MUDDY RIVER LOGANDALE LEVEE
LETTER OF MAP REVISION (LOMR)

500-887

July 2018

GCW
ENGINEERS \ SURVEYORS

Prepared for:

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MUDDY RIVER LOGANDALE LEVEE
LETTER OF MAP REVISION (LOMR)

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Authored By:

Nelson Baggs, E.I.

Prepared by:

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500-887

July 12, 2018

LOMC Clearinghouse
3601 Eisenhower Ave., Suite 500
Alexandria, VA 22304-6426

Subject: LOMR for the Muddy River Logandale Levee

Attention: LOMC Manager

GCW, Inc. has been contracted by Clark County Public Works (CCPW) to complete a Letter of Map Revision (LOMR) based on the CLOMR case no. 13-09-2760R for the Logandale Levee along the Muddy River within Logandale, Clark County, Nevada. The levee project encompasses the reach of the Muddy River between the Wells Siding Diversion Structure and Waite Avenue tying into the existing ground, upstream and downstream of the river. The mapping from Wells Siding to Waite Avenue is approximately 3,400 feet long. The purpose of this LOMR is to correct the existing Community Panel to reflect the levee and other bank improvements that have been constructed.

The current FIRM panel indicates the subject reach of the Muddy River is located within Zones 'AE', 'AE' Floodway, and 'A' SFHAs. The affected Community Panel Map Number is 32003C1105F dated November 16, 2011. See Figure 1 for the project location. The Effective FIRM is shown on Figure 2.

The following information supporting this request for a LOMR is enclosed. This request is based on the proposed levee improvements consisting of reconstruction of a levee system that confines Muddy River flows from the Wells Siding to Waite Avenue. This request is also based on updated topography from after the construction.

- Figure 1 – Vicinity Map
- Figure 2 – Effective FIRM
- Figure 3 –HEC-RAS Model Work Map
- Figure 4 – Revised Annotated FIRM Map
- FEMA Forms
- Hydraulic Modeling Computations
- Site Photographs
- Geotechnical Certification Letter
- Operation and Maintenance Plan
- Topography
- Draft Newspaper Notification
- Project Record Drawings
- Certified Hydraulic Profile
- Project Specifications
- Reference Material
- Electronic Files on disk
    - Report PDF
    - GIS Files
    - CLOMR and CLOMR Approval Letter (CLOMR Case No. 13-09-2760R)

- HEC-RAS Models
- Topography Files

Hydrology

Hydrologic data was referenced from the *1995 Flood Insurance Study Restudy for the Muddy River* (Reference 6, hereinafter referred to as the *1995 FIS Restudy*). According to the *1995 FIS Restudy*, the Muddy River main wash effective flow rate is 21,400 cfs during the 100-year storm event. The reference information is included in the previous CLOMR in Section 5.0 Reference Material.

Aerial Topography and Survey Data

Topographic mapping with a contour interval of 1-foot was generated by AeroTech Mapping (flight date April 30, 2018). The North American Vertical Datum NAVD 1988 was used for the mapping.

Proposed Improvements

Note that all channel improvements, modeling and mapping in support of this LOMR are based on the NAVD88 Datum. See Figures 3 and 4 for the location of the proposed improvements included in the attached Section 1.0 Figures and Affected FIRM Panels.

A large portion of this map revision is based on construction of a levee, subject of NFIP Title 44, Chapter 1 Section 65.10. The following items are required for accreditation of a levee, per 44 CFR 65.10:

1. Freeboard
2. Closures
3. Embankment Protection
4. Embankment and Foundation Stability
5. Settlement
6. Interior Drainage
7. Other Design Criteria

The remainder of the improvements that result in a revision to the SFHA are considered riverine channelization improvements, such as grading and bank improvements within the Muddy River.

Hydraulic Modeling

The hydraulic analyses for the project were performed to determine the limits, height, and stability of the proposed improvements, including a levee system. As indicated in the hydrologic analysis, the 100-year design flow rate is 21,400 cfs.

The *1995 FIS Restudy* served as the basis for the effective hydraulic analysis for this project, and that study's modeling used 4-foot topographic contours and HEC-2 software. The existing conditions analysis from the previous CLOMR included two HEC-RAS models: (1) conversion of the FEMA Effective HEC-2 model (Effective Model) to a HEC-RAS model (Duplicate Effective Model), and (2) re-analyzing and extending the Duplicate Effective Model using field surveyed cross section data performed in January 2011 for the project site (Corrected Effective Model). Note that the boundary conditions for the Corrected Effective model were updated to be normal depth for this LOMR because it was found that the known water surface elevation at the downstream end was artificially raising the WSE. An updated Corrective Effective model has been included. The areas outside the limits of the survey data for these models were reflected by 2-foot contours that were flown and generated in November 2009. Refer to the CLOMR for more detailed discussion of the Duplicate Effective and Corrected Effective models. The post project model included with this LOMR used 1-foot topography taken after the construction of the levee to develop the cross sections for the HEC-RAS model.

The output from the Post Project HEC-RAS model is included in Section 3.0 Engineering Analysis. The Duplicate Effective model and Corrected Effective models can be found in Section 3.0 of the CLOMR.

Summary of Post-Project Model Results

New 1-ft topography was obtained after completion of the proposed improvements. New cross sections based off of this topography were used in the Post Project Model to reflect the proposed condition and better define the water surface profile. Cross sections from the Corrected Effective model that were close to the new sections were chosen for comparison purposes. The results from this model show a decrease of WSE (compared to Corrected Effective Model Results) in the range of 0.1 to 3.0 ft. Table 3, shown below, compares the WSE from the Post Project Model and Corrected Effective Model. The hydraulic models for the Post Project and Corrected Effective model are included in Section 3.0 Engineering Analysis.

TABLE 1 Results Comparison Summary (Corrective Effective vs Post Project)					
Q	**Corrected Effective Model**		**Post Project Model**		**Difference**
(cfs)	**Station**	**WSE (ft)**	**Station**	**WSE (ft)**	**Post - Corr (ft)**
21400	91.4	1428.7	3262.40	1426.8	-1.9
21400	91	1428.3	3123.51	1426.1	-2.2
21400	90.5	1428.2	-	-	NA
21400	90	1425.6	2824.16	1423.3	-2.3
21400	89.5	1424.1	-	-	NA
21400	89	1423.3	2355.69	1421.1	-2.2
21400	88.5	-	2191.11	1417.3	NA
21400	88.4	-	2135.97	1416.6	NA
21400	88	1415.7	-	-	NA
21400	87.4	1411.7	-	-	NA
21400	87	1411	1434.90	1408.2	-2.8
21400	86.5	-	1201.84	1406.4	NA
21400	86.4	1408	1112.97	1405.0	-3.0
21400	86	1402.6	-	-	NA
21400	85.4	1400.3	710.16	1399.1	-1.2
21400	85	1397.2	411.54	1397.0	-0.2
21400	84	1494.8	21.97	1494.7	-0.1

Manning's "n" Values and Losses

Manning's "n" roughness values, expansion, and contraction coefficients for the Muddy River cross sections and transitions have been utilized in the model according to and consistent with the 1995 Muddy River FIS Restudy and the *HEC-RAS River Analysis System Hydraulic Reference Manual* (Reference 5, hereinafter referred to as the HEC-RAS Manual) and the approved CLOMR. The HEC-RAS Manual is included in Section 5.0 Reference Material of the CLOMR showing coefficients for gradual transitions. Contraction and expansion coefficients at all of the cross sections assume values of 0.1 and 0.3, respectively, for gradual transitions under subcritical flow conditions. Below is a table of the Manning's values used in the hydraulic modeling.

TABLE 2 Summary of Manning's 'n' Roughness Coefficients		
Cover Location	**Description**	**Manning's 'n' Value**
Channel	Medium Vegetation w/ Moderate Irregularity/ Obstructions	0.080
Overbank	Medium Vegetation w/ Minor Irregularity/ Obstructions	0.050
Channel	Light Vegetation w/ Minor Irregularity/ Obstructions	0.040
Overbank	Riprap D50 = 12"	0.040
Overbank	Earthen	0.025
Overbank	Concrete	0.016

Boundary Condition and Floodplain Tie-in Locations

Downstream: The floodplain tie-in location is approximately 3,200 feet downstream of the Wells Siding Diversion Structure. This is at Cross Section 21.97 (84 in the duplicate effective and corrective effective models). As shown in the analyses the WSEs at the downstream tie-in location are 0.1-ft different between the Corrective Effective and Post Project models. As mentioned previously, the boundary conditions were updated to be normal depth for this LOMR because it was found that the known water surface elevation at the downstream end was artificially raising the WSE.

Upstream: The floodplain tie-in location is at the downstream end of the existing Wells Siding Diversion Structure. This is near Cross Section 3262.4 (91.4 in the corrective effective model). Since the analysis that generated the effective Zone A floodplain is not available, this location was selected because it is at the upstream end of the proposed "levee condition" improvements, downstream of the Wells Siding Diversion Structure, and allows a reasonable graphically tie-in to the approximate Zone A delineation generally following contours. The Corrected Effective Model results indicate that the flow regime is subcritical. The 100-year water surface elevation is 1428.68.

The Post Project Model results indicate that the flow regime is still subcritical. The 100-year water surface elevation is 1.9 feet lower at 1426.78 due to the downstream improvements.

Levee Criteria

The project is defined as a levee to contain the SFHA between "LL" Stations 15+00 and 28+50 as shown in the certified hydraulic profile included in Section 4 of this study. Below is a summary of the 7 design criteria per NFIP regulations to accredit a levee.

Freeboard:
A levee must provide a minimum of 3-feet of freeboard throughout, 3.5-feet of freeboard at the upstream end, and 4-feet of freeboard upstream of all structures and constrictions. Based off of the Post Project model all of these requirements are met. Refer to the HEC-RAS Summary Table on Figure 3 for a summary of the results and the freeboard provided at each section. Refer to the hydraulic profile in the appendix for further validation of freeboard.

Closures:
A flap gate closure device has been provided at station 27+30 where there is an 18" pipe penetrating the levee. The flap gate functions as a closure device by remaining close when there is pressure from water against the plate covering the pipe opening. A copy of the specifications for the device are included in the reference information of the CLOMR.

Embankment Protection:
The embankment of the levee is reinforced concrete with a cutoff wall. The maximum velocity in the HEC-RAS model is less than 18 ft/s which is less than the 35 ft/s maximum threshold for concrete, therefore no erosion of the embankment is expected to occur. Table 703 from the local Clark County Regional Flood Control District (CCRFCD) Hydraulic Design Manual showing the velocity threshold for concrete has been included in the appendix. The velocities are approximately equal to the velocities used for scour calculations in the *Pre-Final Technical Support Data Notebook for Muddy River Logandale Levee - Wells Siding Diversion Structure to Waite Avenue Flood Control Facility*, therefore the levee cutoff walls are considered adequate for scour protection. The hydraulic calculations for scour from the above referenced study have been included in the appendix.

Embankment and Foundation Stability:
The levee mass was built per the plans and specifications. A certification letter from the geotechnical engineer stating the levee was constructed meeting the design intent and requirements set forth in the plans and specifications has been included. Plans and specifications are included in Section 4 of this study.

Settlement:
The existing levee has been in place for approximately 100 years. The proposed levee height is approximately the same as the existing; therefore, load related settlement within the clay foundation soils is expected to already have occurred. Any rebound settlement resulting from levee removal and replacement is expected to be elastic and completed during construction. This was previously discussed and accepted in the approved CLOMR.

Interior Drainage:
No interior drainage is expected to occur with this project.

Other Design Criteria:
Operation plans and criteria:
The levee will be operated and maintained according to the Clark County Regional Flood Control District Operations and Maintenance Manual included in Section 4.0 of this LOMR.

Certification Requirements:
No significant design changes to levee criteria were completed during construction and the levee was built in substantial conformance with the criteria set forth in the CLOMR.

