)		Specif Force (cu ft)	3505.00	3443.20
Min El Weir Flow (ft)	934.51	Hydr Depth (ft)	7.38	6.71
Min El Prs (ft)	931.20	W.P. Total (ft)	93.50	93.74
Delta EG (ft)	1.35	Conv. Total (cfs)	76989.2	64166.9
Delta WS (ft)	1.49	Top Width (ft)	85.25	85.22
BR Open Area (sq ft)	839.13	Frctn Loss (ft)		
BR Open Vel (ft/s)	7.21	C & E Loss (ft)		
BR Sluice Coef		Shear Total (lb/sq ft)	1.21	1.57
BR Sel Method	Momentum	Power Total (lb/ft s)	7.90	11.35

Proposed

Plan: PIC Sandy Madrid RS: 10200 BR U Profile: 100 year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	LOB	-122.87	-42.60	0.00	0.03	2.18	0.00	1.09	0.07	0.00	0.00
2	Chan	-42.60	-34.08	71.77	22.91	8.63	1.74	2.69	3.13	0.48	1.49
3	Chan	-34.08	-25.56	151.78	35.96	8.66	3.68	4.22	4.22	0.74	3.14
4	Chan	-25.56	-17.04	310.02	56.65	9.24	7.52	6.65	5.47	1.10	6.01
5	Chan	-17.04	-8.52	625.88	85.28	8.96	15.18	10.01	7.34	1.71	12.51
6	Chan	-8.52	0.00	815.76	98.10	8.55	19.78	11.52	8.32	2.06	17.10
7	Chan	0.00	8.52	717.73	91.67	8.74	17.40	10.76	7.83	1.88	14.71
8	Chan	8.52	17.04	498.00	73.62	8.74	12.08	8.64	6.76	1.51	10.21
9	Chan	17.04	25.56	406.36	64.58	8.55	9.85	7.58	6.29	1.35	8.52
10	Chan	25.56	34.08	342.29	58.29	8.56	8.30	6.84	5.87	1.22	7.17
11	Chan	34.08	42.60	184.41	41.96	9.51	4.47	4.93	4.40	0.79	3.47
12	ROB	42.60	122.87	0.01	0.05	3.18	0.00	1.59	0.11	0.00	0.00

Plan: PIC Sandy Madrid RS: 10200 BR U Profile: 500 year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	LOB	-122.87	-42.60	0.01	0.06	3.23	0.00	1.61	0.10	0.00	0.00
2	Chan	-42.60	-34.08	137.68	31.84	8.63	2.46	3.74	4.32	0.78	3.39
3	Chan	-34.08	-25.56	243.51	44.88	8.66	4.35	5.27	5.43	1.10	5.98
4	Chan	-25.56	-17.04	438.63	65.58	9.24	7.83	7.70	6.69	1.51	10.08
5	Chan	-17.04	-8.52	819.14	94.20	8.96	14.62	11.06	8.70	2.23	19.43
6	Chan	-8.52	0.00	1045.69	107.03	8.55	18.66	12.56	9.77	2.66	26.00
7	Chan	0.00	8.52	929.02	100.59	8.74	16.58	11.81	9.24	2.45	22.59
8	Chan	8.52	17.04	668.14	82.55	8.74	11.92	9.69	8.09	2.01	16.25
9	Chan	17.04	25.56	559.01	73.51	8.55	9.98	8.63	7.60	1.83	13.90
10	Chan	25.56	34.08	481.21	67.21	8.56	8.59	7.89	7.16	1.67	11.95
11	Chan	34.08	42.60	281.97	50.88	9.51	5.03	5.97	5.54	1.14	6.30
12	ROB	42.60	122.87	0.01	0.09	4.23	0.00	2.11	0.15	0.00	0.00

Plan: PIC Sandy Madrid RS: 10200 BR D Profile: 100 year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	LOB	-122.87	-42.60	0.00	0.00	0.70	0.00	0.35	0.04	0.00	0.00
2	Chan	-42.60	-34.08	19.21	9.79	8.61	0.47	1.15	1.96	0.29	0.58
3	Chan	-34.08	-25.56	70.52	21.39	8.63	1.71	2.51	3.30	0.64	2.11
4	Chan	-25.56	-17.04	234.89	50.37	12.08	5.70	5.91	4.66	1.07	5.01
5	Chan	-17.04	-8.52	918.58	101.26	8.95	22.27	11.89	9.07	2.92	26.46
6	Chan	-8.52	0.00	917.03	99.73	8.64	22.24	11.71	9.20	2.98	27.37
7	Chan	0.00	8.52	774.09	90.04	8.63	18.77	10.57	8.60	2.69	23.13
8	Chan	8.52	17.04	503.35	71.23	9.16	12.21	8.36	7.07	2.00	14.17
9	Chan	17.04	25.56	321.44	52.97	8.56	7.79	6.22	6.07	1.60	9.68
10	Chan	25.56	34.08	252.99	45.88	8.56	6.13	5.39	5.51	1.38	7.62
11	Chan	34.08	42.60	111.90	29.34	9.51	2.71	3.44	3.81	0.80	3.03
12	ROB	42.60	122.87	0.00	0.01	1.70	0.00	0.85	0.09	0.00	0.00

Plan: PIC Sandy Madrid RS: 10200 BR D Profile: 500 year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	LOB	-122.87	-42.60	0.00	0.02	1.76	0.00	0.88	0.08	0.00	0.00
2	Chan	-42.60	-34.08	63.16	18.83	8.61	1.13	2.21	3.35	0.64	2.14
3	Chan	-34.08	-25.56	140.29	30.43	8.63	2.50	3.57	4.61	1.03	4.75
4	Chan	-25.56	-17.04	341.91	59.40	12.08	6.10	6.97	5.76	1.44	8.26
5	Chan	-17.04	-8.52	1171.11	110.30	8.95	20.90	12.95	10.62	3.60	38.19
6	Chan	-8.52	0.00	1171.58	108.77	8.64	20.91	12.77	10.77	3.68	39.59
7	Chan	0.00	8.52	1003.75	99.08	8.63	17.91	11.63	10.13	3.35	33.97
8	Chan	8.52	17.04	679.09	80.27	9.16	12.12	9.42	8.46	2.56	21.64
9	Chan	17.04	25.56	462.09	62.00	8.56	8.25	7.28	7.45	2.12	15.76
10	Chan	25.56	34.08	377.45	54.92	8.56	6.74	6.45	6.87	1.87	12.88

Plan: PIC Sandy Madrid RS: 10200 BR D Profile: 500 year (Continued)

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
11	Chan	34.08	42.60	193.56	38.37	9.51	3.45	4.50	5.04	1.18	5.94
12	ROB	42.60	122.87	0.01	0.04	2.76	0.00	1.38	0.13	0.00	0.00

Existing

HEC-RAS Plan: madridEXfinal River: Sandy Reach: Madrid

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Madrid	10362	1.1 year	535.00	920.80	924.06	922.48	924.19	0.001980	2.88	206.64	97.34	0.30
Madrid	10362	2 year	1127.00	920.80	925.53	923.32	925.73	0.001928	3.77	354.11	107.83	0.32
Madrid	10362	10 year	2304.00	920.80	927.43	924.67	927.78	0.002097	5.03	583.30	131.76	0.36
Madrid	10362	25 year	2992.00	920.80	928.47	925.22	928.86	0.001993	5.44	730.72	150.33	0.36
Madrid	10362	50 year	3540.00	920.80	930.96	925.67	931.21	0.000895	4.45	1138.03	173.21	0.25
Madrid	10362	100 year	4124.00	920.80	931.90	926.09	932.16	0.000851	4.61	1303.09	179.04	0.25
Madrid	10362	500 year	5604.00	920.80	934.13	927.09	934.43	0.000781	5.02	1752.58	221.51	0.25
Madrid	10362	sept low	5.80	920.80	921.10	921.10	921.14	0.066456	1.56	3.71	47.19	0.98
Madrid	10362	oct low	9.90	920.80	921.13	921.13	921.19	0.078263	2.02	4.89	47.73	1.11
Madrid	10299	1.1 year	535.00	919.80	924.02		924.10	0.000828	2.25	264.97	90.09	0.21
Madrid	10299	2 year	1127.00	919.80	925.47		925.63	0.001133	3.28	401.93	102.08	0.26
Madrid	10299	10 year	2304.00	919.80	927.36		927.66	0.001468	4.61	657.47	153.19	0.31
Madrid	10299	25 year	2992.00	919.80	928.41		928.74	0.001439	5.00	824.19	164.22	0.31
Madrid	10299	50 year	3540.00	919.80	930.94		931.15	0.000686	4.14	1256.35	177.65	0.22
Madrid	10299	100 year	4124.00	919.80	931.87		932.11	0.000678	4.36	1426.12	187.57	0.23
Madrid	10299	500 year	5604.00	919.80	934.12		934.38	0.000623	4.71	1886.50	213.04	0.22
Madrid	10299	sept low	5.80	919.80	920.89	920.10	920.89	0.000026	0.14	40.68	52.36	0.03
Madrid	10299	oct low	9.90	919.80	921.01	920.16	921.01	0.000047	0.21	47.26	53.20	0.04
Madrid	10257	1.1 year	535.00	918.10	924.01		924.06	0.000516	1.94	275.47	64.09	0.17
Madrid	10257	2 year	1127.00	918.10	925.44		925.58	0.000908	3.04	379.91	77.81	0.23
Madrid	10257	10 year	2304.00	918.10	927.27		927.59	0.001426	4.60	532.35	88.58	0.30
Madrid	10257	25 year	2992.00	918.10	928.26		928.67	0.001553	5.22	622.69	94.57	0.32
Madrid	10257	50 year	3540.00	918.10	930.79		931.11	0.000852	4.62	882.33	110.76	0.25
Madrid	10257	100 year	4124.00	918.10	931.71		932.06	0.000867	4.92	987.09	118.78	0.25
Madrid	10257	500 year	5604.00	918.10	933.90		934.33	0.000862	5.49	1299.25	163.48	0.26
Madrid	10257	sept low	5.80	918.10	920.89		920.89	0.000001	0.06	97.31	50.51	0.01
Madrid	10257	oct low	9.90	918.10	921.01		921.01	0.000003	0.10	103.65	51.11	0.01
Madrid	10233	1.1 year	535.00	918.70	923.90		924.04	0.001579	3.01	182.12	52.09	0.27
Madrid	10233	2 year	1127.00	918.70	925.19		925.52	0.002699	4.70	253.25	59.27	0.37
Madrid	10233	10 year	2304.00	918.70	926.70		927.49	0.004742	7.26	353.78	73.09	0.50
Madrid	10233	25 year	2992.00	918.70	927.56		928.55	0.005228	8.19	419.01	77.26	0.53
Madrid	10233	50 year	3540.00	918.70	930.44		931.05	0.002343	6.59	653.66	86.87	0.36
Madrid	10233	100 year	4124.00	918.70	931.32		932.00	0.002407	6.98	732.90	93.10	0.37
Madrid	10233	500 year	5604.00	918.70	933.45		934.26	0.002419	7.72	984.02	183.17	0.37
Madrid	10233	sept low	5.80	918.70	920.89		920.89	0.000014	0.14	40.95	32.57	0.02
Madrid	10233	oct low	9.90	918.70	921.01		921.01	0.000045	0.22	45.17	44.19	0.04
Madrid	10222	1.1 year	535.00	916.80	923.91	919.71	924.00	0.000675	2.45	218.37	38.02	0.18
Madrid	10222	2 year	1127.00	916.80	925.20	921.11	925.47	0.001640	4.21	267.57	38.47	0.28
Madrid	10222	10 year	2304.00	916.80	926.66	923.00	927.44	0.003924	7.11	324.08	38.99	0.43
Madrid	10222	25 year	2992.00	916.80	927.31	923.91	928.45	0.005323	8.56	349.55	39.22	0.51
Madrid	10222	50 year	3540.00	916.80	929.98	924.61	930.92	0.003519	7.77	455.60	40.16	0.41
Madrid	10222	100 year	4124.00	916.80	930.70	925.31	931.83	0.004018	8.51	484.71	40.41	0.43
Madrid	10222	500 year	5604.00	916.80	932.39	926.96	933.98	0.005148	10.13	553.31	41.01	0.49
Madrid	10222	sept low	5.80	916.80	920.89	917.09	920.89	0.000001	0.06	105.08	36.47	0.01
Madrid	10222	oct low	9.90	916.80	921.01	917.17	921.01	0.000002	0.09	109.65	37.00	0.01
Madrid	10200		Bridge									
Madrid	10197	1.1 year	535.00	915.00	922.22		922.32	0.000766	2.52	211.97	37.65	0.19
Madrid	10197	2 year	1127.00	915.00	923.49		923.78	0.001846	4.33	260.08	38.01	0.29
Madrid	10197	10 year	2304.00	915.00	924.86		925.70	0.004517	7.38	312.20	38.40	0.46
Madrid	10197	25 year	2992.00	915.00	925.42		926.67	0.006264	8.96	334.01	38.56	0.54
Madrid	10197	50 year	3540.00	915.00	925.83		927.42	0.007689	10.13	349.57	38.67	0.59
Madrid	10197	100 year	4124.00	915.00	926.19		928.19	0.009323	11.34	363.56	38.78	0.65
Madrid	10197	500 year	5604.00	915.00	926.79	925.45	930.05	0.014379	14.47	387.20	38.95	0.81
Madrid	10197	sept low	5.80	915.00	919.09		919.09	0.000001	0.06	98.18	32.89	0.01
Madrid	10197	oct low	9.90	915.00	919.22		919.22	0.000002	0.10	102.59	33.29	0.01
Madrid	10166	1.1 year	535.00	909.90	922.26		922.28	0.000072	1.08	498.98	64.97	0.07
Madrid	10166	2 year	1127.00	909.90	923.60		923.66	0.000190	1.96	587.11	66.36	0.11
Madrid	10166	10 year	2304.00	909.90	925.17		925.35	0.000472	3.42	692.40	67.98	0.18
Madrid	10166	25 year	2992.00	909.90	925.88		926.15	0.000643	4.16	741.26	68.72	0.21
Madrid	10166	50 year	3540.00	909.90	926.42		926.76	0.000774	4.70	778.12	69.27	0.24
Madrid	10166	100 year	4124.00	909.90	926.93		927.36	0.000914	5.25	813.97	69.81	0.26
Madrid	10166	500 year	5604.00	909.90	928.03		928.69	0.001275	6.56	891.33	72.50	0.31
Madrid	10166	sept low	5.80	909.90	919.09		919.09	0.000000	0.02	298.58	59.93	0.00
Madrid	10166	oct low	9.90	909.90	919.22		919.22	0.000000	0.03	306.62	60.82	0.00
Madrid	10136	1.1 year	535.00	906.20	922.26		922.27	0.000017	0.64	852.80	86.70	0.03
Madrid	10136	2 year	1127.00	906.20	923.62		923.64	0.000050	1.20	973.61	92.07	0.05
Madrid	10136	10 year	2304.00	906.20	925.24		925.31	0.000137	2.16	1127.30	98.43	0.10
Madrid	10136	25 year	2992.00	906.20	925.98		926.09	0.000193	2.65	1202.02	101.36	0.12