Mapping

The 100-year floodplain, floodway, and base flood elevations (BFE) are based on HEC-RAS modeling for subcritical flow. The floodplain and BFE were delineated on topographic maps based on the improvements. The top widths calculated in the HEC-RAS model will be contained within the proposed levee from Wells Siding to Waite Avenue. The area protected by the proposed levee on the landside that was previously delineated as Zone A due to a breakout at the upstream end of the improvements will be revised to Shaded Zone X. Excerpt from the 1995 FIS showing that 21,400 cfs is contained in the Muddy River without breakout downstream of the levee is included in Section 4; therefore, validating the removal of the Zone 'A' landside SFHA by this LOMR. Note that sections of Zone A past the proposed improvements adjacent to the floodway not due to the former levee breakout remain the same as in the effective FIRM. The Proposed FIRM revisions are shown on Figure 4.

If you have any questions or require additional information, please do not hesitate to call us at (702) 804-2000.

Cordially,

GCW, INC.

Steve Jones, P.E.
Vice President
Flood Control Division Manager

Nelson Baggs, E.I.
Engineering Intern
Flood Control Division

Encl.
cc: John Catanese, CCPW
Joe Yatson, CCPW
Abigail Mayrena, CCRFCD

REFERENCES

1. Federal Emergency Management Agency. *Guidelines and Specifications for Flood Hazard Mapping Partners.* April 2003.
2. U.S. Army Corps of Engineers, *HEC-RAS River Analysis System*. September 2016 Version 5.0.3.
3. Clark County Regional Flood Control District (CCRFCD) *Hydrologic Criteria and Drainage Design Manual.* August 1999.
4. FEMA, Department of Homeland Security, *Code of Federal Regulations - Emergency Management and Assistance*. Accessed: October 13, 2011.
5. U.S. Army Corps of Engineers, *HEC-RAS River Analysis System Hydraulic Reference Manual*. January 2016 Version 5.0.
6. G.C. Wallace, *Flood Insurance Study Restudy Muddy River, Clark County, Nevada*. July 1995.
7. G.C. Wallace, *Flood Hazard Mapping Study Muddy River Levee*. March 2010.
8. FEMA, *Flood Insurance Study Clark County, Nevada and Incorporated Areas*, November 2011.
9. Kleinfelder, *Geotechnical Evaluation Report Muddy River Logandale Levee*. June 2013.
10. G.C. Wallace, *Prefinal Technical Support Data Notebook for Muddy River Logandale Levee Wells Siding Diversion Structure to Waite Avenue Flood Control Facility*. August 2013.

SUPPORTING DOCUMENTATION FOR LOMR

1. **FIGURES AND AFFECTED FIRM PANELS**
    - Figure 1 - Vicinity Map
    - Figure 2 – Effective FIRM
    - Figure 3 – HEC-RAS Work Map
    - Figure 4 – Revised Annotated FIRM

2. **FEMA FORMS**
    - MT-2 Form 1: Overview & Concurrence Form
    - MT-2 Form 2: Riverine Hydrology & Hydraulics Form with Attachment
    - MT-2 Form 3: Riverine Structures Form with Attachment
    - Payment Information Form

3. **ENGINEERING ANALYSIS**
    - HEC-RAS Model: Post Project Model (HEC-RAS Report on CD)
    - HEC-RAS Model: Corrected Effective Model (HEC-RAS Report on CD)
    - HEC-RAS Model: Post Project Mixed Flow Regime (HEC-RAS Report on CD)
    - HEC-RAS Model: Post Project Mixed Flow Regime Critical Depth (HEC-RAS Report on CD)

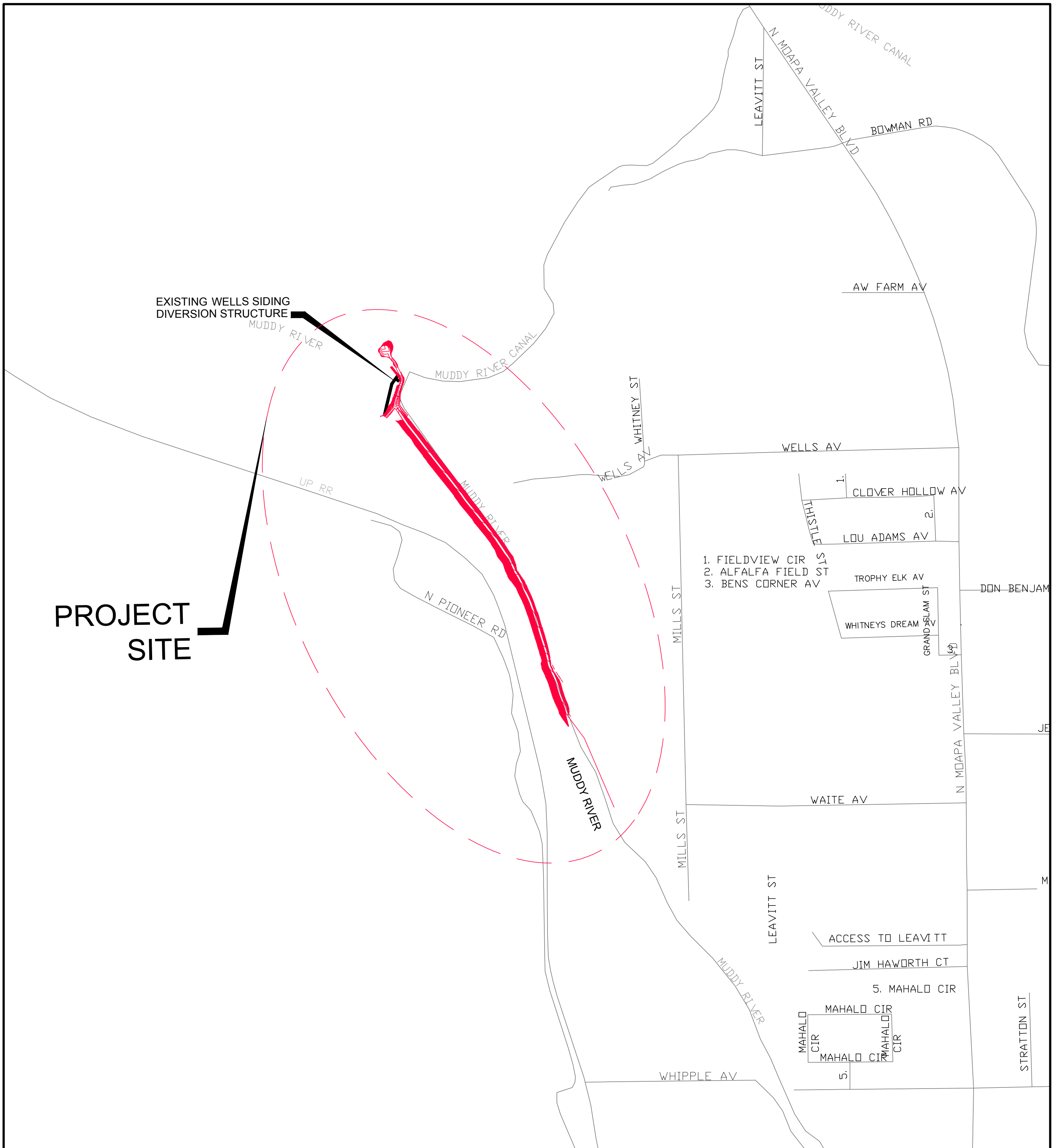
4. **SUPPORTING INFORMATION**
    - Site Investigation Photographs
    - Operation and Maintenance Plan (on CD)
    - Topography (on CD)
    - Geotechnical Certification Letter
    - Newspaper Notification
    - Record Drawings
    - Certified Hydraulic Profile
    - Project Specifications (on CD)

5. **REFERENCE MATERIALS**
    - Flood Zone Figure from the *Flood Insurance Study,* 1995
    - CCRFCD Manual Table 703 – Maximum Permissible Velocities
    - Geotechnical Evaluation Report Muddy River Logandale Levee Excerpt
    - Prefinal Technical Support Data Notebook Scour Hydraulic Calculations

6. **ADDITIONAL ELECTRONIC FILES (ON CD)**
    - Report PDF
    - GIS Shape Files
    - CLOMR
    - HEC-RAS Models
    - Topography

1. FIGURES AND AFFECTED FIRM PANELS

Figure 1 - Vicinity Map
Figure 2 – Effective FIRM
Figure 3 – HEC-RAS Work Map
Figure 4 – Revised Annotated FIRM



GRAPHIC SCALE

1000 0 500 1000

(IN FEET)

1 inch = 1000 ft.

NORTH

CLARK COUNTY DEPARTMENT OF PUBLIC WORKS

MUDDY RIVER LOGANDALE LEVEE

FIGURE 1

VICINITY MAP

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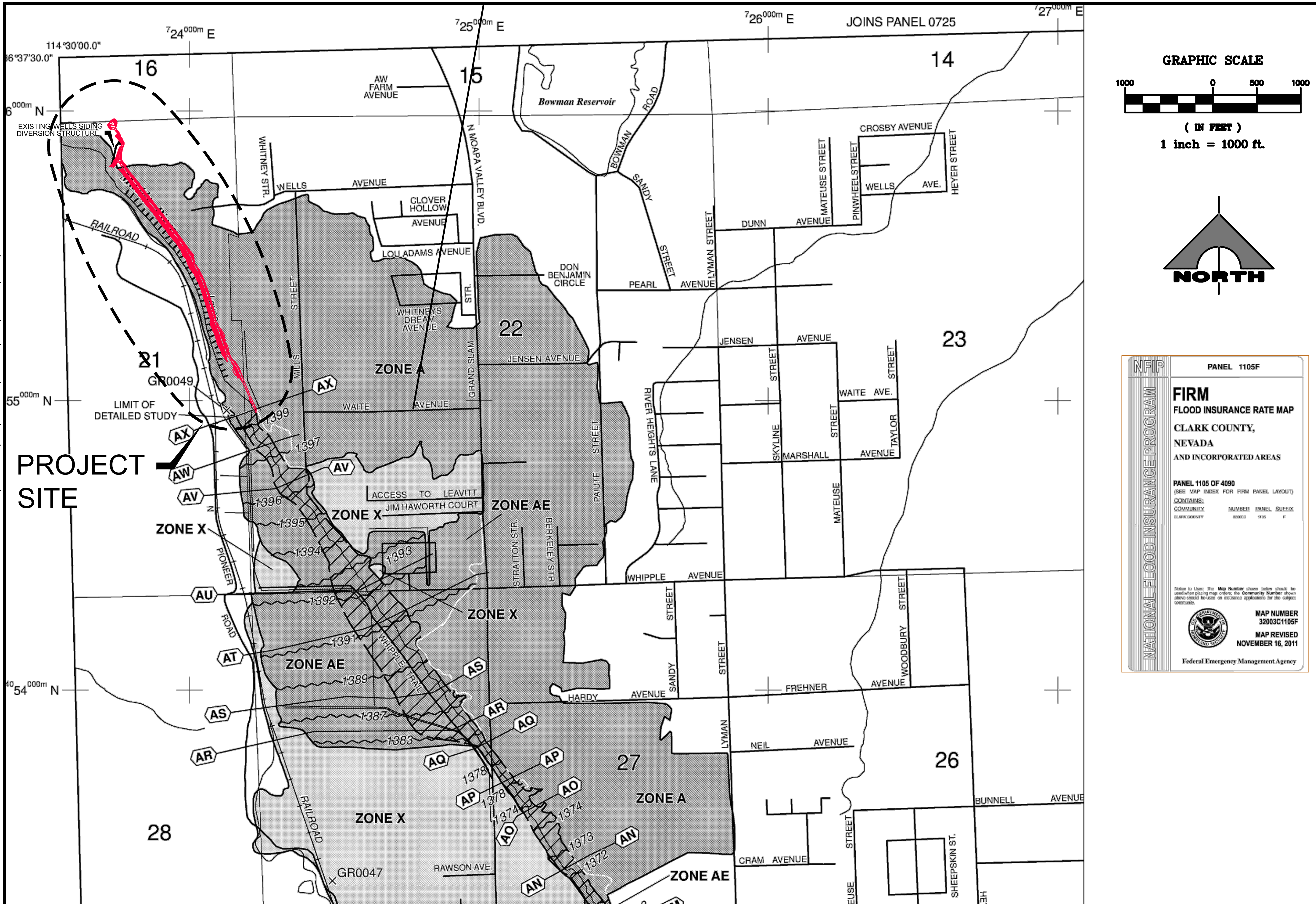

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MUDDY RIVER LONGANDALE LEVEE

FIGURE 2
EFFECTIVE FIRM

SHEET
FIG 2
1 OF 1 SHTS

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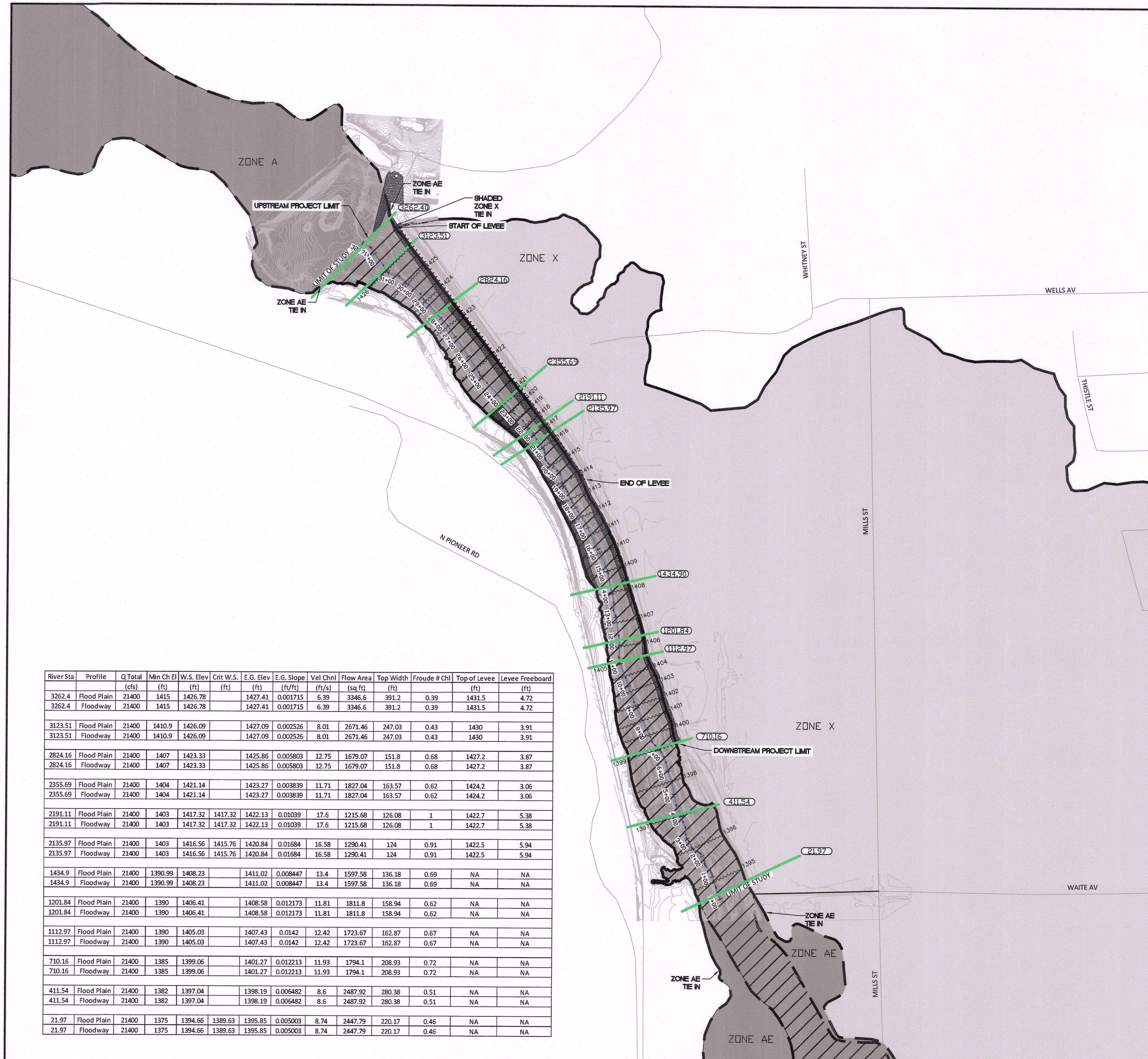
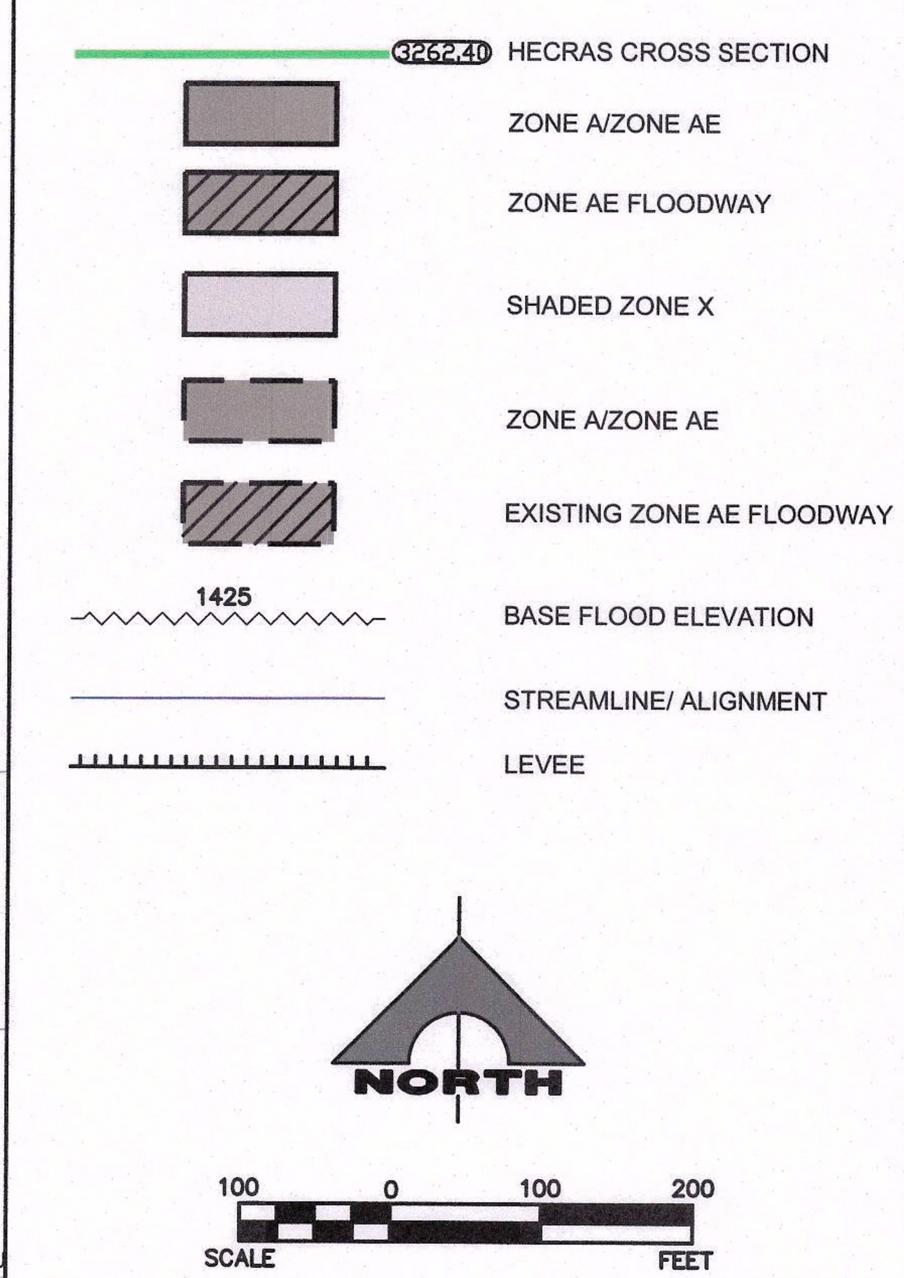
NELSON BAGGS



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	Top of Levee	Levee Freeboard
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	(ft)
3262.4	Flood Plain	21400	1415	1426.78		1427.41	0.001715	6.39	3346.6	391.2	0.39	1431.5	4.72
3262.4	Floodway	21400	1415	1426.78		1427.41	0.001715	6.39	3346.6	391.2	0.39	1431.5	4.72
3123.51	Flood Plain	21400	1410.9	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43	1430	3.91
3123.51	Floodway	21400	1410.9	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43	1430	3.91
2824.16	Flood Plain	21400	1407	1423.33		1425.86	0.005803	12.75	1679.07	151.8	0.68	1427.2	3.87
2824.16	Floodway	21400	1407	1423.33		1425.86	0.005803	12.75	1679.07	151.8	0.68	1427.2	3.87
2355.69	Flood Plain	21400	1404	1421.14		1423.27	0.003839	11.71	1827.04	163.57	0.62	1424.2	3.06
2355.69	Floodway	21400	1404	1421.14		1423.27	0.003839	11.71	1827.04	163.57	0.62	1424.2	3.06
2191.11	Flood Plain	21400	1403	1417.32	1417.32	1422.13	0.01039	17.6	1215.68	126.08	1	1422.7	5.38
2191.11	Floodway	21400	1403	1417.32	1417.32	1422.13	0.01039	17.6	1215.68	126.08	1	1422.7	5.38
2135.97	Flood Plain	21400	1403	1416.56	1415.76	1420.84	0.01684	16.58	1290.41	124	0.91	1422.5	5.94
2135.97	Floodway	21400	1403	1416.56	1415.76	1420.84	0.01684	16.58	1290.41	124	0.91	1422.5	5.94
1434.9	Flood Plain	21400	1390.99	1408.23		1411.02	0.008447	13.4	1597.58	136.18	0.69	NA	NA
1434.9	Floodway	21400	1390.99	1408.23		1411.02	0.008447	13.4	1597.58	136.18	0.69	NA	NA
1201.84	Flood Plain	21400	1390	1406.41		1408.58	0.012173	11.81	1811.8	158.94	0.62	NA	NA
1201.84	Floodway	21400	1390	1406.41		1408.58	0.012173	11.81	1811.8	158.94	0.62	NA	NA
1112.97	Flood Plain	21400	1390	1405.03		1407.43	0.0142	12.42	1723.67	162.87	0.67	NA	NA
1112.97	Floodway	21400	1390	1405.03		1407.43	0.0142	12.42	1723.67	162.87	0.67	NA	NA
710.16	Flood Plain	21400	1385	1399.06		1401.27	0.012213	11.93	1794.1	208.93	0.72	NA	NA
710.16	Floodway	21400	1385	1399.06		1401.27	0.012213	11.93	1794.1	208.93	0.72	NA	NA
411.54	Flood Plain	21400	1382	1397.04		1398.19	0.006482	8.6	2487.92	280.38	0.51	NA	NA
411.54	Floodway	21400	1382	1397.04		1398.19	0.006482	8.6	2487.92	280.38	0.51	NA	NA
21.97	Flood Plain	21400	1375	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46	NA	NA
21.97	Floodway	21400	1375	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46	NA	NA