HEC-RAS Plan: madridEXfinal River: Sandy Reach: Madrid (Continued)

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Madrid	10136	50 year	3540.00	906.20	926.55		926.68	0.000237	3.01	1259.70	103.84	0.14
Madrid	10136	100 year	4124.00	906.20	927.09		927.27	0.000286	3.39	1319.16	114.73	0.15
Madrid	10136	500 year	5604.00	906.20	928.28		928.56	0.000413	4.27	1472.62	165.95	0.18
Madrid	10136	sept low	5.80	906.20	919.09		919.09	0.000000	0.01	588.86	79.51	0.00
Madrid	10136	oct low	9.90	906.20	919.22		919.22	0.000000	0.02	599.47	79.81	0.00
Madrid	10103	1.1 year	535.00	911.00	922.26		922.27	0.000035	0.76	729.13	109.45	0.05
Madrid	10103	2 year	1127.00	911.00	923.61		923.64	0.000093	1.35	878.60	111.56	0.08
Madrid	10103	10 year	2304.00	911.00	925.22		925.30	0.000232	2.34	1059.47	114.09	0.12
Madrid	10103	25 year	2992.00	911.00	925.96		926.08	0.000316	2.83	1145.26	116.70	0.15
Madrid	10103	50 year	3540.00	911.00	926.52		926.67	0.000386	3.19	1211.67	125.24	0.16
Madrid	10103	100 year	4124.00	911.00	927.07		927.25	0.000454	3.53	1286.95	145.99	0.18
Madrid	10103	500 year	5604.00	911.00	928.26		928.54	0.000605	4.34	1483.08	199.52	0.21
Madrid	10103	sept low	5.80	911.00	919.09		919.09	0.000000	0.01	442.22	78.59	0.00
Madrid	10103	oct low	9.90	911.00	919.22		919.22	0.000000	0.02	452.72	79.05	0.00
Madrid	10064	1.1 year	535.00	915.70	922.21		922.26	0.000374	1.78	320.37	84.59	0.14
Madrid	10064	2 year	1127.00	915.70	923.50		923.62	0.000722	2.88	456.11	116.70	0.20
Madrid	10064	10 year	2304.00	915.70	924.97		925.26	0.001340	4.52	631.74	122.55	0.29
Madrid	10064	25 year	2992.00	915.70	925.64		926.03	0.001640	5.29	714.48	125.06	0.32
Madrid	10064	50 year	3540.00	915.70	926.14		926.61	0.001833	5.82	778.18	127.09	0.35
Madrid	10064	100 year	4124.00	915.70	926.63		927.18	0.002026	6.34	842.30	150.81	0.37
Madrid	10064	500 year	5604.00	915.70	927.70		928.45	0.002445	7.49	1036.25	190.46	0.41
Madrid	10064	sept low	5.80	915.70	919.09		919.09	0.000001	0.05	120.35	51.26	0.01
Madrid	10064	oct low	9.90	915.70	919.22		919.22	0.000002	0.08	127.20	51.73	0.01
Madrid	10041	1.1 year	535.00	917.50	922.12		922.24	0.001280	2.87	211.25	90.27	0.26
Madrid	10041	2 year	1127.00	917.50	923.31		923.58	0.002069	4.37	340.03	134.03	0.34
Madrid	10041	10 year	2304.00	917.50	924.66		925.19	0.003166	6.34	524.78	138.55	0.44
Madrid	10041	25 year	2992.00	917.50	925.27		925.95	0.003680	7.27	610.46	144.51	0.49
Madrid	10041	50 year	3540.00	917.50	925.74		926.52	0.004000	7.91	679.36	154.14	0.51
Madrid	10041	100 year	4124.00	917.50	926.19		927.08	0.004289	8.52	751.65	164.94	0.53
Madrid	10041	500 year	5604.00	917.50	927.22		928.33	0.004747	9.73	959.53	239.05	0.57
Madrid	10041	sept low	5.80	917.50	919.09		919.09	0.000014	0.14	42.29	35.52	0.02
Madrid	10041	oct low	9.90	917.50	919.22		919.22	0.000030	0.21	47.10	36.91	0.03
Madrid	10020	1.1 year	535.00	918.10	922.07		922.21	0.001982	3.08	202.80	89.06	0.31
Madrid	10020	2 year	1127.00	918.10	923.23		923.53	0.002875	4.59	319.56	132.33	0.39
Madrid	10020	10 year	2304.00	918.10	924.57		925.11	0.003955	6.45	499.85	137.00	0.48
Madrid	10020	25 year	2992.00	918.10	925.19		925.86	0.004380	7.28	585.15	139.30	0.51
Madrid	10020	50 year	3540.00	918.10	925.66		926.42	0.004589	7.82	651.76	144.25	0.53
Madrid	10020	100 year	4124.00	918.10	926.11		926.98	0.004809	8.37	719.33	152.27	0.55
Madrid	10020	500 year	5604.00	918.10	927.12		928.22	0.005330	9.62	904.20	214.12	0.59
Madrid	10020	sept low	5.80	918.10	919.09		919.09	0.000135	0.29	19.97	30.10	0.06
Madrid	10020	oct low	9.90	918.10	919.22		919.22	0.000235	0.41	24.03	32.63	0.08
Madrid	9987	1.1 year	535.00	918.50	921.79	920.98	922.08	0.006009	4.42	130.00	70.83	0.51
Madrid	9987	2 year	1127.00	918.50	922.91	921.95	923.38	0.006001	5.76	264.62	148.74	0.55
Madrid	9987	10 year	2304.00	918.50	924.30	923.44	924.94	0.006007	7.22	475.16	155.59	0.58
Madrid	9987	25 year	2992.00	918.50	924.95	923.94	925.68	0.005999	7.86	577.82	160.13	0.59
Madrid	9987	50 year	3540.00	918.50	925.44	924.30	926.25	0.006003	8.32	658.34	169.64	0.60
Madrid	9987	100 year	4124.00	918.50	925.92	924.63	926.80	0.006002	8.76	742.43	179.55	0.61
Madrid	9987	500 year	5604.00	918.50	926.98	925.37	928.01	0.006003	9.70	961.18	232.11	0.62
Madrid	9987	sept low	5.80	918.50	919.05	918.82	919.07	0.006002	1.08	5.35	19.30	0.36
Madrid	9987	oct low	9.90	918.50	919.17	918.92	919.20	0.005999	1.28	7.75	21.78	0.38

Existing

HEC-RAS Plan: madridEXfinal River: Sandy Reach: Madrid

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
Madrid	10233	1.1 year	924.04	923.90		0.01	0.02	52.09		531.27	3.73	3.01
Madrid	10233	2 year	925.52	925.19		0.02	0.03	59.27		1108.22	18.78	4.70
Madrid	10233	10 year	927.49	926.70		0.04	0.00	73.09		2219.11	84.89	7.26
Madrid	10233	25 year	928.55	927.56		0.06	0.04	77.26		2828.23	163.77	8.19
Madrid	10233	50 year	931.05	930.44		0.03	0.10	86.87		3154.20	385.80	6.59
Madrid	10233	100 year	932.00	931.32		0.03	0.13	93.10		3628.52	495.48	6.98
Madrid	10233	500 year	934.26	933.45		0.04	0.24	183.17	15.38	4779.85	808.77	7.72
Madrid	10233	sept low	920.89	920.89		0.00	0.00	32.57		5.80		0.14
Madrid	10233	oct low	921.01	921.01		0.00	0.00	44.19		9.90		0.22
Madrid	10222	1.1 year	924.00	923.91	919.71			38.02		535.00		2.45
Madrid	10222	2 year	925.47	925.20	921.11			38.47		1127.00		4.21
Madrid	10222	10 year	927.44	926.66	923.00			38.99		2304.00		7.11
Madrid	10222	25 year	928.45	927.31	923.91			39.22		2992.00		8.56
Madrid	10222	50 year	930.92	929.98	924.61			40.16		3540.00		7.77
Madrid	10222	100 year	931.83	930.70	925.31			40.41		4124.00		8.51
Madrid	10222	500 year	933.98	932.39	926.96			41.01		5604.00		10.13
Madrid	10222	sept low	920.89	920.89	917.09			36.47		5.80		0.06
Madrid	10222	oct low	921.01	921.01	917.17			37.00		9.90		0.09
Madrid	10200 BR U	1.1 year	924.00	923.91	919.71			38.02		535.00		2.45
Madrid	10200 BR U	2 year	925.47	925.19	921.12			38.47		1127.00		4.22
Madrid	10200 BR U	10 year	927.43	926.64	923.00			38.98		2304.00		7.12
Madrid	10200 BR U	25 year	928.44	927.29	923.96			39.21		2992.00		8.57
Madrid	10200 BR U	50 year	930.92	928.60	924.63			39.67		3540.00		8.84
Madrid	10200 BR U	100 year	931.83	928.60	925.35			39.67		4124.00		10.30
Madrid	10200 BR U	500 year	933.98	932.39	926.98				273.56	5042.97	278.81	12.00
Madrid	10200 BR U	sept low	920.89	920.89	917.09			36.47		5.80		0.06
Madrid	10200 BR U	oct low	921.01	921.01	917.17			37.00		9.90		0.09
Madrid	10200 BR D	1.1 year	922.32	922.22	917.89			37.65		535.00		2.52
Madrid	10200 BR D	2 year	923.79	923.50	919.46			38.02		1127.00		4.33
Madrid	10200 BR D	10 year	925.72	924.87	921.47			38.40		2304.00		7.36
Madrid	10200 BR D	25 year	926.69	925.45	922.39			38.57		2992.00		8.93
Madrid	10200 BR D	50 year	927.42	925.83	923.11			38.67		3540.00		10.13
Madrid	10200 BR D	100 year	928.19	926.19	923.82			38.78		4124.00		11.34
Madrid	10200 BR D	500 year	933.90	932.39	925.46				273.56	5042.97	278.81	10.56
Madrid	10200 BR D	sept low	919.09	919.09	915.17			32.89		5.80		0.06
Madrid	10200 BR D	oct low	919.22	919.22	915.24			33.29		9.90		0.10
Madrid	10197	1.1 year	922.32	922.22		0.00	0.04	37.65		535.00		2.52
Madrid	10197	2 year	923.78	923.49		0.01	0.12	38.01		1127.00		4.33
Madrid	10197	10 year	925.70	924.86		0.02	0.33	38.40		2304.00		7.38
Madrid	10197	25 year	926.67	925.42		0.03	0.49	38.56		2992.00		8.96
Madrid	10197	50 year	927.42	925.83		0.04	0.63	38.67		3540.00		10.13
Madrid	10197	100 year	928.19	926.19		0.04	0.79	38.78		4124.00		11.34
Madrid	10197	500 year	930.05	926.79	925.45	0.06	1.30	38.95		5604.00		14.47
Madrid	10197	sept low	919.09	919.09		0.00	0.00	32.89		5.80		0.06
Madrid	10197	oct low	919.22	919.22		0.00	0.00	33.29		9.90		0.10
Madrid	10166	1.1 year	922.28	922.26		0.00	0.00	64.97	1.11	533.87	0.02	1.08
Madrid	10166	2 year	923.66	923.60		0.00	0.01	66.36	4.07	1122.82	0.11	1.96
Madrid	10166	10 year	925.35	925.17		0.01	0.03	67.98	13.12	2290.48	0.40	3.42
Madrid	10166	25 year	926.15	925.88		0.01	0.05	68.72	20.10	2971.26	0.64	4.16
Madrid	10166	50 year	926.76	926.42		0.01	0.06	69.27	26.57	3512.56	0.87	4.70
Madrid	10166	100 year	927.36	926.93		0.01	0.08	69.81	34.16	4088.70	1.14	5.25
Madrid	10166	500 year	928.69	928.03		0.02	0.12	72.50	55.95	5546.11	1.94	6.56
Madrid	10166	sept low	919.09	919.09		0.00	0.00	59.93	0.00	5.80		0.02
Madrid	10166	oct low	919.22	919.22		0.00	0.00	60.82	0.00	9.90		0.03