LEGEND



PROFESSIONAL ENGINEER STATE OF NEVADA STEPHEN M. JONES EXP. 6-30-19 CIVIL No. 19638

DATE: 7/18/2018

CLARK COUNTY, NV
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MUDDY RIVER LOGANDALE LEVEE

LOMR
HEC-RAS WORK MAP

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PROJECT NO. 500-887

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Nelson Boggs

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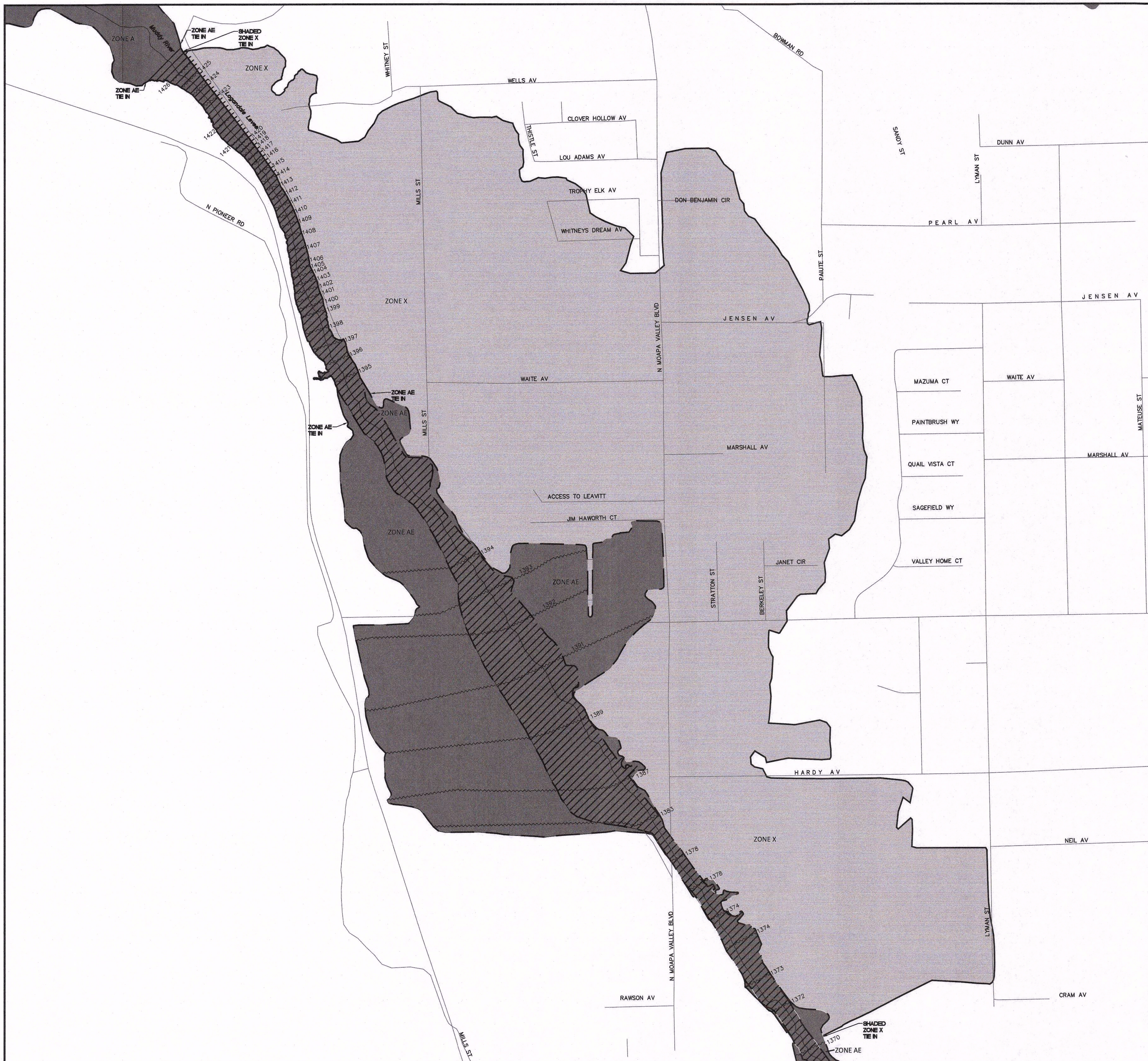
DRAWING
FIG3
1 OF 1 SHTS



LEGEND

- ZONE A/ZONE AE
- ZONE AE FLOODWAY
- SHADED ZONE X
- EXISTING ZONE A/ZONE AE
- EXISTING ZONE AE FLOODWAY
- LEVEE

NORTH

SCALE 400 0 400 800 FEET

NOTES

FLOODING SOURCE MUDDY RIVER
CLARK COUNTY, NEVADA

FIRM PANEL AFFECTED: 320003 1105F

DATUM: NAVD 88

PROFESSIONAL ENGINEER STATE OF NEVADA
STEPHEN M. JONES
EXP. 6-30-19
CIVIL
No. 19638

DATE: 7/18/2018

REV	DATE	DESCRIPTION	DATE	AGEN APP	DATE	GCW APP	DATE

PROJECT NO. 500-887

DESIGN:
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PLOT TIME: 10:36:43

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Nelson Biggs

CLARK COUNTY, NV
DEPARTMENT OF PUBLIC WORKS

MUDDY RIVER LOGANDALE LEVEE

LOMR

REVISED ANNOTATED FIRM

DRAWING
FIG4
1 OF 1 SHTS

2. FEMA FORMS

MT-2 Form 1: Overview & Concurrence Form
MT-2 Form 2: Riverine Hydrology & Hydraulics Form with Attachment
MT-2 Form 3: Riverine Structures Form with Attachment
Payment Information Form

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a (NFIP) Flood Insurance Rate Maps (FIRM).

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
320003	Clark County	NV	32003C	1105F	11/16/11

2. a. Flooding Source: Muddy River

   b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Muddy River Logandale Levee

4. FEMA zone designations affected: A,AE,X (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

   a. The basis for this revision request is (check all that apply)

   ☒ Physical Change ☒ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes

   ☐ Coastal Analysis ☒ Hydraulic Analysis ☐ Hydrologic Analysis ☐ Corrections

   ☐ Weir-Dam Changes ☒ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes

   ☒ New Topographic Data ☐ Other (Attach Description)

   Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures: ☒ Channelization ☒ Levee/Floodwall ☐ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other (Attach Description)

6. ☒ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☒ Yes Fee amount: $8,000.00

☐ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: John Catanese	Company: Clark County Public Works Department	
Mailing Address: 500 S. Grand Central Pkwy Las Vegas, NV 89106	Daytime Telephone No.: 702-455-6616	Fax No.:
	E-Mail Address: Catanese@ClarkCountyNV.gov	
Signature of Requester (required):	Date:	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirements for when fill is placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: John Catanese, Associate Engineer	Community Name: Clark County	
Mailing Address: 500 S. Grand Central Pkwy Las Vegas, NV 89106	Daytime Telephone No.: 702-455-6616	Fax No.:
	E-Mail Address: Catanese@ClarkCountyNV.gov	
Community Official's Signature (required):	Date:	

<u>CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR</u>

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Stephen Jones, PE	License No.: 19638	Expiration Date: 06/30/19
Company Name: GCW, Inc.	Telephone No.: (702) 804-2130	Fax No.: (702) 804-2299
Signature:	Date:	E-Mail Address: SJones@gcwengineering.com

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	**Required if ...**
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

PROFESSIONAL ENGINEER-STATE OF NEVADA
STEPHEN M. JONES
EXP. 6-30-19
CIVIL
No. 19638

Seal (Optional)

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Muddy River

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

   ☒ Not revised (skip to section B) ☐ No existing analysis ☐ Improved data
   ☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

   ☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model → Specify Model: ______
   ☐ Regional Regression Equations ☐ Other (please attach description)

   Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

   If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

   Is the hydrology for the revised flooding source(s) affected by sediment transport? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit*	200' Downstream of Waite Ave.	21.97	1394.8	1394.7
Upstream Limit*	1,020' Upstream of Wells Ave.	3262.4	1428.7	1426.8

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: HEC-RAS

3. Pre-Submittal Review of Hydraulic Models*

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4.

Models Submitted	**Natural Run**		**Floodway Run**		**Datum**
Duplicate Effective Model*	File Name: MRLEVEEUP.PRJ	Plan Name: MRLEVEEDUP.G01	File Name: NA	Plan Name: NA	NAVD88
Corrected Effective Model*	File Name: MRLEVEECOR.PRJ	Plan Name: Corrected Effective	File Name: NA	Plan Name: NA	NAVD88
Existing or Pre-Project Conditions Model	File Name: NA	Plan Name: NA	File Name: NA	Plan Name: NA	NA
Revised or Post-Project Conditions Model	File Name: LOMR.PRJ	Plan Name: Plan 02	File Name: NA	Plan Name: NA	NAVD88
Other - (attach description)	File Name:	Plan Name:	File Name:	Plan Name:	

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: Topography

Source: AeroTech Mapping Date: April 30, 2018

Accuracy: +/- 6"

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:

   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.

   b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? ☐ Yes ☒ No

   If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☒ Yes ☐ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☒ Yes ☐ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

MT-2 FORM 2 ATTACHMENT

B. #1- Upstream tie-in is greater than 0.5-feet. This is acceptable because the revised water surface elevation is lower than the effective and the flow is contained in the channel. The Landside SFHA was removed because of levee containment in Muddy River. No new analysis is needed because HEC-RAS shows flood containment by the levee. The Landside SFHAs were revised between Wells Avenue and Cram Avenue.

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

O.M.B. NO. 1660-0016
Expires February 28, 2014

RIVERINE STRUCTURES FORM

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20598-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

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DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Muddy River

Note**:** Fill out one form for each flooding source studied.

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:
Channelization..............complete Section B
Bridge/Culvert...............complete Section C
Dam.............................complete Section D
Levee/Floodwall............complete Section E
Sediment Transport........complete Section F (if required)

Description Of Modeled Structure

1. Name of Structure: Logandale Levee

   Type (check one): ☐ Channelization ☐ Bridge/Culvert ☒ Levee/Floodwall ☐ Dam

   Location of Structure: 1,020' Upstream of Wells Ave.

   Downstream Limit/Cross Section: 260' Downstream of Section 2135.97

   Upstream Limit/Cross Section: 3262.4

2. Name of Structure: Bank Improvements

   Type (check one): ☒ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: 590' Downstream of Wells Ave.

   Downstream Limit/Cross Section: 710.16

   Upstream Limit/Cross Section: 260' Downstream of Section 2135.97

3. Name of Structure: _____

   Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: _____

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

NOTE: FOR MORE STRUCTURES, ATTACH ADDITIONAL PAGES AS NEEDED.

B. CHANNELIZATION

Flooding Source: Muddy River

Name of Structure: Logandale Levee

1. Hydraulic Considerations

   The channel was designed to carry 21400 (cfs) and/or the 100-year flood.
   The design elevation in the channel is based on (check one):

   ☒ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

   If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

   ☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions

   ☐ Other locations (specify): _____

2. Channel Design Plans

   Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Accessory Structures

   The channelization includes (check one):

   ☒ Levees [Attach Section E (Levee/Floodwall)] ☐ Drop structures ☐ Superelevated sections

   ☐ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator

   ☐ Weir ☐ Other (Describe):

4. Sediment Transport Considerations

   Are the hydraulics of the channel affected by sediment transport? ☐ Yes ☒ No

   If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: _____

Name of Structure: _____

1. This revision reflects (check one):

   ☐ Bridge/culvert not modeled in the FIS

   ☐ Modified bridge/culvert previously modeled in the FIS

   ☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): _____
   If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

   ☐ Dimensions (height, width, span, radius, length)

   ☐ Shape (culverts only)

   ☐ Material

   ☐ Beveling or Rounding

   ☐ Wing Wall Angle

   ☐ Skew Angle

   ☐ Distances Between Cross Sections

   ☐ Erosion Protection

   ☐ Low Chord Elevations – Upstream and Downstream

   ☐ Top of Road Elevations – Upstream and Downstream

   ☐ Structure Invert Elevations – Upstream and Downstream

   ☐ Stream Invert Elevations – Upstream and Downstream

   ☐ Cross-Section Locations

4. Sediment Transport Considerations

   Are the hydraulics of the structure affected by sediment transport? ☐ Yes ☐ No

   If Yes, then fill out Section F (Sediment Transport) of Form 3. If no, then attach an explanation.

B. CHANNELIZATION

Flooding Source: Muddy River

Name of Structure: Bank Improvements

1. Hydraulic Considerations

The channel was designed to carry 21400 (cfs) and/or the 100-year flood.
The design elevation in the channel is based on (check one):

☒ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions

☐ Other locations (specify): _____

2. Channel Design Plans

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Accessory Structures

The channelization includes (check one):

☐ Levees [Attach Section E (Levee/Floodwall)] ☐ Drop structures ☐ Superelevated sections

☐ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator

☐ Weir ☐ Other (Describe):

4. Sediment Transport Considerations

Are the hydraulics of the channel affected by sediment transport? ☐ Yes ☒ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: _____

Name of Structure: _____

1. This revision reflects (check one):

☐ Bridge/culvert not modeled in the FIS

☐ Modified bridge/culvert previously modeled in the FIS

☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): _____
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

☐ Dimensions (height, width, span, radius, length)

☐ Shape (culverts only)

☐ Material

☐ Beveling or Rounding

☐ Wing Wall Angle

☐ Skew Angle

☐ Distances Between Cross Sections

☐ Erosion Protection

☐ Low Chord Elevations – Upstream and Downstream

☐ Top of Road Elevations – Upstream and Downstream

☐ Structure Invert Elevations – Upstream and Downstream

☐ Stream Invert Elevations – Upstream and Downstream

☐ Cross-Section Locations

4. Sediment Transport Considerations

Are the hydraulics of the structure affected by sediment transport? ☐ Yes ☐ No

If Yes, then fill out Section F (Sediment Transport) of Form 3. If no, then attach an explanation.

D. DAM/BASIN

Flooding Source: _____
Name of Structure: _____

1. This request is for (check one): ☐ Existing dam/basin ☐ New dam/basin ☐ Modification of existing dam/basin

2. The dam/basin was designed by (check one): ☐ Federal agency ☐ State agency ☐ Private organization ☐ Local government agency

   Name of the agency or organization: _____

3. The Dam was permitted as (check one): ☐ Federal Dam ☐ State Dam

   Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

   Permit or ID number __________________ Permitting Agency or Organization ______________________________

   a. ☐ Local Government Dam ☐ Private Dam

   Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm? (must account for the maximum volume of runoff)

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why debris/sediment analysis was not considered?

6. Does the Base Flood Elevation behind the dam/basin or downstream of the dam/basin change? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

	Stillwater Elevation Behind the Dam/Basin	
FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)	_____	_____
50-year (2%)	_____	_____
100-year (1%)	_____	_____
500-year (0.2%)	_____	_____
Normal Pool Elevation	_____	_____

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

☒ upgrading of an existing levee/floodwall system ☐ a newly constructed levee/floodwall system ☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☒ earthen embankment, dike, berm, etc. Station 15+00 to 28+50
☐ structural floodwall Station _____ to _____
☐ Other (describe): Station _____ to _____

c. Structural Type (check one): ☐ monolithic cast-in place reinforced concrete ☐ reinforced concrete masonry block ☐ sheet piling
☒ Other (describe): Earthen Mass

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☒ No

If Yes, by which agency? _____

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers: C1-C4
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers: C6-C9
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers: C7,S1
4. A layout detail for the embankment protection measures. Sheet Numbers: C1-C4
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, Floodwall structure, closure structures, and pump stations. Sheet Numbers: C11-C13,S2

2. Freeboard

a. The minimum freeboard provided above the BFE is:

3.06 ft

Riverine

3.0 feet or more at the downstream end and throughout ☒ Yes ☐ No

3.5 feet or more at the upstream end ☒ Yes ☐ No

4.0 feet within 100 feet upstream of all structures and/or constrictions ☒ Yes ☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater). ☐ Yes ☐ No

2.0 feet above the 1%-annual-chance stillwater surge elevation ☐ Yes ☐ No

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☒ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☒ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device
27+30	Left	18" IRR	1406.1	Flap Gate

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope land side is: 2:1

b. The maximum levee slope flood side is: 1.5:1

c. The range of velocities along the levee during the base flood is: 6 (min.) to 18 (max.)

d. Embankment material is protected by (describe what kind): Reinforced Concrete Lining

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☒ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

NA

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:
See section 5.3.2 and Table 5-3 in Section 5.2 of the geotechnical report.

☒ Overall height: Sta.: 18+00, height 10.1 ft.

☒ Limiting foundation soil strength:

Strength ϕ = 30 degrees, c = 100 psf

Slope: SS = 2 (h) to 1 (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):
Spencer's Method

c. Summary of stability analysis results: Stabiliy analysis described in Section 5.3 with results presented in 5.3.4

E. LEVEE/FLOODWALL (CONTINUED)

5. Embankment And Foundation Stability (continued)

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction	Sta 18+00=1.6 Sta23+00=1.5	1.3
II	Sudden drawdown	Sta18+00=1.2 Sta 23+00=1.1	1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage	Sta18+00=2.0 Sta23+00=1.9	1.4
VI	Earthquake (Case I)	Sta18+00=1.3 Sta23+00=1.2	1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☒ Yes ☐ No

If Yes, describe methodology used: Finit Element Modeling. Steady State w/ 100 WSE. See Section 5.3 (CLOMR).

e. Was a seepage analysis for the foundation performed? ☒ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☒ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☒ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is 20 hours.

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one): ☐ UBC (1988) ☐ Other (specify): _____

b. Stability analysis submitted provides for: ☐ Overturning ☐ Sliding If not, explain: _____

c. Loading included in the analyses were: ☐ Lateral earth @ P_A = _____ psf; P_p = _____ psf

☐ Surcharge-Slope @ _____, ☐ surface _____ psf

☐ Wind @ P_w = _____ psf

☐ Seepage (Uplift); _____ ☐ Earthquake @ P_{eq} = _____ %g

☐ 1%-annual-chance significant wave height: _____ ft.

☐ 1%-annual-chance significant wave period: _____ sec.

d. Summary of Stability Analysis Results: Factors of Safety.
Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)
Note: (Extend table on an added sheet as needed and reference)

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability (continued)

   e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☒ Yes ☐ No

b. The computed range of settlement is N/A ft. to _____ ft.

c. Settlement of the levee crest is determined to be primarily from : ☐ Foundation consolidation ☐ Embankment compression ☒ Other (Describe): See attach

d. Differential settlement of floodwalls ☐ has ☒ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: _____ acres
Draining to ponding area: _____ acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: _____ cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

e. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is _____ cfs

h. The length of levee system used to drive this seepage rate in item g: _____ ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☒ No

If Yes, include the number of pumping plants: _____ For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☒ is not a problem
Hydrocompaction ☐ is ☒ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☒ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:
N/A

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☒ No Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☒ No
If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why sediment transport was not considered.

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☒ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☒ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☒ Yes ☐ No If the answer is No to any of the above, please attach supporting documentation.

E. LEVEE/FLOODWALL (CONTINUED)

11. Maintenance Plan

Please attach a copy of the fomal maintenance plan for the levee/floodwall

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

CERTIFICATION OF THE LEVEE DOCUMENTION

This certification is to be signed and sealed by a licensed registered professional engineer authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.10(e) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Stephen Jones, PE License No.: 19638 Expiration Date: 06/30/19

Company Name: GCW, Inc. Telephone No.: (702) 804-2130 Fax No.: (702) 804-2299

Signature: _____ Date: _____ E-Mail Address: SJones@gcwengineering.com

F. SEDIMENT TRANSPORT

Flooding Source: _____

Name of Structure: _____

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume _____ acre-feet

Debris load associated with the base flood discharge: Volume _____ acre-feet

Sediment transport rate _____ (percent concentration by volume)

Method used to estimate sediment transport: _____

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition: _____

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport: _____

Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

MT-2 FORM 3 ATTACHMENT

B. #1- Logandale Levee: A mixed flow regime HEC-RAS model was computed with the upstream boundary condition kept the same as the subcritical flow regime model and with the upstream boundary condition at critical depth to verify if a hydraulic jump is possible at the inlet to the channel. The results of the model indicate no hydraulic jump at the inlet of the channel. The models did show a possible hydraulic jump at approximately HEC-RAS station 2135.97, however all water surface elevations remain at or below the subcritical flow regime model.

B. #1- Bank Improvements: Based off of the mixed flow regime HEC-RAS models no hydraulic jumps are expected to occur within the bank improvements downstream of the levee.

B. #2- Logandale Levee and Bank Improvements: Record drawings that reflect the as-built condition and certified hydraulic profiles with WSEs and ground elevations have been included in the appendix.

- Record drawings are included with this LOMR to show horizontal location of improvements. The certified hydraulic profiles included with this LOMR utilize as-built data obtained from the X Sheets and water surface elevations from the HEC-RAS model to show freeboard.

B. #3 –Bank Improvements: No accessory structures within Bank Improvements.

B. #4 – Logandale Levee and Bank Improvements: There is no opportunity for significant sediment to build up along the proposed system, therefore sedimentation was not considered for design.

E. #1b - The levee improvements are on the east bank. Improvements on the west bank are considered only for bank protection and channelization.

E. #5 – A certified letter from the geotechnical engineer that inspected the construction of the levee for its structural stability has been included in the appendix.

E. #6 - Not applicable.

E. #7c – As stated in the geotechnical report the existing levee has been in place for approximately 100 years. The proposed levee height is approximately the same as the existing; therefore, load related settlement within the clay foundation soils is expected to already have occurred. Any rebound settlement resulting from levee removal and replacement is expected to be elastic and completed during construction. Refer to the excerpt from the geotechnical report included in the appendix for a more detailed discussion.

E. #8 - Not applicable.

E. #9d - There is no opportunity for significant sediment to build up along the proposed system, therefore sedimentation was not considered for design.

FEDERAL EMERGENCY MANAGEMENT AGENCY

PAYMENT INFORMATION FORM

Community Name:

Project Identifier:

THIS FORM MUST BE MAILED, ALONG WITH THE APPROPRIATE FEE, TO THE ADDRESS BELOW OR FAXED TO THE FAX NUMBER BELOW.

Please make check or money order payable to the National Flood Insurance Program.

Type of Request:

☐ MT-1 application
☐ MT-2 application

LOMC Clearinghouse
3601 Eisenhower Ave. Suite 500
Alexandria, VA 22304-6426
Attn.: LOMC Manager

☐ EDR application

FEMA Project Library
3601 Eisenhower Ave. Suite 500
Alexandria, VA 22304-6426
FAX (703) 960-9125

Request No. (if known): ____________________ **Check No.:** ____________________ **Amount:** _____

☐ INITIAL FEE* ☐ FINAL FEE ☐ FEE BALANCE** ☐ MASTER CARD ☐ VISA ☐ CHECK ☐ MONEY ORDER

*Note: Check only for EDR and/or Alluvial Fan requests (as appropriate).