Plan: madridEXfinal Sandy Madrid RS: 10200 Profile: 100 year

E.G. US. (ft)	931.83	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	930.70	E.G. Elev (ft)	931.83	928.19
Q Total (cfs)	4124.00	W.S. Elev (ft)	928.60	926.19
Q Bridge (cfs)	4124.00	Crit W.S. (ft)	925.35	923.82
Q Weir (cfs)		Max Chl Dpth (ft)	11.80	11.19
Weir Sta Lft (ft)		Vel Total (ft/s)	10.30	11.34
Weir Sta Rgt (ft)		Flow Area (sq ft)	400.54	363.56
Weir Submerg		Froude # Chl	0.57	0.65
Weir Max Depth (ft)		Specif Force (cu ft)	3433.43	3253.39
Min El Weir Flow (ft)	933.01	Hydr Depth (ft)	10.10	9.38
Min El Prs (ft)	928.60	W.P. Total (ft)	54.84	54.18
Delta EG (ft)	3.64	Conv. Total (cfs)	49787.5	42711.0
Delta WS (ft)	4.52	Top Width (ft)	39.67	38.78
BR Open Area (sq ft)	400.54	Frctn Loss (ft)		
BR Open Vel (ft/s)	10.30	C & E Loss (ft)		
BR Sluice Coef	0.45	Shear Total (lb/sq ft)	3.13	3.91
BR Sel Method	Press Only	Power Total (lb/ft s)	32.21	44.31

Plan: madridEXfinal Sandy Madrid RS: 10200 BR U Profile: 100 year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	Chan	-21.65	-17.53	33.98	12.33	9.35	0.82	4.46	2.76	0.57	1.56
2	Chan	-17.53	-13.41	411.80	42.26	4.82	9.99	10.25	9.74	3.75	36.59
3	Chan	-13.41	-9.28	521.63	45.99	4.18	12.65	11.16	11.34	4.72	53.48
4	Chan	-9.28	-5.16	562.89	47.93	4.13	13.65	11.63	11.74	4.97	58.36
5	Chan	-5.16	-1.04	571.90	48.35	4.12	13.87	11.73	11.83	5.02	59.41
6	Chan	-1.04	3.08	571.67	48.36	4.13	13.86	11.73	11.82	5.02	59.32
7	Chan	3.08	7.21	510.69	45.81	4.27	12.38	11.11	11.15	4.60	51.24
8	Chan	7.21	11.33	444.13	41.84	4.20	10.77	10.15	10.61	4.27	45.32
9	Chan	11.33	15.45	362.55	37.55	4.34	8.79	9.11	9.66	3.70	35.77
10	Chan	15.45	19.57	132.76	30.13	11.31	3.22	7.66	4.41	1.14	5.03

Plan: madridEXfinal Sandy Madrid RS: 10200 BR D Profile: 100 year

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity	Shear	Power
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)	(lb/sq ft)	(lb/ft s)
1	Chan	-21.65	-17.58	107.49	25.50	12.77	2.61	8.26	4.22	1.16	4.90
2	Chan	-17.58	-13.51	605.51	45.53	4.07	14.68	11.19	13.30	6.51	86.58
3	Chan	-13.51	-9.44	605.51	45.53	4.07	14.68	11.19	13.30	6.51	86.58
4	Chan	-9.44	-5.37	605.51	45.53	4.07	14.68	11.19	13.30	6.51	86.58
5	Chan	-5.37	-1.30	581.94	44.68	4.12	14.11	10.98	13.02	6.31	82.18
6	Chan	-1.30	2.77	516.88	41.84	4.18	12.53	10.28	12.35	5.83	72.00
7	Chan	2.77	6.84	413.13	36.95	4.28	10.02	9.08	11.18	5.02	56.12
8	Chan	6.84	10.91	340.16	32.52	4.17	8.25	7.99	10.46	4.54	47.52
9	Chan	10.91	14.98	278.16	28.98	4.22	6.74	7.12	9.60	3.99	38.32
10	Chan	14.98	19.05	69.72	16.48	8.22	1.69	5.27	4.23	1.17	4.94

Madrid: Weymouth Bridge

Span of Curent Bridge: 45 FT
Year of Construction: 1933
Type of Bridge: Concrete T Beam

Madrid

September-October Low Flows:	5.8 (SEPT)	9.9 (OCT)	Channel Type:
Existing Flow Depth for Low Flows:	2.2-2.3'		Incised Stream
Drop in water surface through bridge:	0.63'		Rock Base
Maximum Velocity (low flow):	0.16-0.18 fps		No chance of meandering

Bank Full Width				
Stream Cross Section Number	1. Width of Channel at time of Survey (FT)	2. Natural Channel Geomorphic Estimate (FT)	3. Cross Section Survey Plots (FT)	4. Hydraulic Model HECRAS 1.1-year flow width (FT)
99+87	45	75	53	71
100+20	50	75	53	67
100+41	50	75	55	67
100+64	54	75	68	60
101+03	82	75	87	109
101+36	80	75	85	87
101+66	60	75	62	65
Average each method	60.1	75.0	66.1	75.1
AVERAGE WIDTH (FT): Downstream River Segment (Using Methods 2, 3, 4):				**72**
Bridge	47/40			40
102+33				50
102+58	47	75	60	60
102+99	53	75	78	85
103+62	60	75	72	76
104+10	60	75		
104+60	60	75		
105+10	55	75		
105+60	50	75		
Average of each method	55	75	70.0	73.7
AVERAGE WIDTH (FT): Upstream River Segment (Using Methods 2, 3, 4):				**73**

Recommended Bank Full Width (Perpendicular to the channel edge): 73.0 FT

Bridge Length required for Bank Width Recommended (Skew = 35°): 90.0 FT

METHODS:

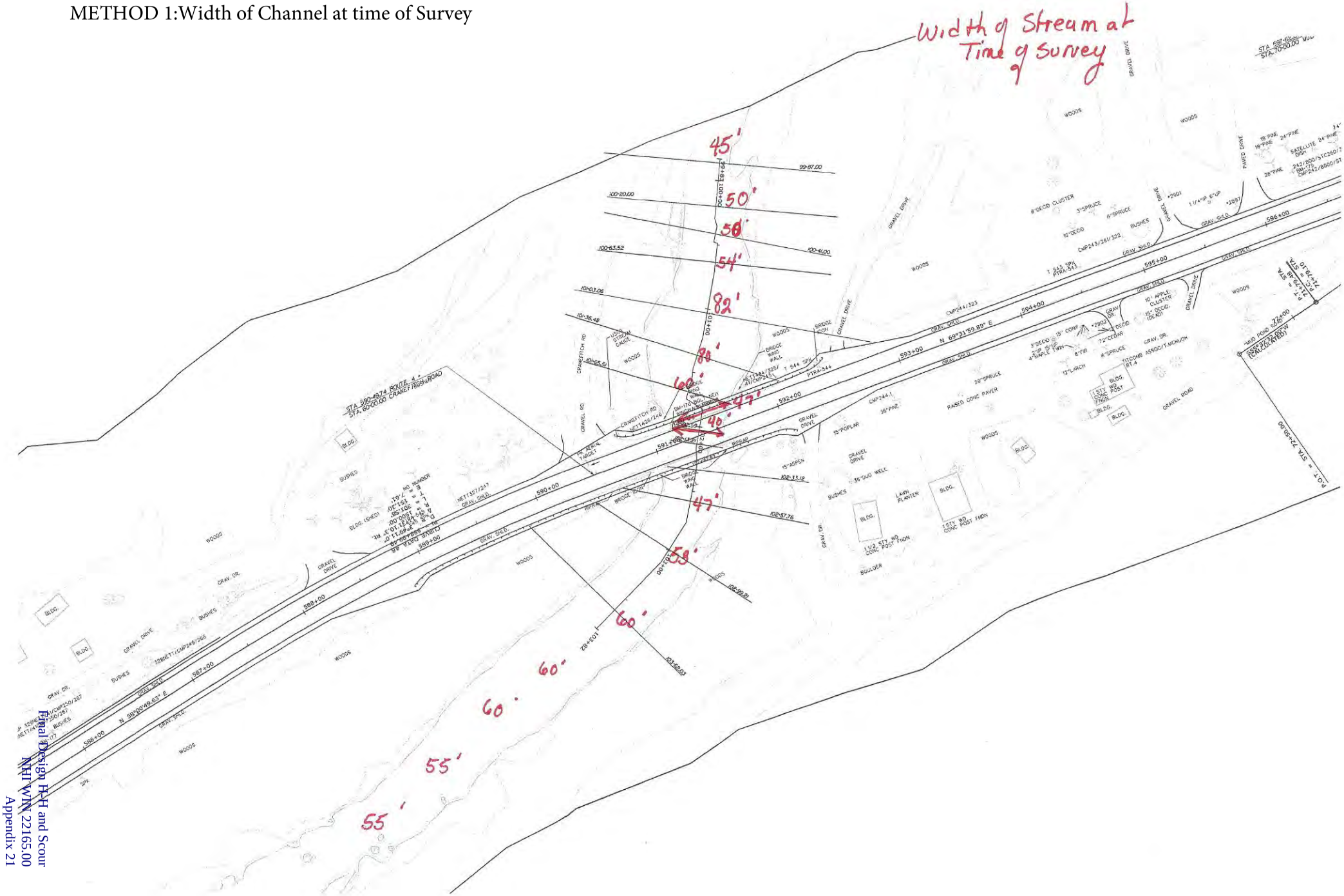
1. Width of Channel at Time of Survey: Data provided for rough check of channel width and is subject to water levels at the time the survey was taken. The data is *not* used in the average calculation used to derive bank full width as it can be subjective.

2. Natural Geomorphic Channel: Assessment of channel width based on important channel features such as slope, bedrock outcrops and the channel alignment without constrictions (bridge in this case). Data *is* considered in the average.

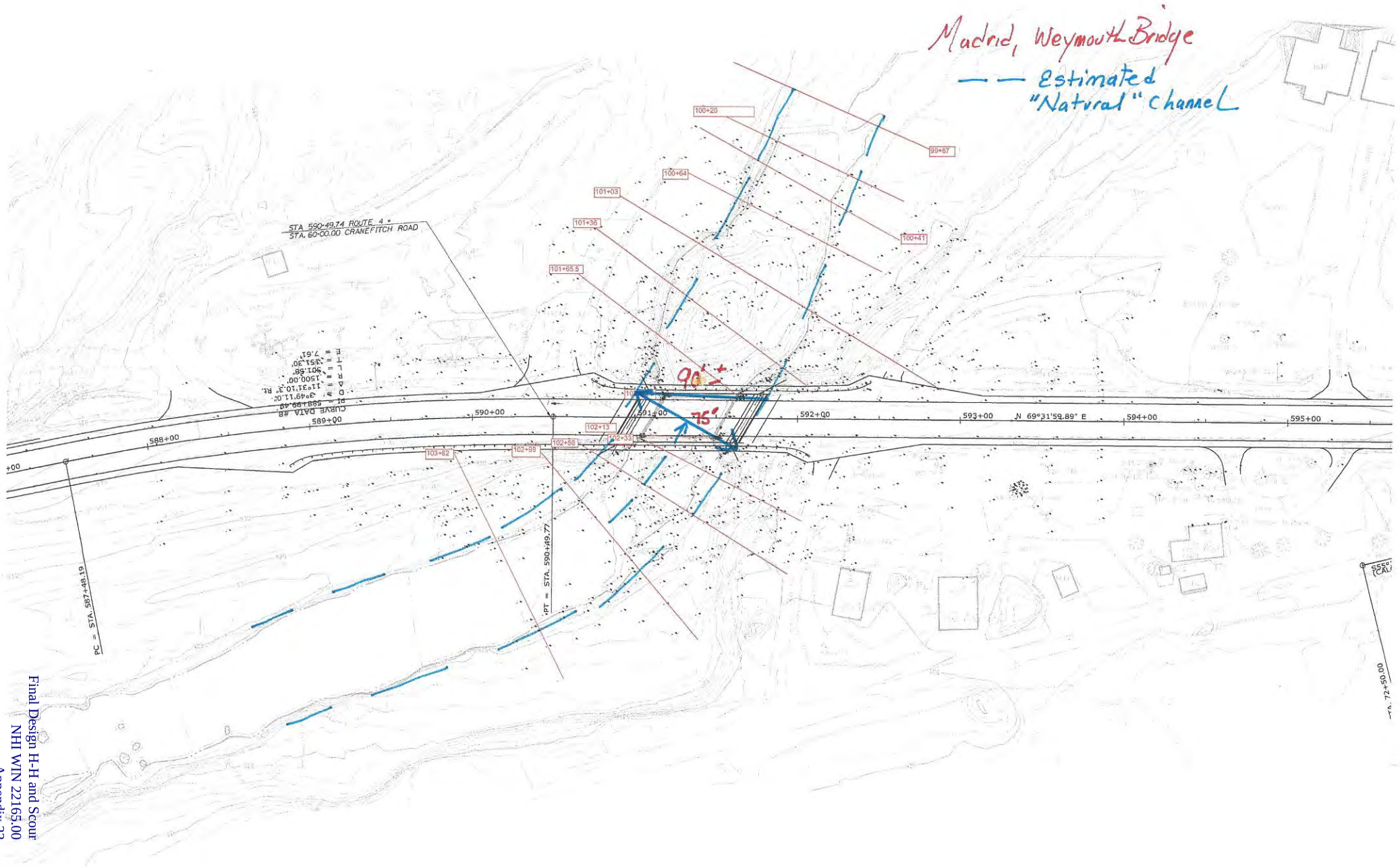
3. Cross Section Survey Plot Data: Width of channel is estimated from channel survey information. The bank edge of the channel is the change in slope in the topography; no specific water level is considered. Data *is* considered in the average.

4. Hydraulic Model HECRAS 1.1-year flow width: Most reliable data for bank full width assessment. Using model HECRAS and the 1.1-year streamflow, channel width is calculated from the 1.1 year flow data output, intersection of water level and channel bank. Data *is* considered in the average.

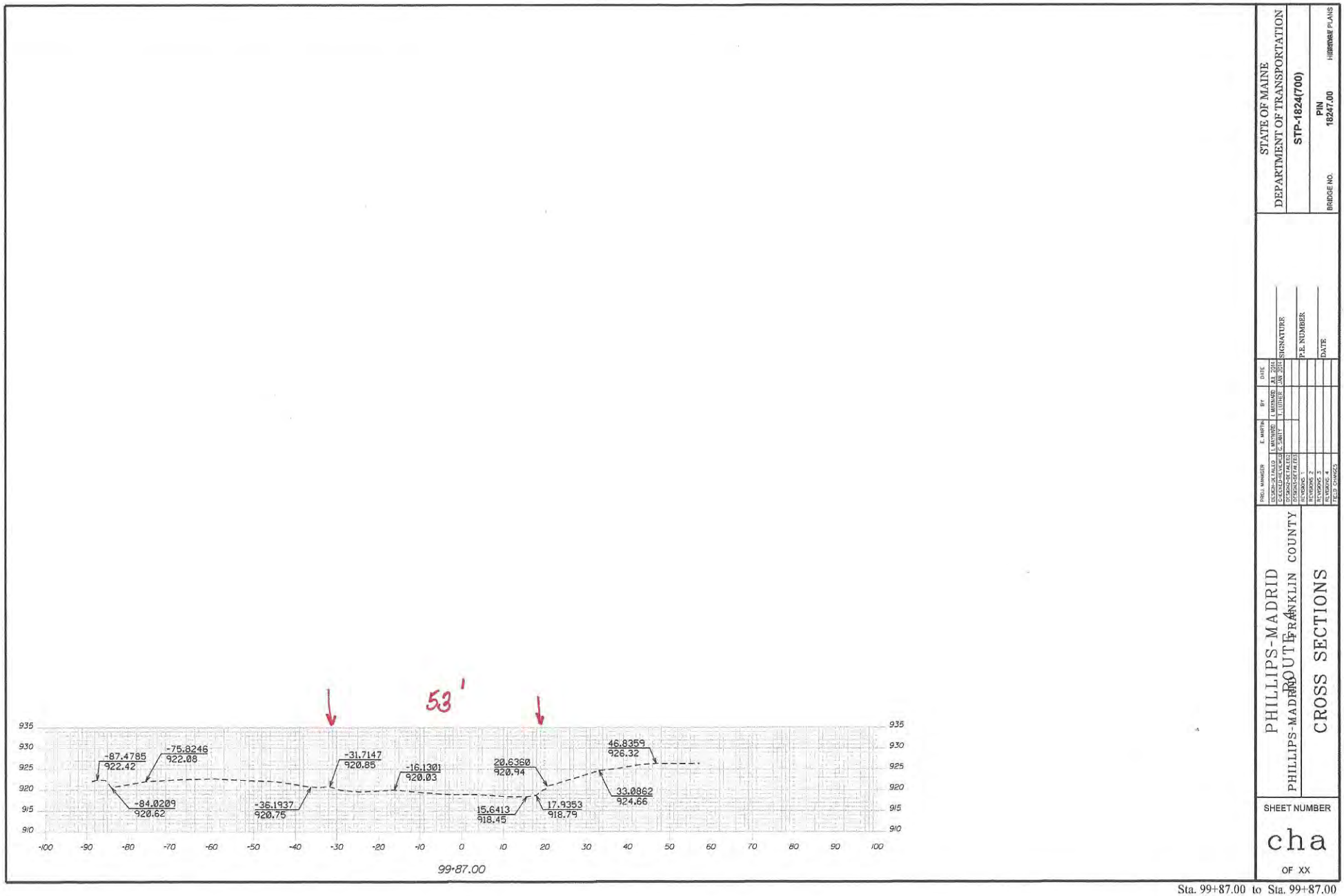
METHOD 1:Width of Channel at time of Survey

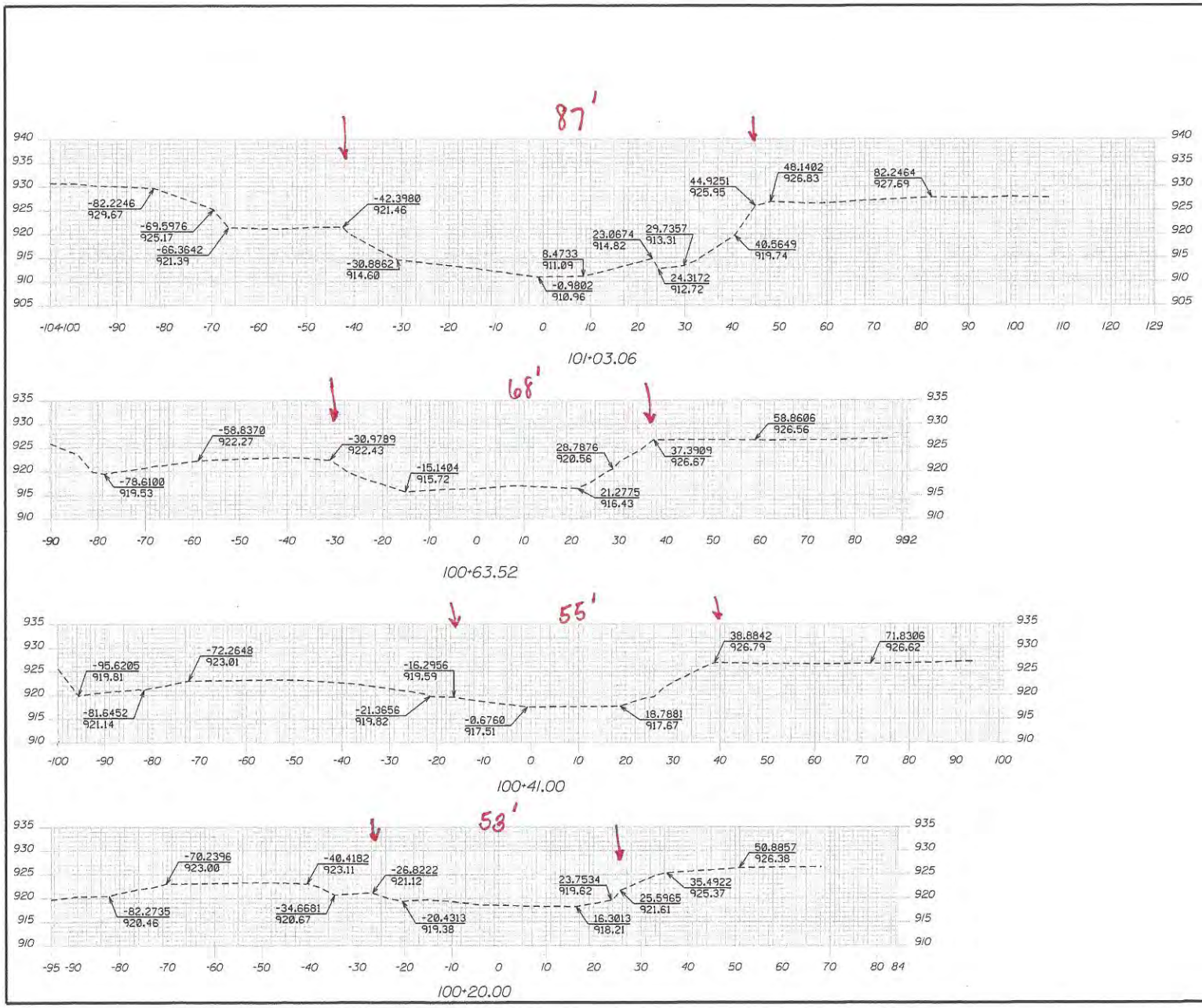


METHOD 2: Natural Channel Geomorphic Estimate



METHOD 3: Channel Cross Section Survey Plots





STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-1824(700)

PIN 18247.00

BRIDGE NO.

HIGHWAY PLANS

PROJ. MANAGER: E. MARTIN
DESIGNED: J. MAYNARD — JUL 2014
CHECKED-REVIEWED: G. SMITH — JAN 2014
DESIGNED-DETAILED:
CHECKED-DETAILED:
REVISIONS 1
REVISIONS 2
REVISIONS 3
REVISIONS 4
FIELD CHANGES

SIGNATURE
P.E. NUMBER
DATE

PHILLIPS-MADRID
PHILLIPS-MADRID ROUTE 4 FRANKLIN COUNTY

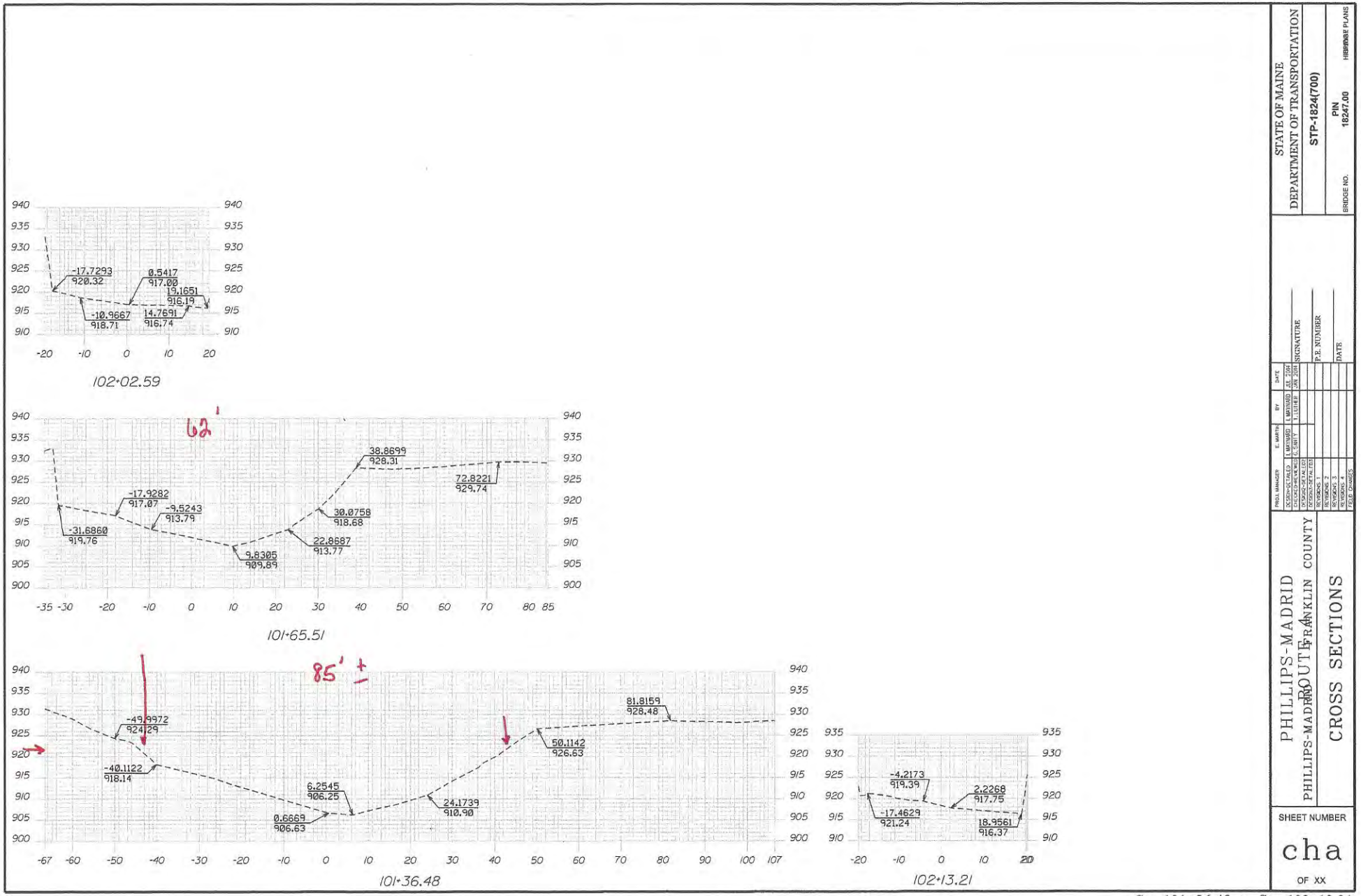
CROSS SECTIONS

SHEET NUMBER
cha
OF XX

Sta. 100+20.00 to Sta. 101+03.06

Date:10/7/2014
Username: common
Division: HIGHWAY
Filename: ...\channel cross sections.DGN

Final Design H-H and Scour
NHI WIN 22165.00
Appendix 24



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-1824(700)

PIN 18247.00

BRIDGE NO.