****Note: Check only if submitting a corrected fee for an ongoing request.**

COMPLETE THIS SECTION *ONLY* IF PAYING BY CREDIT CARD

CARD NUMBER EXP. DATE

1	2	3	4	–	5	6	7	8	–	9	10	11	12	–	13	14	15	16		Month	–	Year

____________ ____

Date Signature

NAME *(AS IT APPEARS ON CARD)*: ______________________
(please print or type)

ADDRESS: ____________________________________
(*for your credit card receipt-please print or type*) ____________________________________

DAYTIME PHONE: ____________________________

3. ENGINEERING ANALYSIS

HEC-RAS Model: Post Project Model
HEC-RAS Model: Corrected Effective Model
HEC-RAS Model: Post Project Mixed Flow Regime
HEC-RAS Model: Post Project Mixed Flow Regime Critical Depth

HEC-RAS Model: Post Project Model

HEC-RAS Plan: Plan 04   River: RIVER   Reach: Site 2

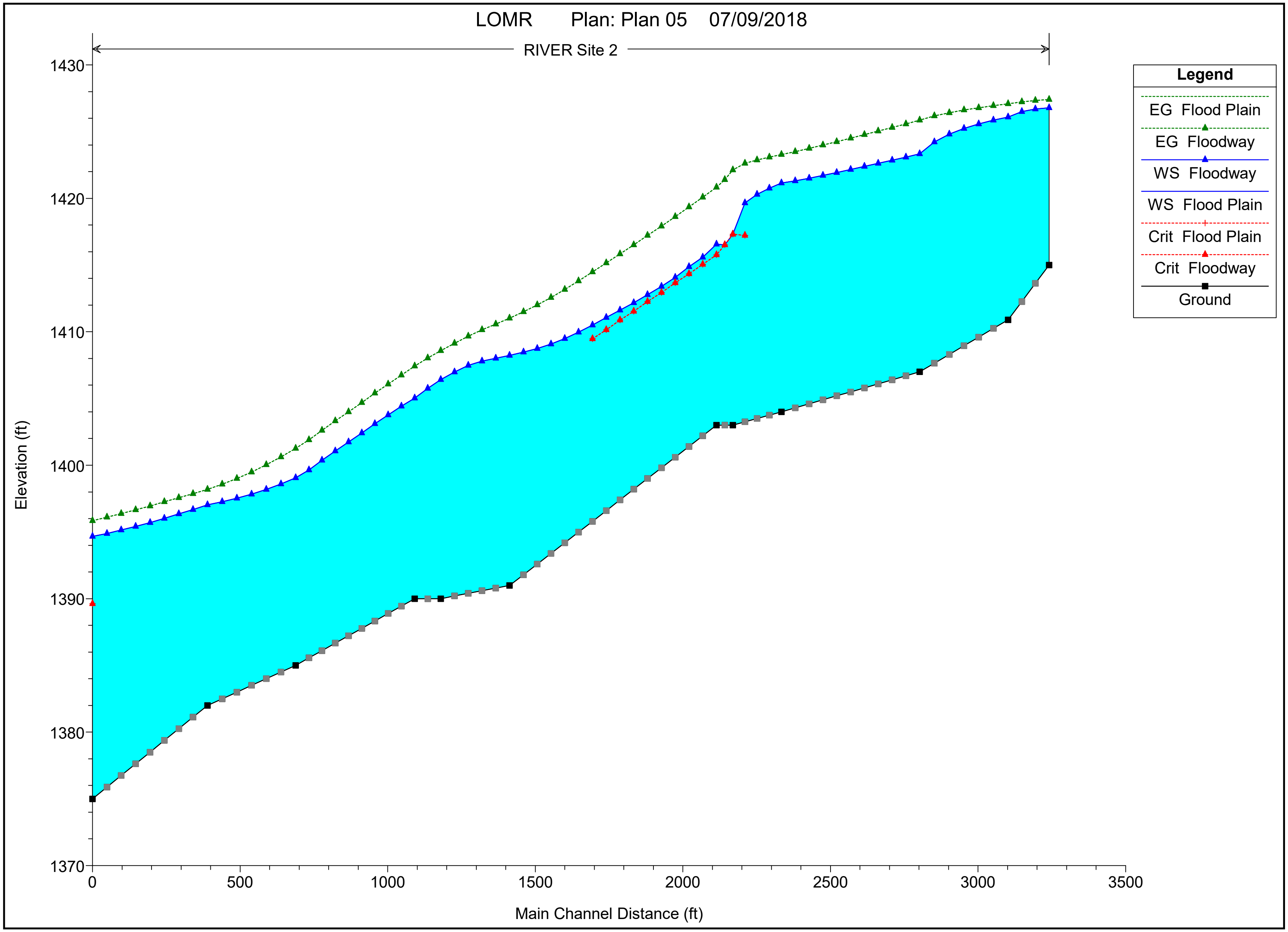
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	3262.4	Flood Plain	21400.00	1415.00	1426.78		1427.41	0.001715	6.39	3346.60	391.20	0.39
Site 2	3262.4	Floodway	21400.00	1415.00	1426.78		1427.41	0.001715	6.39	3346.60	391.20	0.39
Site 2	3216.10*	Flood Plain	21400.00	1413.63	1426.69		1427.33	0.002074	6.41	3336.40	367.92	0.38
Site 2	3216.10*	Floodway	21400.00	1413.63	1426.69		1427.33	0.002074	6.41	3336.40	367.92	0.38
Site 2	3169.81*	Flood Plain	21400.00	1412.27	1426.49		1427.22	0.002053	6.85	3122.00	312.15	0.38
Site 2	3169.81*	Floodway	21400.00	1412.27	1426.49		1427.22	0.002053	6.85	3122.00	312.15	0.38
Site 2	3123.51	Flood Plain	21400.00	1410.90	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43
Site 2	3123.51	Floodway	21400.00	1410.90	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43
Site 2	3073.62*	Flood Plain	21400.00	1410.25	1425.85		1426.95	0.002741	8.39	2550.19	231.79	0.45
Site 2	3073.62*	Floodway	21400.00	1410.25	1425.85		1426.95	0.002741	8.39	2550.19	231.79	0.45
Site 2	3023.73*	Flood Plain	21400.00	1409.60	1425.57		1426.79	0.002965	8.86	2415.55	216.27	0.47
Site 2	3023.73*	Floodway	21400.00	1409.60	1425.57		1426.79	0.002965	8.86	2415.55	216.27	0.47
Site 2	2973.84*	Flood Plain	21400.00	1408.95	1425.23		1426.62	0.003334	9.44	2266.58	200.39	0.49
Site 2	2973.84*	Floodway	21400.00	1408.95	1425.23		1426.62	0.003334	9.44	2266.58	200.39	0.49
Site 2	2923.94*	Flood Plain	21400.00	1408.30	1424.80		1426.42	0.003815	10.19	2100.33	184.52	0.53
Site 2	2923.94*	Floodway	21400.00	1408.30	1424.80		1426.42	0.003815	10.19	2100.33	184.52	0.53
Site 2	2874.05*	Flood Plain	21400.00	1407.65	1424.22		1426.17	0.004647	11.20	1910.09	168.45	0.59
Site 2	2874.05*	Floodway	21400.00	1407.65	1424.22		1426.17	0.004647	11.20	1910.09	168.45	0.59
Site 2	2824.16	Flood Plain	21400.00	1407.00	1423.33		1425.86	0.005803	12.75	1679.07	151.80	0.68
Site 2	2824.16	Floodway	21400.00	1407.00	1423.33		1425.86	0.005803	12.75	1679.07	151.80	0.68
Site 2	2777.31*	Flood Plain	21400.00	1406.70	1423.09		1425.58	0.005638	12.65	1691.78	153.45	0.67
Site 2	2777.31*	Floodway	21400.00	1406.70	1423.09		1425.58	0.005638	12.65	1691.78	153.45	0.67
Site 2	2730.47*	Flood Plain	21400.00	1406.40	1422.86		1425.30	0.005567	12.55	1705.06	155.10	0.67
Site 2	2730.47*	Floodway	21400.00	1406.40	1422.86		1425.30	0.005567	12.55	1705.06	155.10	0.67
Site 2	2683.62*	Flood Plain	21400.00	1406.10	1422.62		1425.03	0.005515	12.46	1717.99	156.70	0.66
Site 2	2683.62*	Floodway	21400.00	1406.10	1422.62		1425.03	0.005515	12.46	1717.99	156.70	0.66
Site 2	2636.77*	Flood Plain	21400.00	1405.80	1422.39		1424.77	0.005435	12.36	1731.08	158.28	0.66
Site 2	2636.77*	Floodway	21400.00	1405.80	1422.39		1424.77	0.005435	12.36	1731.08	158.28	0.66
Site 2	2589.93*	Flood Plain	21400.00	1405.50	1422.16		1424.50	0.005376	12.27	1744.17	159.80	0.65
Site 2	2589.93*	Floodway	21400.00	1405.50	1422.16		1424.50	0.005376	12.27	1744.17	159.80	0.65
Site 2	2543.08*	Flood Plain	21400.00	1405.20	1421.94		1424.24	0.005275	12.18	1757.64	160.61	0.65
Site 2	2543.08*	Floodway	21400.00	1405.20	1421.94		1424.24	0.005275	12.18	1757.64	160.61	0.65
Site 2	2496.23*	Flood Plain	21400.00	1404.90	1421.72		1423.99	0.005150	12.08	1772.01	161.31	0.64
Site 2	2496.23*	Floodway	21400.00	1404.90	1421.72		1423.99	0.005150	12.08	1772.01	161.31	0.64
Site 2	2449.38*	Flood Plain	21400.00	1404.60	1421.51		1423.74	0.005012	11.97	1787.50	162.13	0.64
Site 2	2449.38*	Floodway	21400.00	1404.60	1421.51		1423.74	0.005012	11.97	1787.50	162.13	0.64
Site 2	2402.54*	Flood Plain	21400.00	1404.30	1421.31		1423.49	0.004896	11.86	1804.01	162.78	0.63
Site 2	2402.54*	Floodway	21400.00	1404.30	1421.31		1423.49	0.004896	11.86	1804.01	162.78	0.63
Site 2	2355.69	Flood Plain	21400.00	1404.00	1421.14		1423.27	0.003839	11.71	1827.04	163.57	0.62
Site 2	2355.69	Floodway	21400.00	1404.00	1421.14		1423.27	0.003839	11.71	1827.04	163.57	0.62
Site 2	2314.55*	Flood Plain	21400.00	1403.75	1420.77		1423.09	0.004284	12.22	1750.71	157.63	0.65
Site 2	2314.55*	Floodway	21400.00	1403.75	1420.77		1423.09	0.004284	12.22	1750.71	157.63	0.65
Site 2	2273.40*	Flood Plain	21400.00	1403.50	1420.29		1422.87	0.004843	12.89	1660.63	150.87	0.68
Site 2	2273.40*	Floodway	21400.00	1403.50	1420.29		1422.87	0.004843	12.89	1660.63	150.87	0.68
Site 2	2232.26*	Flood Plain	21400.00	1403.25	1419.65	1417.23	1422.62	0.005424	13.82	1548.21	143.28	0.74
Site 2	2232.26*	Floodway	21400.00	1403.25	1419.65	1417.23	1422.62	0.005424	13.82	1548.21	143.28	0.74
Site 2	2191.11	Flood Plain	21400.00	1403.00	1417.32	1417.32	1422.13	0.010390	17.60	1215.68	126.08	1.00
Site 2	2191.11	Floodway	21400.00	1403.00	1417.32	1417.32	1422.13	0.010390	17.60	1215.68	126.08	1.00
Site 2	2163.54*	Flood Plain	21400.00	1403.00	1416.51	1416.51	1421.41	0.010396	17.75	1205.63	123.46	1.00
Site 2	2163.54*	Floodway	21400.00	1403.00	1416.51	1416.51	1421.41	0.010396	17.75	1205.63	123.46	1.00
Site 2	2135.97	Flood Plain	21400.00	1403.00	1416.56	1415.76	1420.84	0.016840	16.58	1290.41	124.00	0.91
Site 2	2135.97	Floodway	21400.00	1403.00	1416.56	1415.76	1420.84	0.016840	16.58	1290.41	124.00	0.91
Site 2	2089.23*	Flood Plain	21400.00	1402.20	1415.59	1415.06	1420.08	0.015107	17.00	1259.04	122.57	0.93

HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2 (Continued)