HIGHWAY PLANS

	PROJ. MANAGER	E. MARTIN	BY	DATE
DESIGN-DETAILED	L.MARSHALL	L.MARSHALL	JUL 2014	
CHECKED-REVIEWED	L.MARSHALL	T. LILLIE	JAN 2015	SIGNATURE
DESIGN-DETAILED	C. SMITH			
REVISIONS 1				P.E. NUMBER
REVISIONS 2				
REVISIONS 3				
REVISIONS 4				DATE
FIELD CHANGES				

PHILLIPS-MADRID
PHILLIPS-MADRID ROUTE 4 FRANKLIN COUNTY

CROSS SECTIONS

SHEET NUMBER

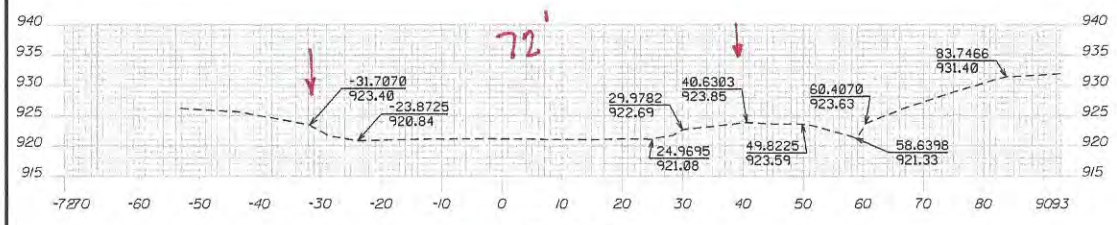
cha

OF XX

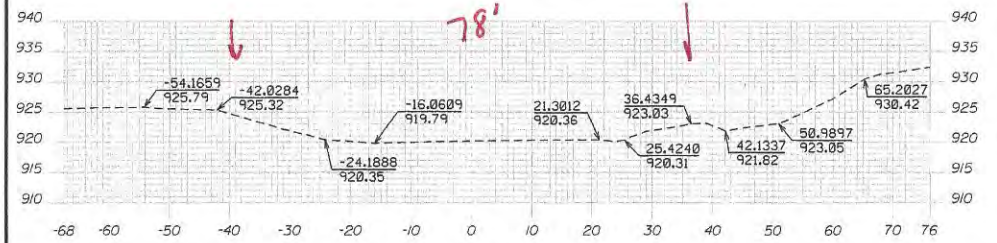
Sta. 101+36.48 to Sta. 102+13.21

Date:10/7/2014
Username: common
Division: HIGHWAY
Filename: ...\channel cross sections.DGN

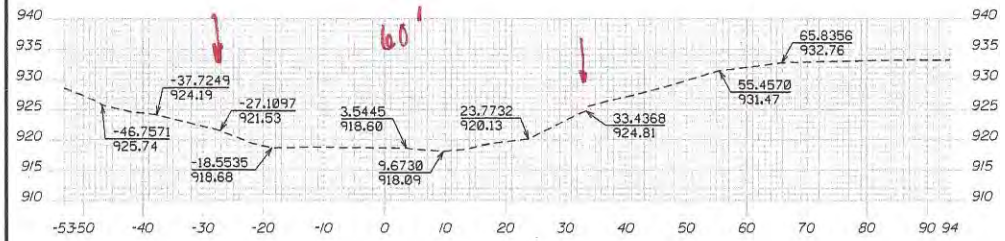
Final Design H-H and Scour
NHI WIN 22165.00
Appendix 25



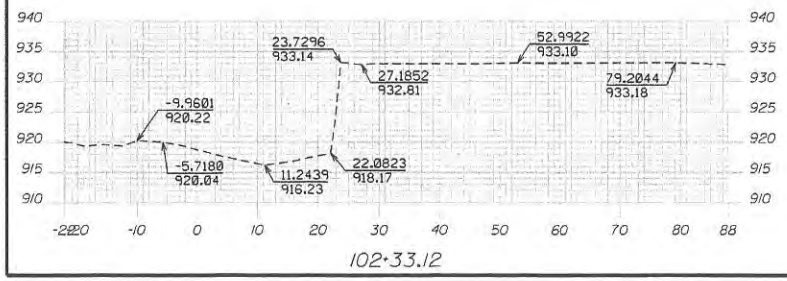
103+62.03



102+99.21



102+57.76



102+33.12

Sta. 102+33.12 to Sta. 103+62.03

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-1824(700)

PIN 18247.00

BRIDGE NO.

HIGHWAY PLANS

PROJ. MANAGER E. MARTIN
DESIGNED BY I. MEYNARD JAN 2014
CHECKED/REVIEWED G. SMITH I. LOUHEED JAN 2014
DESIGN DETAILED
REVISIONS 1
REVISIONS 2
REVISIONS 3
REVISIONS 4
FIELD CHANGES

SIGNATURE
P.E. NUMBER
DATE

PHILLIPS-MADRID
PHILLIPS-MADRID SOUTH FRANKLIN COUNTY

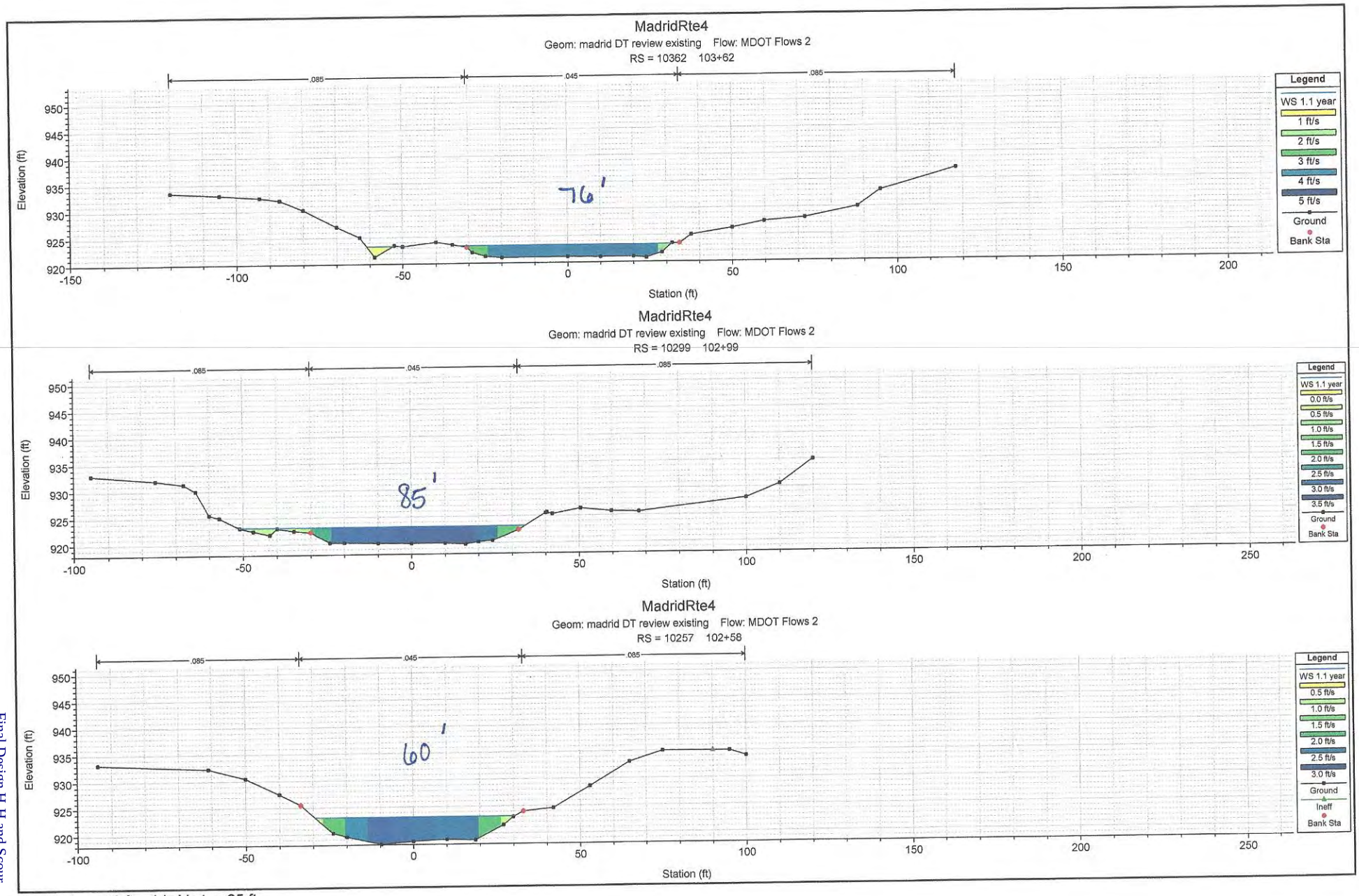
CROSS SECTIONS

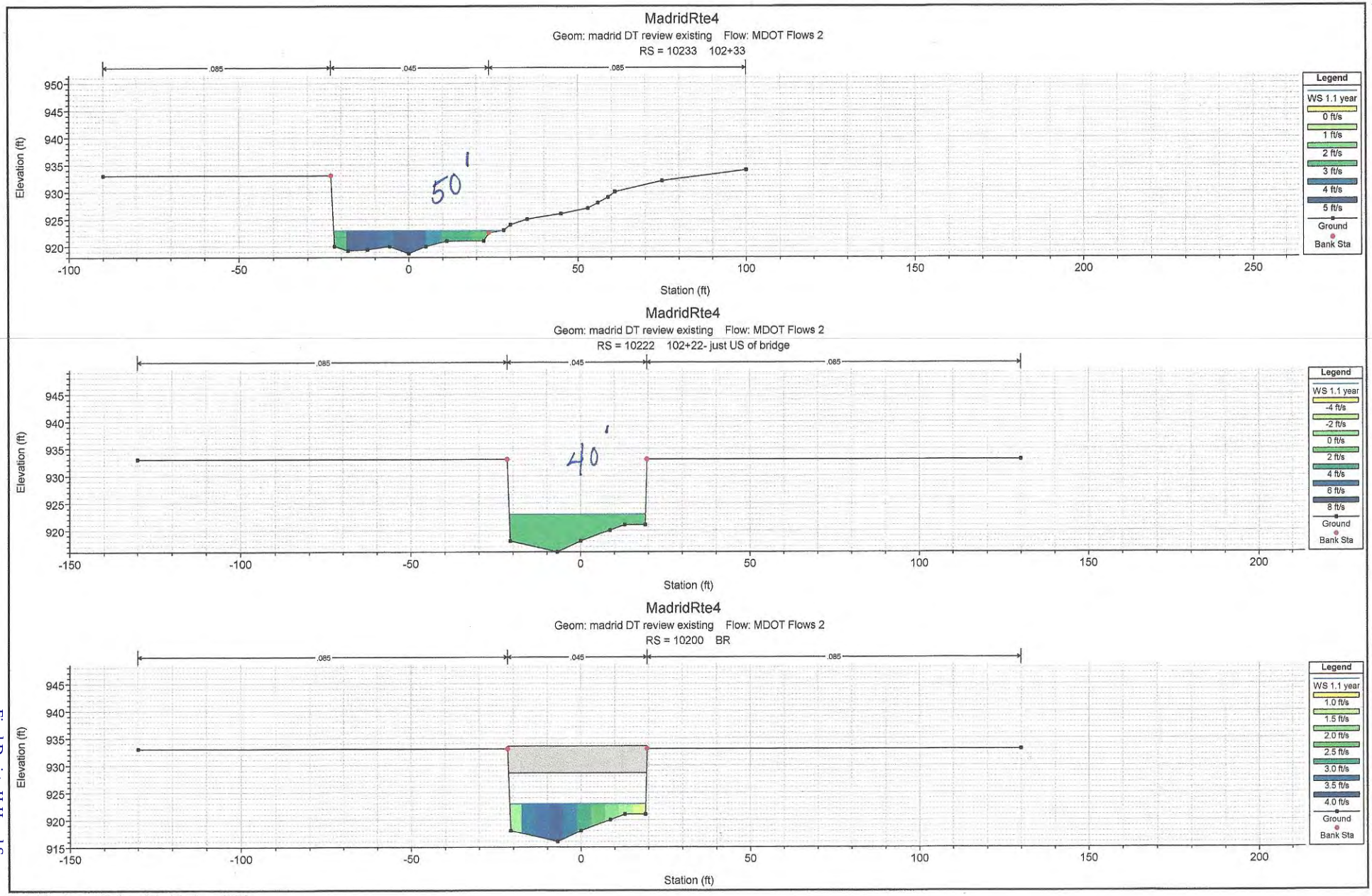
SHEET NUMBER
cha
OF XX

Usernome: common Date:10/7/2014
Division: HIGHWAY
Filenome: ...\channel cross sections.DGN

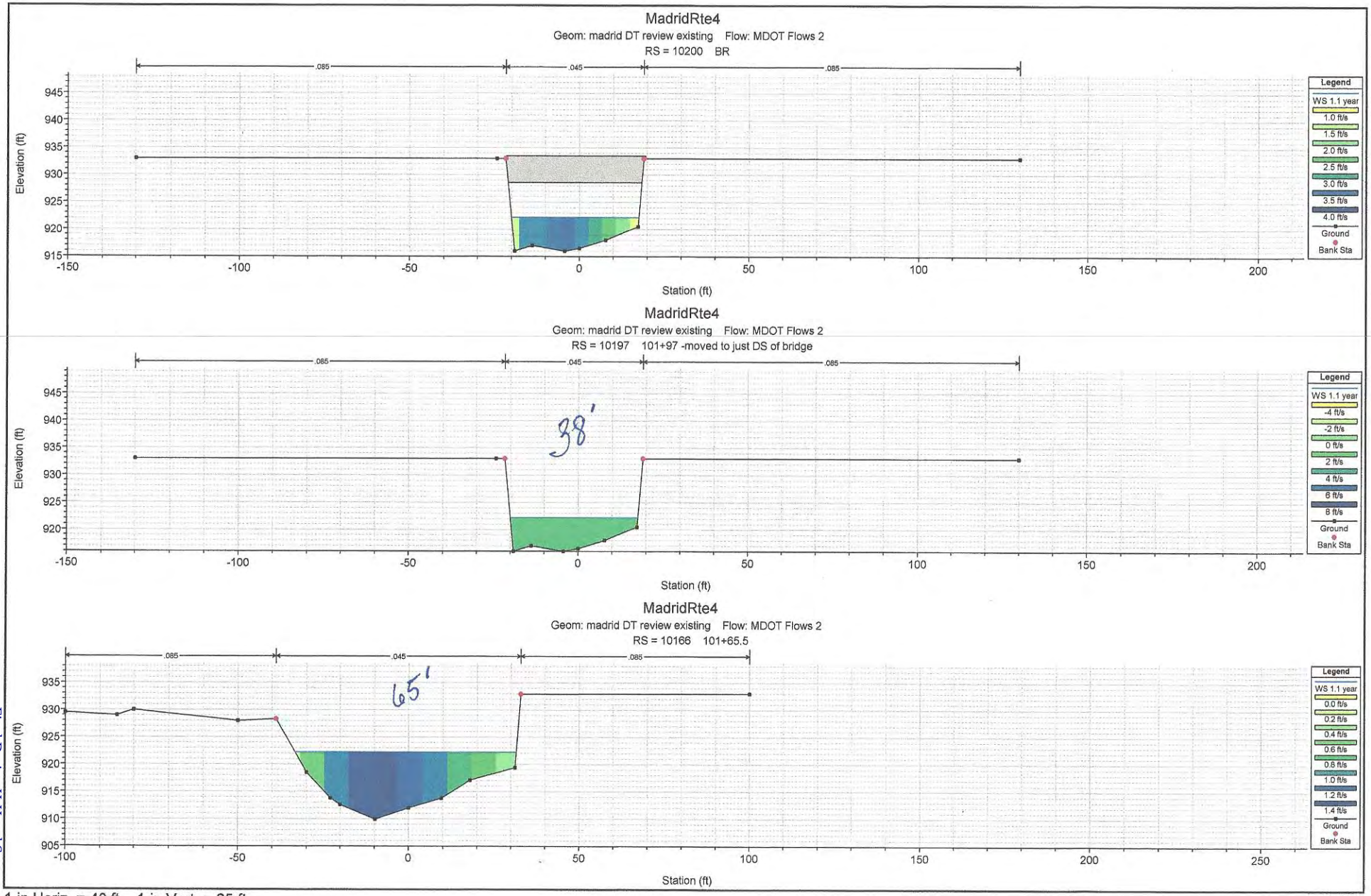
Final Design H-H and Scour
NHI WIN 22165.00
Appendix 26