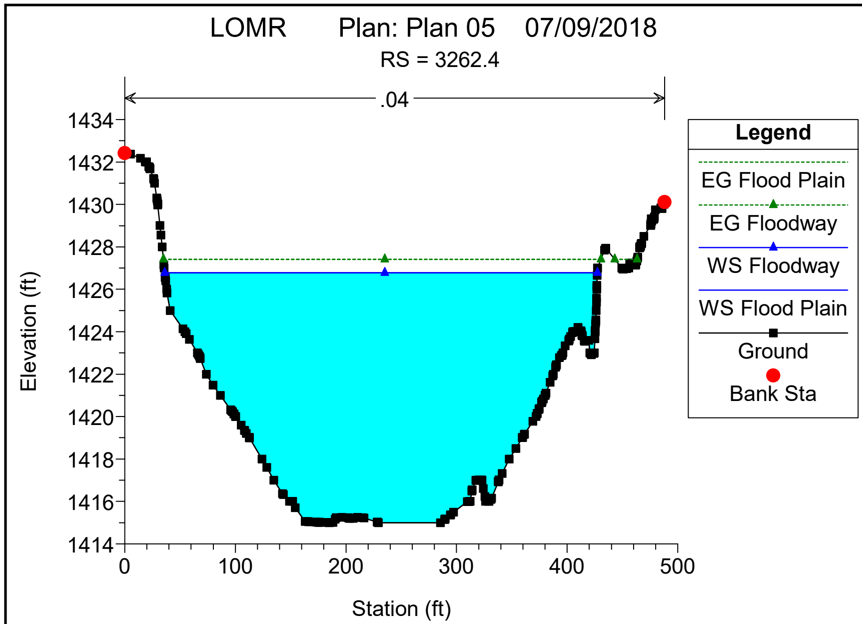
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	2089.23*	Floodway	21400.00	1402.20	1415.59	1415.06	1420.08	0.015107	17.00	1259.04	122.57	0.93
Site 2	2042.49*	Flood Plain	21400.00	1401.40	1414.87	1414.34	1419.36	0.015327	17.00	1259.07	123.04	0.94
Site 2	2042.49*	Floodway	21400.00	1401.40	1414.87	1414.34	1419.36	0.015327	17.00	1259.07	123.04	0.94
Site 2	1995.76*	Flood Plain	21400.00	1400.60	1414.08	1413.66	1418.63	0.015116	17.11	1250.87	123.18	0.95
Site 2	1995.76*	Floodway	21400.00	1400.60	1414.08	1413.66	1418.63	0.015116	17.11	1250.87	123.18	0.95
Site 2	1949.02*	Flood Plain	21400.00	1399.80	1413.41	1412.93	1417.92	0.014696	17.04	1255.81	123.73	0.94
Site 2	1949.02*	Floodway	21400.00	1399.80	1413.41	1412.93	1417.92	0.014696	17.04	1255.81	123.73	0.94
Site 2	1902.28*	Flood Plain	21400.00	1399.00	1412.77	1412.26	1417.22	0.014605	16.91	1265.25	124.40	0.93
Site 2	1902.28*	Floodway	21400.00	1399.00	1412.77	1412.26	1417.22	0.014605	16.91	1265.25	124.40	0.93
Site 2	1855.54*	Flood Plain	21400.00	1398.20	1412.17	1411.54	1416.52	0.013993	16.73	1279.49	125.19	0.92
Site 2	1855.54*	Floodway	21400.00	1398.20	1412.17	1411.54	1416.52	0.013993	16.73	1279.49	125.19	0.92
Site 2	1808.80*	Flood Plain	21400.00	1397.40	1411.63	1410.87	1415.84	0.013512	16.46	1300.18	126.13	0.90
Site 2	1808.80*	Floodway	21400.00	1397.40	1411.63	1410.87	1415.84	0.013512	16.46	1300.18	126.13	0.90
Site 2	1762.07*	Flood Plain	21400.00	1396.59	1411.07	1410.14	1415.16	0.013879	16.21	1320.37	127.03	0.89
Site 2	1762.07*	Floodway	21400.00	1396.59	1411.07	1410.14	1415.16	0.013879	16.21	1320.37	127.03	0.89
Site 2	1715.33*	Flood Plain	21400.00	1395.79	1410.51	1409.48	1414.48	0.013667	15.99	1338.30	127.89	0.87
Site 2	1715.33*	Floodway	21400.00	1395.79	1410.51	1409.48	1414.48	0.013667	15.99	1338.30	127.89	0.87
Site 2	1668.59*	Flood Plain	21400.00	1394.99	1409.97		1413.82	0.013127	15.73	1360.40	128.81	0.85
Site 2	1668.59*	Floodway	21400.00	1394.99	1409.97		1413.82	0.013127	15.73	1360.40	128.81	0.85
Site 2	1621.85*	Flood Plain	21400.00	1394.19	1409.49		1413.18	0.012272	15.40	1389.41	129.91	0.83
Site 2	1621.85*	Floodway	21400.00	1394.19	1409.49		1413.18	0.012272	15.40	1389.41	129.91	0.83
Site 2	1575.11*	Flood Plain	21400.00	1393.39	1409.08		1412.57	0.011131	14.98	1428.38	131.21	0.80
Site 2	1575.11*	Floodway	21400.00	1393.39	1409.08		1412.57	0.011131	14.98	1428.38	131.21	0.80
Site 2	1528.38*	Flood Plain	21400.00	1392.59	1408.75		1412.01	0.010087	14.49	1477.05	132.71	0.77
Site 2	1528.38*	Floodway	21400.00	1392.59	1408.75		1412.01	0.010087	14.49	1477.05	132.71	0.77
Site 2	1481.64*	Flood Plain	21400.00	1391.79	1408.47		1411.50	0.008803	13.94	1534.67	134.39	0.73
Site 2	1481.64*	Floodway	21400.00	1391.79	1408.47		1411.50	0.008803	13.94	1534.67	134.39	0.73
Site 2	1434.9	Flood Plain	21400.00	1390.99	1408.23		1411.02	0.008447	13.40	1597.58	136.18	0.69
Site 2	1434.9	Floodway	21400.00	1390.99	1408.23		1411.02	0.008447	13.40	1597.58	136.18	0.69
Site 2	1388.29*	Flood Plain	21400.00	1390.79	1408.02		1410.57	0.007947	12.82	1669.87	141.46	0.66
Site 2	1388.29*	Floodway	21400.00	1390.79	1408.02		1410.57	0.007947	12.82	1669.87	141.46	0.66
Site 2	1341.68*	Flood Plain	21400.00	1390.59	1407.80		1410.15	0.007640	12.29	1741.43	151.82	0.64
Site 2	1341.68*	Floodway	21400.00	1390.59	1407.80		1410.15	0.007640	12.29	1741.43	151.82	0.64
Site 2	1295.06*	Flood Plain	21400.00	1390.40	1407.48		1409.68	0.011086	11.90	1798.73	157.20	0.62
Site 2	1295.06*	Floodway	21400.00	1390.40	1407.48		1409.68	0.011086	11.90	1798.73	157.20	0.62
Site 2	1248.45*	Flood Plain	21400.00	1390.20	1406.98		1409.14	0.011510	11.77	1817.68	158.17	0.61
Site 2	1248.45*	Floodway	21400.00	1390.20	1406.98		1409.14	0.011510	11.77	1817.68	158.17	0.61
Site 2	1201.84	Flood Plain	21400.00	1390.00	1406.41		1408.58	0.012173	11.81	1811.80	158.94	0.62
Site 2	1201.84	Floodway	21400.00	1390.00	1406.41		1408.58	0.012173	11.81	1811.80	158.94	0.62
Site 2	1157.41*	Flood Plain	21400.00	1390.00	1405.76		1408.03	0.012372	12.07	1772.94	161.29	0.64
Site 2	1157.41*	Floodway	21400.00	1390.00	1405.76		1408.03	0.012372	12.07	1772.94	161.29	0.64
Site 2	1112.97	Flood Plain	21400.00	1390.00	1405.03		1407.43	0.014200	12.42	1723.67	162.87	0.67
Site 2	1112.97	Floodway	21400.00	1390.00	1405.03		1407.43	0.014200	12.42	1723.67	162.87	0.67
Site 2	1068.21*	Flood Plain	21400.00	1389.44	1404.42		1406.76	0.014791	12.28	1742.84	168.38	0.67
Site 2	1068.21*	Floodway	21400.00	1389.44	1404.42		1406.76	0.014791	12.28	1742.84	168.38	0.67
Site 2	1023.46*	Flood Plain	21400.00	1388.89	1403.78		1406.08	0.014994	12.18	1756.44	173.86	0.68
Site 2	1023.46*	Floodway	21400.00	1388.89	1403.78		1406.08	0.014994	12.18	1756.44	173.86	0.68
Site 2	978.70*	Flood Plain	21400.00	1388.33	1403.11		1405.40	0.015452	12.12	1765.45	179.29	0.68
Site 2	978.70*	Floodway	21400.00	1388.33	1403.11		1405.40	0.015452	12.12	1765.45	179.29	0.68
Site 2	933.94*	Flood Plain	21400.00	1387.78	1402.42		1404.69	0.015862	12.10	1768.13	184.50	0.69
Site 2	933.94*	Floodway	21400.00	1387.78	1402.42		1404.69	0.015862	12.10	1768.13	184.50	0.69
Site 2	889.19*	Flood Plain	21400.00	1387.22	1401.73		1404.00	0.015039	12.08	1772.18	189.46	0.70
Site 2	889.19*	Floodway	21400.00	1387.22	1401.73		1404.00	0.015039	12.08	1772.18	189.46	0.70

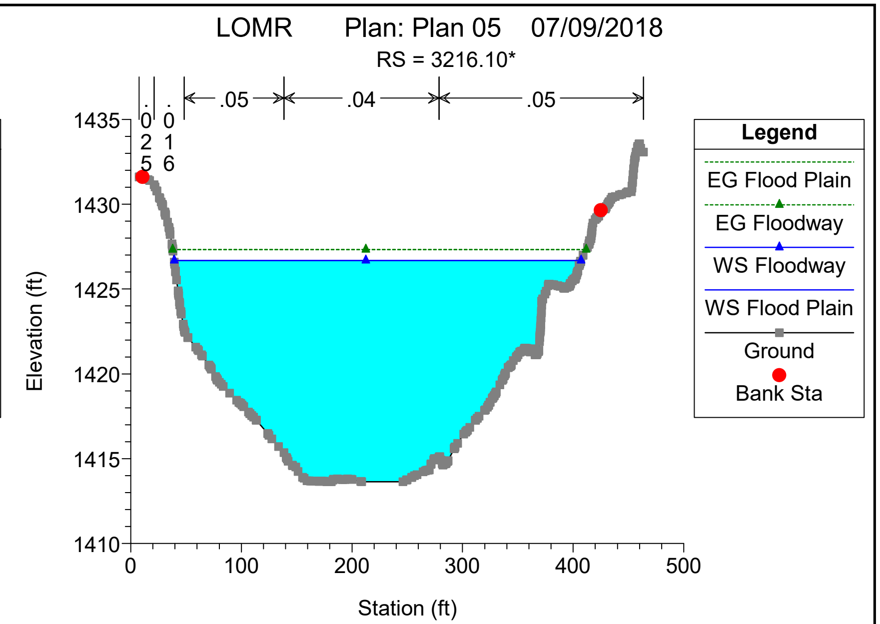
HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2 (Continued)