METHOD 4: Hydraulic Model HECRAS 1.1-year flow width

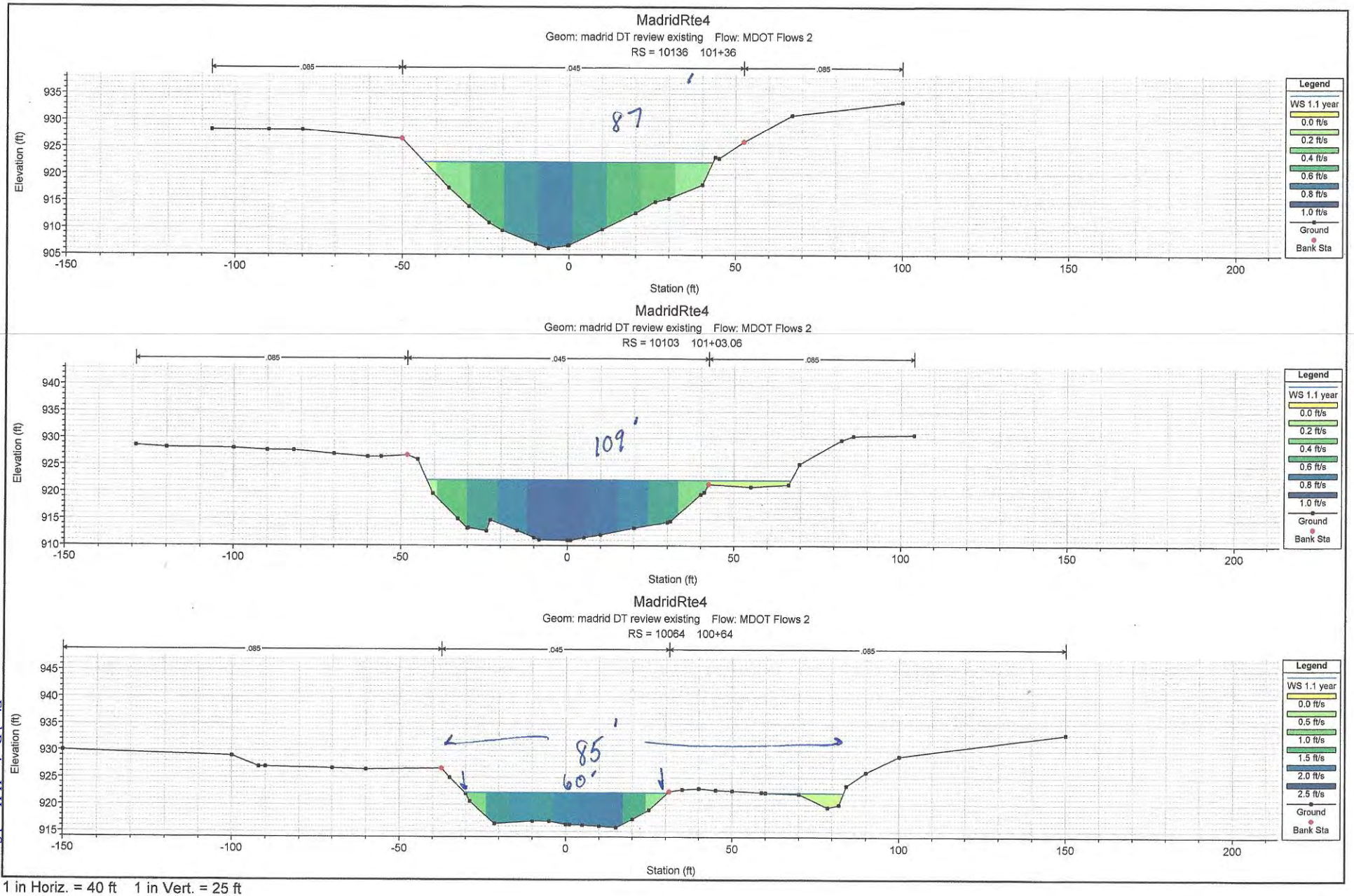




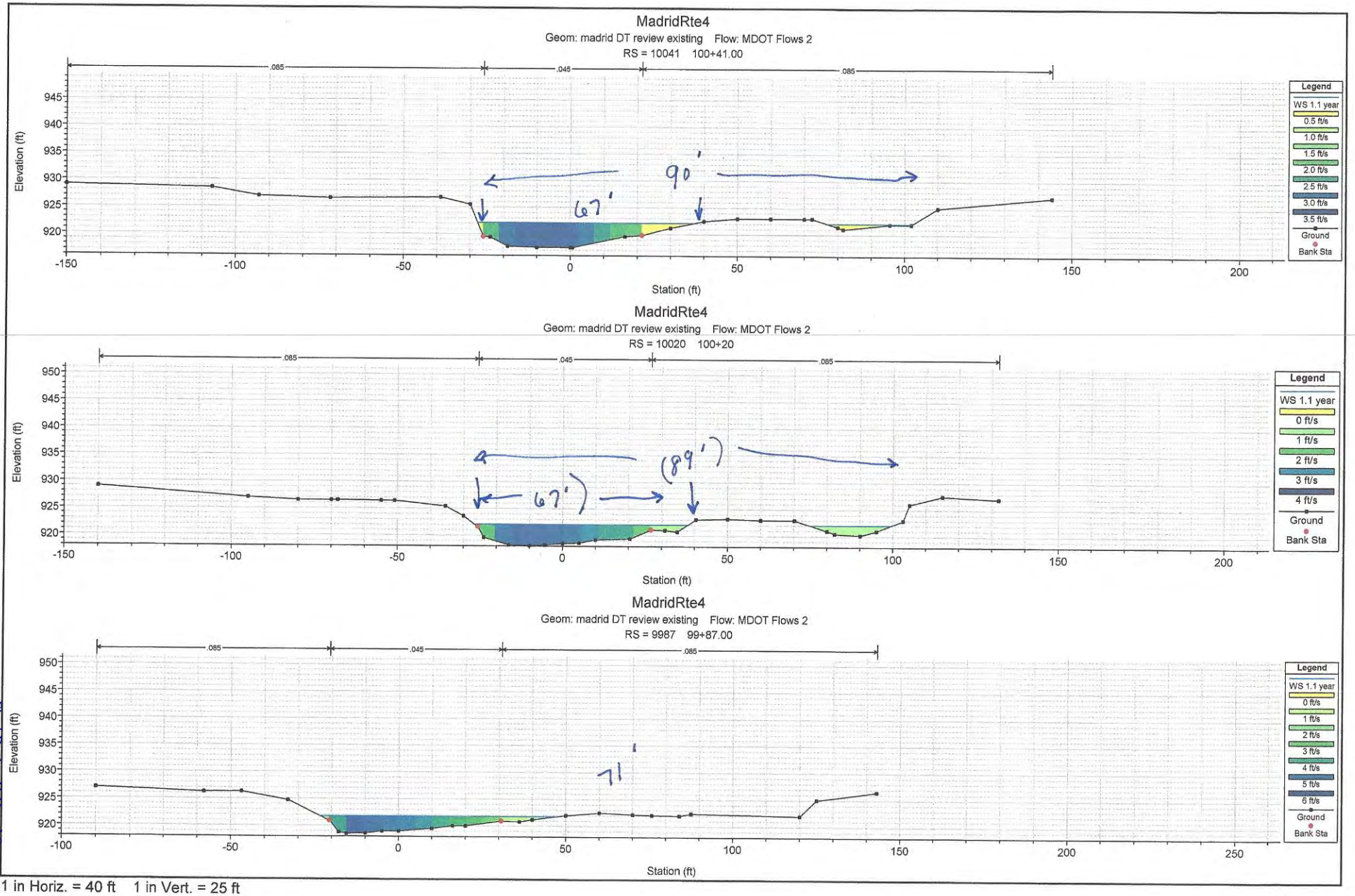
1 in Horiz. = 40 ft 1 in Vert. = 25 ft



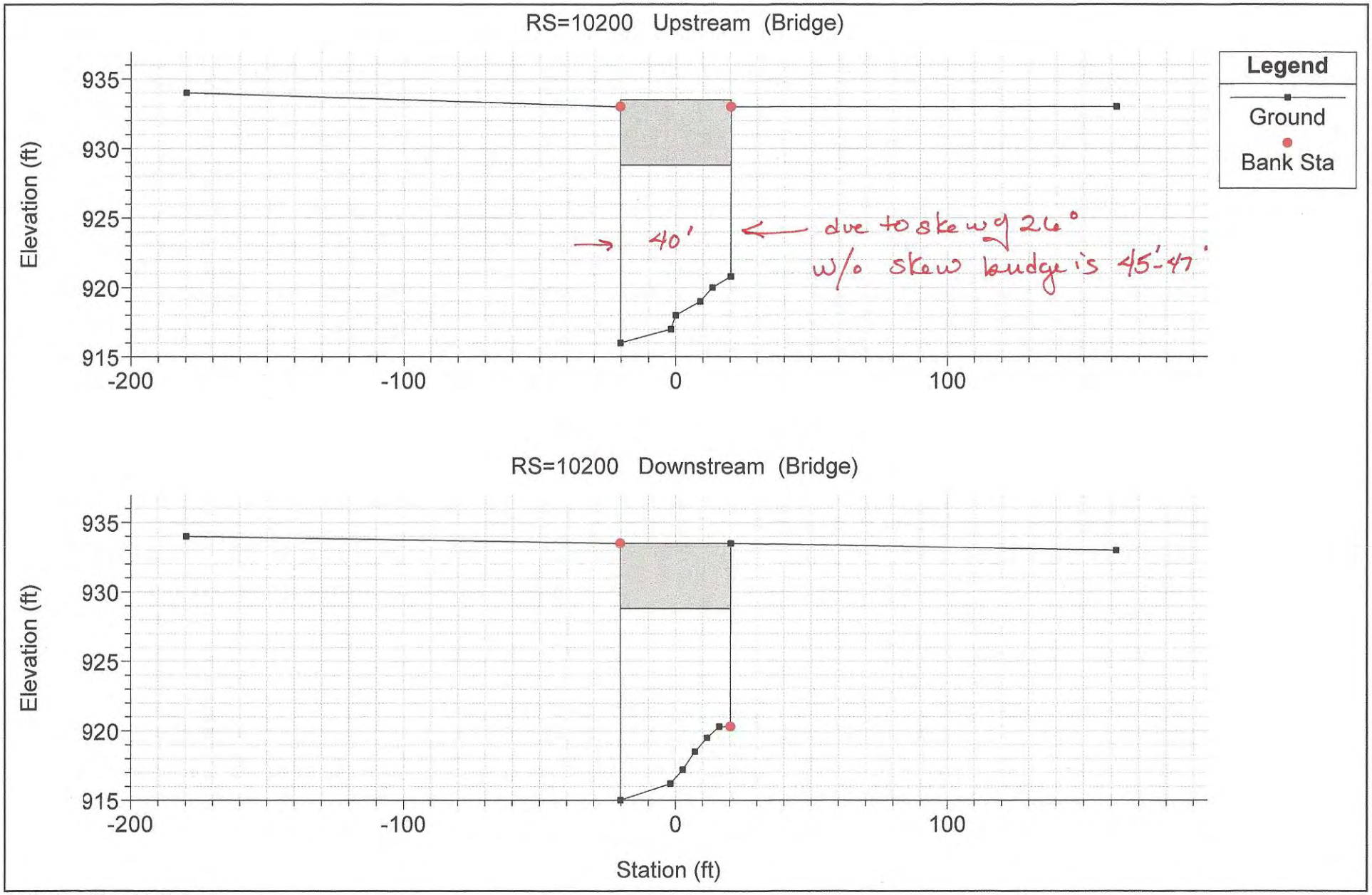
1 in Horiz. = 40 ft 1 in Vert. = 25 ft



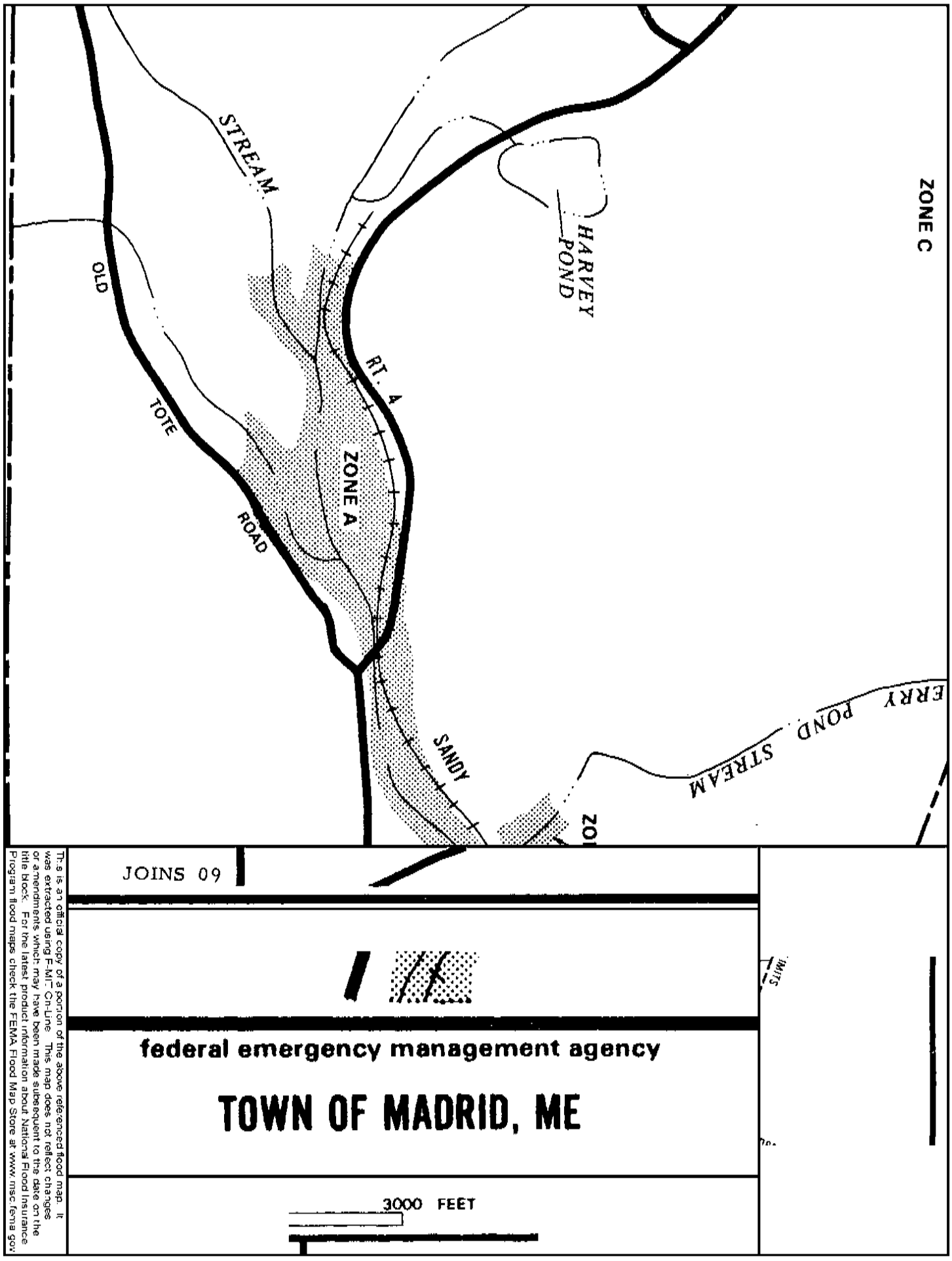
1 in Horiz. = 40 ft 1 in Vert. = 25 ft



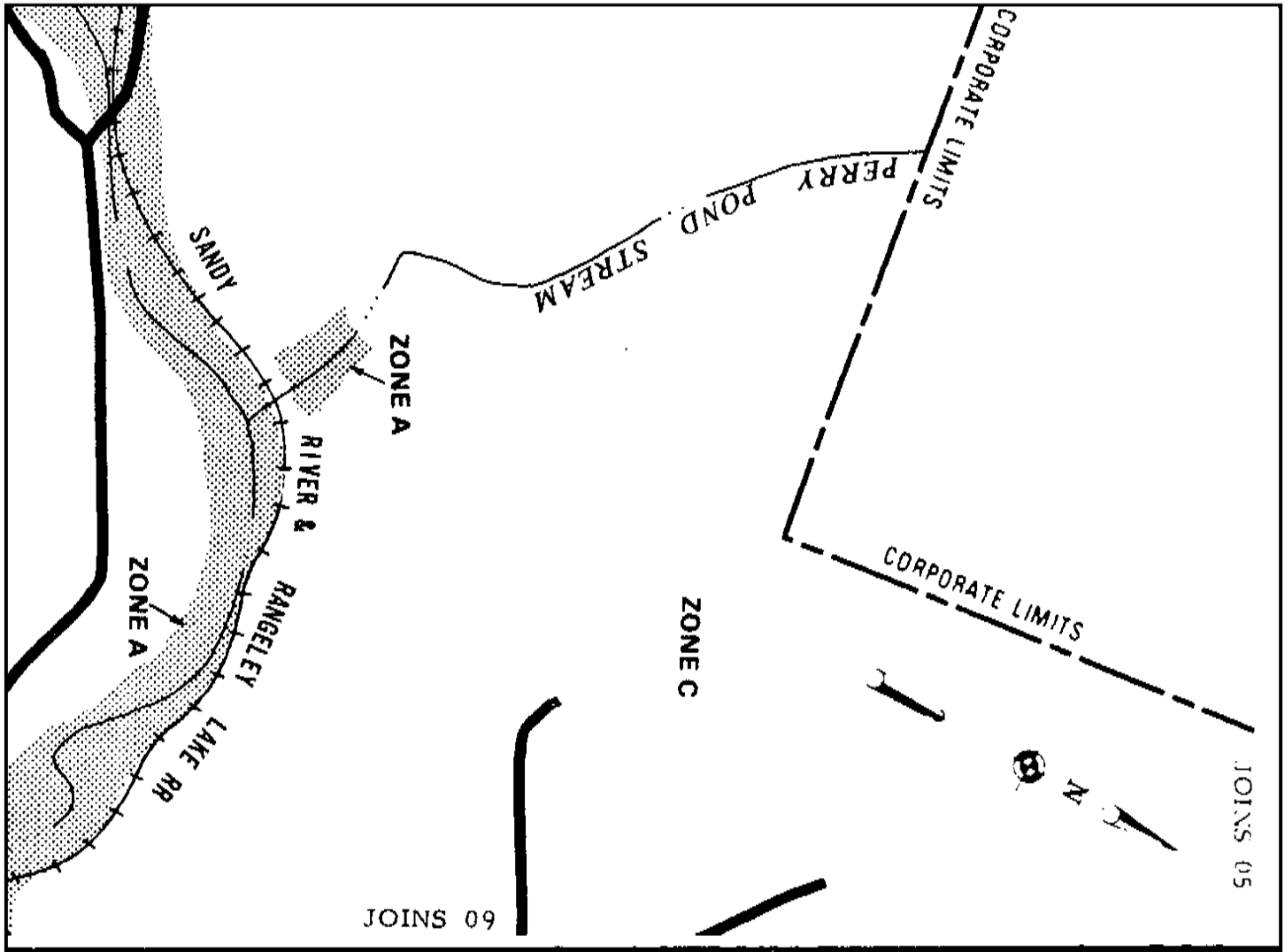
1 in Horiz. = 40 ft 1 in Vert. = 25 ft



1 in Horiz. = 50 1 in Vert. = 4



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



gement agency

RID, ME

.)

APPROXIMATE SCALE

1000 0 1000 2000 3000 FEET

FLOOD INSURANCE RATE MAP
COMMUNITY NUMBER 230350 A

EFFECTIVE DATE
AUGUST 19, 1985

JOINS 09

LIMITS

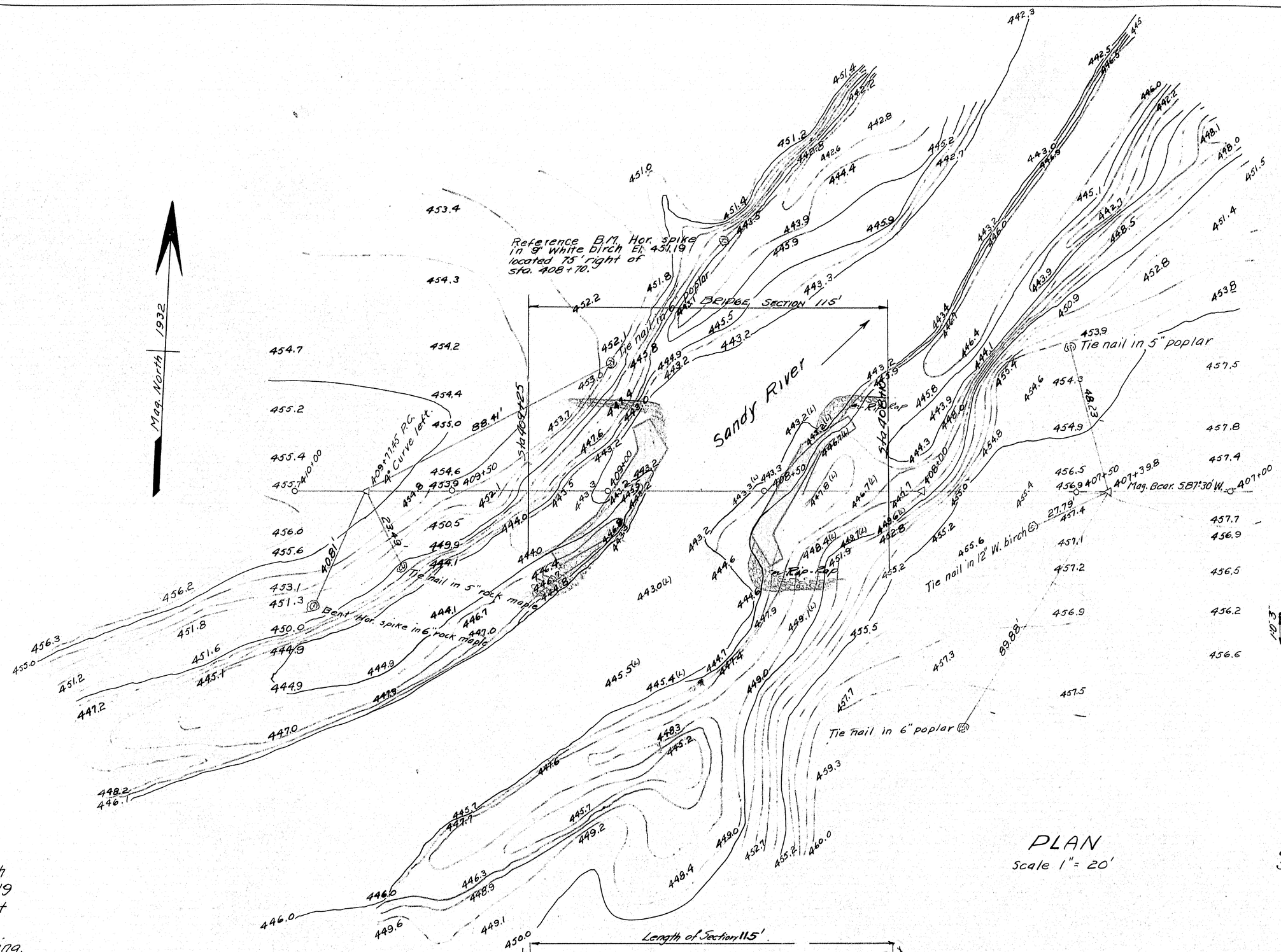
federal emergency management agency

TOWN OF MADRID, ME

3000 FEET

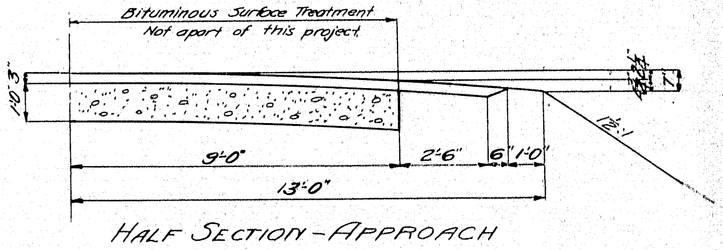
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program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

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
9	MAINE	NRH 1468		2	7



PLAN
Scale 1" = 20'

PROFILE
Scales Hor. 1" = 20' Vert. 1" = 5'



HALF SECTION - APPROACH
3" Gravel Surface
12" Gravel Base

Notes -
Traffic Use existing bridge about 500' upstream.
Stream - Swift current. Rapids and falls of 1.5' drop just upstream of center line. High water of Sept. 1932 El. 451.9 3.' above planking of present bridge. High water of 1927 reported at 3.5' above planking. For waterway study use former survey of existing bridge site.
Foundation - Ledge.

Highway B.M. # 40
Elev. 460.63
Point on N.E. side of ledge over → mark 110' left of Sta. 406+40.

Survey - Beckman
Plotted - Whitten

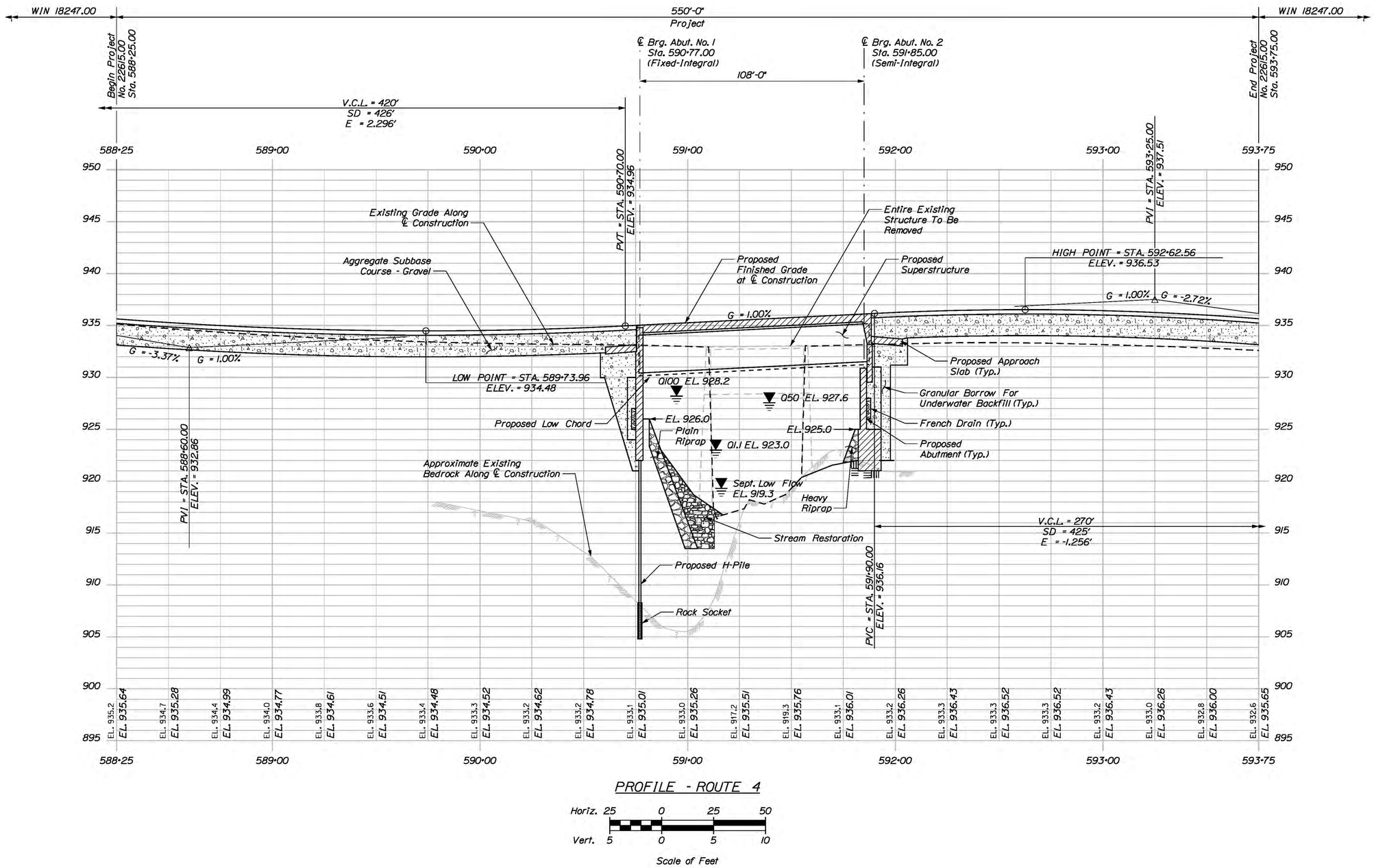
Town 04-16
Bridge 2934

MAINE HIGHWAY COMMISSION
BRIDGE DIVISION
WEYMOUTH BRIDGE
OVER
SANDY RIVER
IN THE TOWN OF
MADRID FRANKLIN CO.
SURVEY
Sheet 2 of 7 Augusta Me. December 1932

17-127

0 1 2 3 4 5 INCHES


MADRID
103+82
103+00
102+00
101+00
99+83 100+00
590+00
591+00
592+00
593+00
CURVE DATA #9
PI = 589+02.04
D = 3°49'11.0"
Δ = 11°16'23.6"
R = 1500.00'
L = 295.13'
T = 148.04'
E = 7.29'
GRAVEL RD
CRANEFITCH RD
GRAVEL DRIVE
GRAV. DR.
WOODS
BUSHES
BLDG.
BOULDER
N 69°31'59.89"



PROFILE - ROUTE 4

Horiz. 25 0 25 50

Vert. 5 0 5 10

Scale of Feet

PRELIMINARY
NOT FOR CONSTRUCTION

Stantec

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2261(500)

WIN 22615.00

BRIDGE NO. 2934

BRIDGE PLANS

	M. WIGHT	BY	DATE
PROJ. MANAGER	M. WIGHT	SJB	FEB 2017
DESIGN-DETAILED	SJB	MJD/TWM	FEB 2017
CHECKED-REVIEWED	PJP	JCS	FEB 2017
DESIGN2-DETAILED2	DOT		
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

WEYMOUTH BRIDGE
SANDY RIVER
MADRID FRANKLIN COUNTY

PROFILE - ROUTE 4

SHEET NUMBER

5

OF 26

Filename: ...\00\BRIDGE\MSTA\005_Profile.dgn Division: BRIDGE Username: dataylor Date:2/6/2017

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-2261(500)

WIN 22615.00

BRIDGE NO. 2934

BRIDGE PLANS

WEYMOUTH BRIDGE
SANDY RIVER
MADRID FRANKLIN COUNTY

GENERAL PLAN

PROJ. MANAGER	M. WIGHT		
DESIGN-DETAILED	SJB	FEB 2017	SIGNATURE
CHECKED-REVIEWED	PJP	MAY 1YYM	
DESIGN2-DETAILED2	DDT	JGS	P.E. NUMBER
DESIGN3-DETAILED3		FEB 2017	
REVISIONS 1			DATE
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SHEET NUMBER

4

OF 26

PRELIMINARY
NOT FOR CONSTRUCTION

Stantec

NOTE

1. The clearing limits shown have been adjusted for the temporary detour impacts. See Sheet 18 for Conceptual Temporary Detour Plan.

MAINE DEPARTMENT OF TRANSPORTATION

BRIDGE SCOUR ASSESSMENT

SUMMARY REPORT

Bridge Name: Weymouth	Town: Madrid	Bridge #: 2934
Feature Carried: Route 4	Stream: Sandy River	River Basin: Kennebec
Assessment By: D. Bryant		Assessment Date: 1/17/2010
Check By: D. Reynolds		Check Date: 1/29/10
MDOT PIN: 15631.10		TYLI Project No: 411588.10

NOTES

- Observations left and right are facing downstream -
- Elevations refer to bridge plan datum unless otherwise noted -
- The information shown in this report is obtained from available MDOT bridge plans and records, supplemented by field review -

1. SUMMARY AND CONCLUSIONS

The following factors have the most significant influence on the recommendations:

Positive Influence:
- Right abutment/streambed on ledge.
- Dam control 3 miles upstream.
- Bridge circa 1933 has probably withstood at least one >100 year flood event in 1987 and two > 50 year storms with no major recorded negative impacts in inspection reports.

Negative Influence:
- Poor flow alignment.
- Left abutment on spread footing and in channel. Minor abutment concrete cracks and road settlement.
- No available historic flood data.
- Compared to construction plans, up to 4' of scour at left abutment, thalweg shifted to left and is now near abutment. Approximately 1.5' exposure left abutment, downstream.
- MaineDOT inspection reports indicate ongoing scour issues with left abutment, high velocities.
- Scourable bed material. Some bank erosion and scour hole observed downstream.
- Thalweg at bottom of left abutment footings.
- Bridge opening slightly narrower than channel or floodplain width. Steep upstream banks.
- Debris noted in area – mostly downstream.
- Left abutment riprap in fair condition, inspection reports note some missing.
- High water on plans very close to low chord elevation.

Conclusions:
- Difficult access to abutments due to steep banks. Headroom adequate but water along left abutment is deep. Temporary stream diversion likely required during low flow.
- Grout mat or concrete cable mat likely effective countermeasure alternatives to riprap due to deep water.
- Hydraulic and scour evaluation recommended. Three pass/fail abbreviated POA criteria were not met. Full POA. recommended. Installation of countermeasures required to improve Item 113 rating.

2. RECOMMENDATIONS

a. Scour Vulnerability (Long term, Contraction, Abutment, Pier):

- Moderate potential for contraction scour. Low potential for right abutment scour, high potential for left abutment scour. Moderate potential for pressure flow. Footing exposure up to 1.5 feet, thalweg at bottom of left, spread footing. Poor flow alignment. Scouring noted in inspection reports. Scourable bed. Riprap in fair condition, but some is missing. Vertical wall abutments with exposed left footing in channel.

b. Recommended NBI Ratings:

Item 60 : 3 Item 61: 3 Item 71: 8 Item 113: 3

c. POA Recommended (X): Full __X__ Abbreviated _____

Scour Evaluation Report

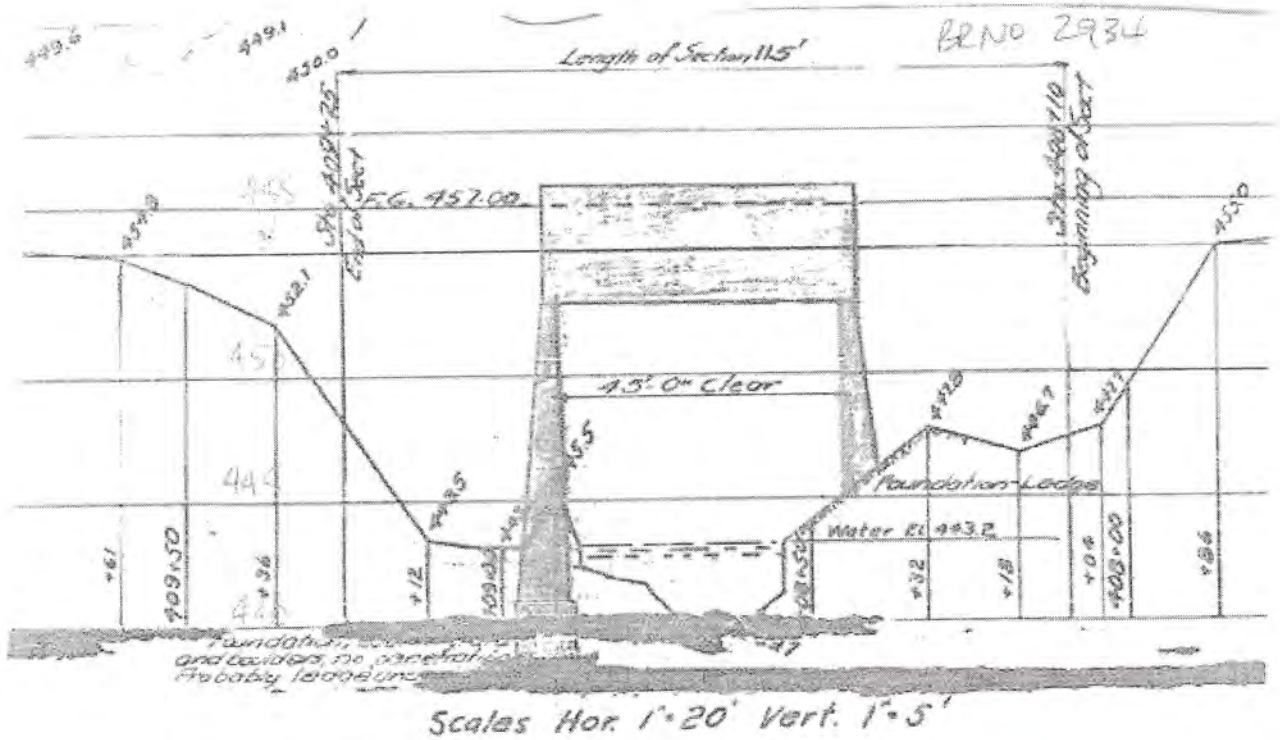
Division	TOWN	BRNAME	BRNO	Field Review/ Date:
7	Madrid	Weymouth	2934	10/2[illegible]/[illegible]8

ITEM113	FNDAT	Stream	PLANLOC	Year Built
3	32N	Sandy River		1933

FIELD/ OFFICE REVIEW NOTES

Riprap 1936 53, 57. Channel repairs 1968. Stone blanket 1983. Plan Notes: Foundation ledge. Stream rapid, falls.

PLANS



Contraction Scour

filled in variables

key computed variables

Vc = Ku * y^(1/6) * D ^(1/3) Critical Velocity in fps

Ku	6.19
D50 mm	1
D50 M	0.001
y	5.6
	8.6

S	0.002
	0.003

ave depth in us section

	V*/T<.5	V*/T>.5<2	V*/T>2
k1	0.59	0.64	0.69
V*=(gyS1)^.5	100	0.6005331	
	500	0.91146037	
T, fig 6.8	mps	0.12	
	fps	0.0375	
V*/T	100	16.0142159	
	500	24.3056098	

y	y ^.167	D	D^.333	Ku	VC
5.6	1.33336	0.001	0.100231	6.19	0.827252
8.6	1.43239	0.001	0.100231	6.19	0.888693

Live Bed Scour

y2/y1 = (Q2/Q1)^(6/7) * (W1/W2)^k1

		100	500
y1	ave depth in US channel	5.6	8.6
y2	ave depth in contracted section after scour	6.1	9.7
y0	existing depth in contracted section	7.4	8.4
Q1	flow in US channel section	3790.0	4950.0
Q2	flow in contracted channel section	4124.0	5604.0
W1	bottom width of US main channel transporting bed material	85.0	85.0
W2	bottom width of main channel in contracted section	83.0	83.0
Ys	scour depth	0.5	1.1

(Q2/Q1)^(6/7)		(W1/W2)^k1	
100	500	100	500
1.075077	1.112228	1.016565	1.016565