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)	
Site 2	844.43*	Flood Plain	21400.00	1386.67	1401.06		1403.32	0.015253	12.04	1778.12	194.29	0.70
Site 2	844.43*	Floodway	21400.00	1386.67	1401.06		1403.32	0.015253	12.04	1778.12	194.29	0.70
Site 2	799.67*	Flood Plain	21400.00	1386.11	1400.37		1402.62	0.015774	12.03	1778.54	199.06	0.71
Site 2	799.67*	Floodway	21400.00	1386.11	1400.37		1402.62	0.015774	12.03	1778.54	199.06	0.71
Site 2	754.92*	Flood Plain	21400.00	1385.56	1399.64		1401.91	0.016002	12.08	1771.25	203.76	0.72
Site 2	754.92*	Floodway	21400.00	1385.56	1399.64		1401.91	0.016002	12.08	1771.25	203.76	0.72
Site 2	710.16	Flood Plain	21400.00	1385.00	1399.06		1401.27	0.012213	11.93	1794.10	208.93	0.72
Site 2	710.16	Floodway	21400.00	1385.00	1399.06		1401.27	0.012213	11.93	1794.10	208.93	0.72
Site 2	660.39*	Flood Plain	21400.00	1384.50	1398.60		1400.63	0.011441	11.42	1873.20	219.30	0.69
Site 2	660.39*	Floodway	21400.00	1384.50	1398.60		1400.63	0.011441	11.42	1873.20	219.30	0.69
Site 2	610.62*	Flood Plain	21400.00	1384.00	1398.19		1400.03	0.010319	10.90	1963.96	230.02	0.66
Site 2	610.62*	Floodway	21400.00	1384.00	1398.19		1400.03	0.010319	10.90	1963.96	230.02	0.66
Site 2	560.85*	Flood Plain	21400.00	1383.50	1397.83		1399.49	0.009185	10.33	2070.75	241.27	0.62
Site 2	560.85*	Floodway	21400.00	1383.50	1397.83		1399.49	0.009185	10.33	2070.75	241.27	0.62
Site 2	511.08*	Flood Plain	21400.00	1383.00	1397.52		1399.01	0.008245	9.76	2192.62	253.25	0.58
Site 2	511.08*	Floodway	21400.00	1383.00	1397.52		1399.01	0.008245	9.76	2192.62	253.25	0.58
Site 2	461.31*	Flood Plain	21400.00	1382.50	1397.26		1398.57	0.007098	9.18	2332.26	266.44	0.55
Site 2	461.31*	Floodway	21400.00	1382.50	1397.26		1398.57	0.007098	9.18	2332.26	266.44	0.55
Site 2	411.54	Flood Plain	21400.00	1382.00	1397.04		1398.19	0.006482	8.60	2487.92	280.38	0.51
Site 2	411.54	Floodway	21400.00	1382.00	1397.04		1398.19	0.006482	8.60	2487.92	280.38	0.51
Site 2	362.84*	Flood Plain	21400.00	1381.12	1396.69		1397.87	0.006383	8.73	2450.72	273.74	0.51
Site 2	362.84*	Floodway	21400.00	1381.12	1396.69		1397.87	0.006383	8.73	2450.72	273.74	0.51
Site 2	314.15*	Flood Plain	21400.00	1380.25	1396.35		1397.56	0.006138	8.83	2422.75	266.95	0.52
Site 2	314.15*	Floodway	21400.00	1380.25	1396.35		1397.56	0.006138	8.83	2422.75	266.95	0.52
Site 2	265.45*	Flood Plain	21400.00	1379.38	1396.02		1397.26	0.006273	8.91	2402.04	260.04	0.52
Site 2	265.45*	Floodway	21400.00	1379.38	1396.02		1397.26	0.006273	8.91	2402.04	260.04	0.52
Site 2	216.76*	Flood Plain	21400.00	1378.50	1395.70		1396.95	0.006169	8.96	2387.59	252.79	0.51
Site 2	216.76*	Floodway	21400.00	1378.50	1395.70		1396.95	0.006169	8.96	2387.59	252.79	0.51
Site 2	168.06*	Flood Plain	21400.00	1377.62	1395.41		1396.66	0.005679	8.97	2385.70	245.07	0.51
Site 2	168.06*	Floodway	21400.00	1377.62	1395.41		1396.66	0.005679	8.97	2385.70	245.07	0.51
Site 2	119.36*	Flood Plain	21400.00	1376.75	1395.14		1396.38	0.005673	8.93	2395.09	235.49	0.49
Site 2	119.36*	Floodway	21400.00	1376.75	1395.14		1396.38	0.005673	8.93	2395.09	235.49	0.49
Site 2	70.67*	Flood Plain	21400.00	1375.88	1394.89		1396.11	0.005316	8.86	2416.42	226.90	0.48
Site 2	70.67*	Floodway	21400.00	1375.88	1394.89		1396.11	0.005316	8.86	2416.42	226.90	0.48
Site 2	21.97	Flood Plain	21400.00	1375.00	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46
Site 2	21.97	Floodway	21400.00	1375.00	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46



LOMR Plan: Plan 05 07/09/2018
RIVER Site 2
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Elevation (ft)
1370
1380
1390
1400
1410
1420
1430
Main Channel Distance (ft)
0
500
1000
1500
2000
2500
3000
3500


LOMR Plan: Plan 05 07/09/2018
RS = 3262.4
.04
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta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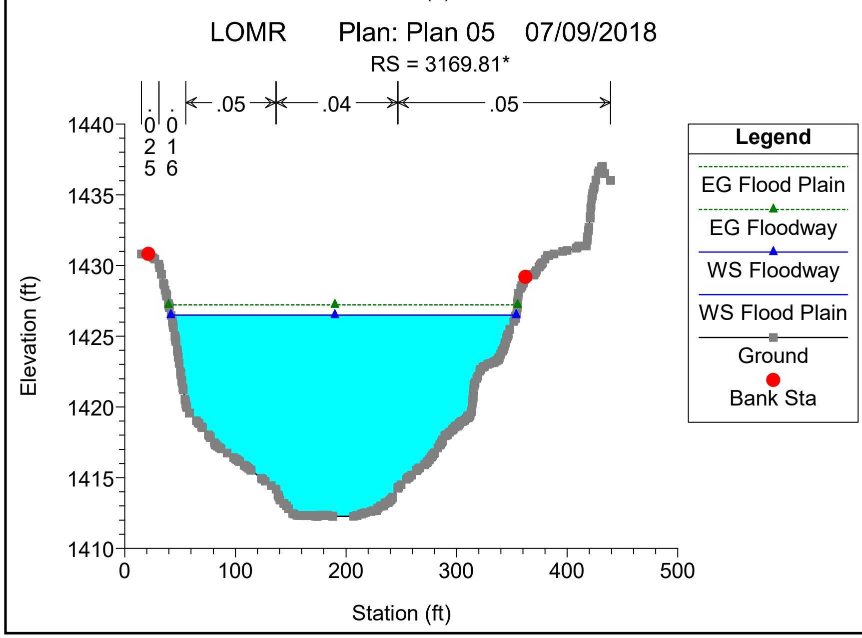
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
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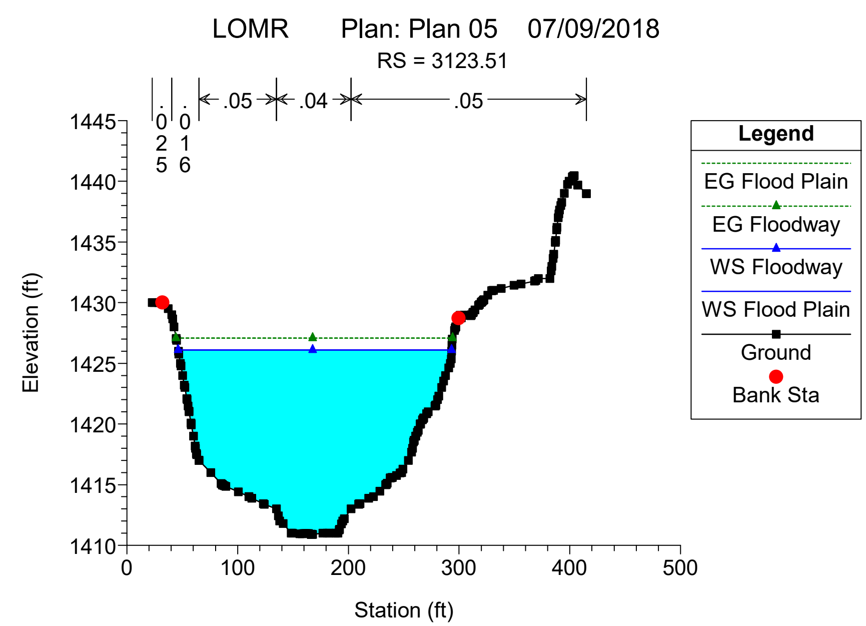
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta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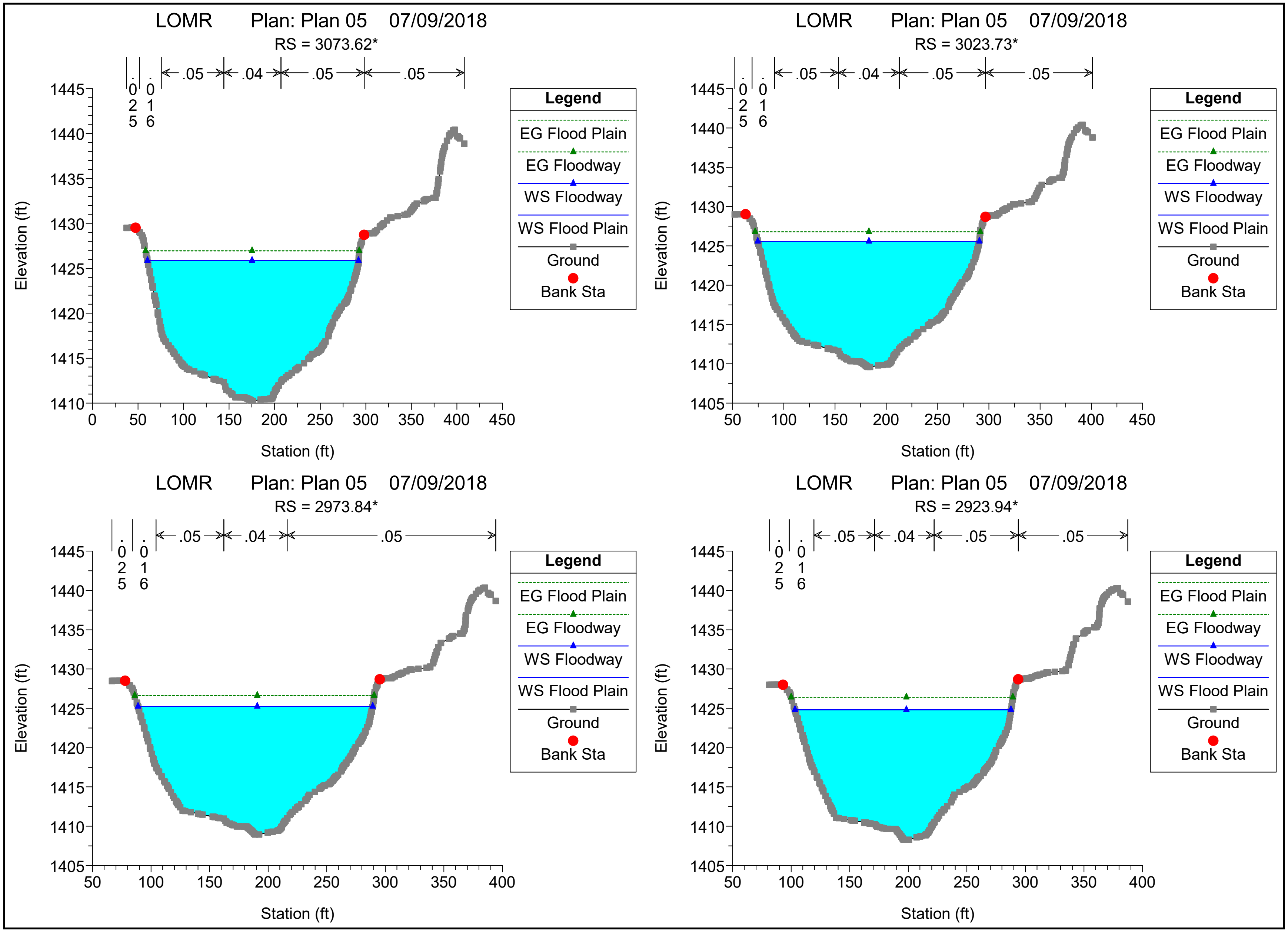
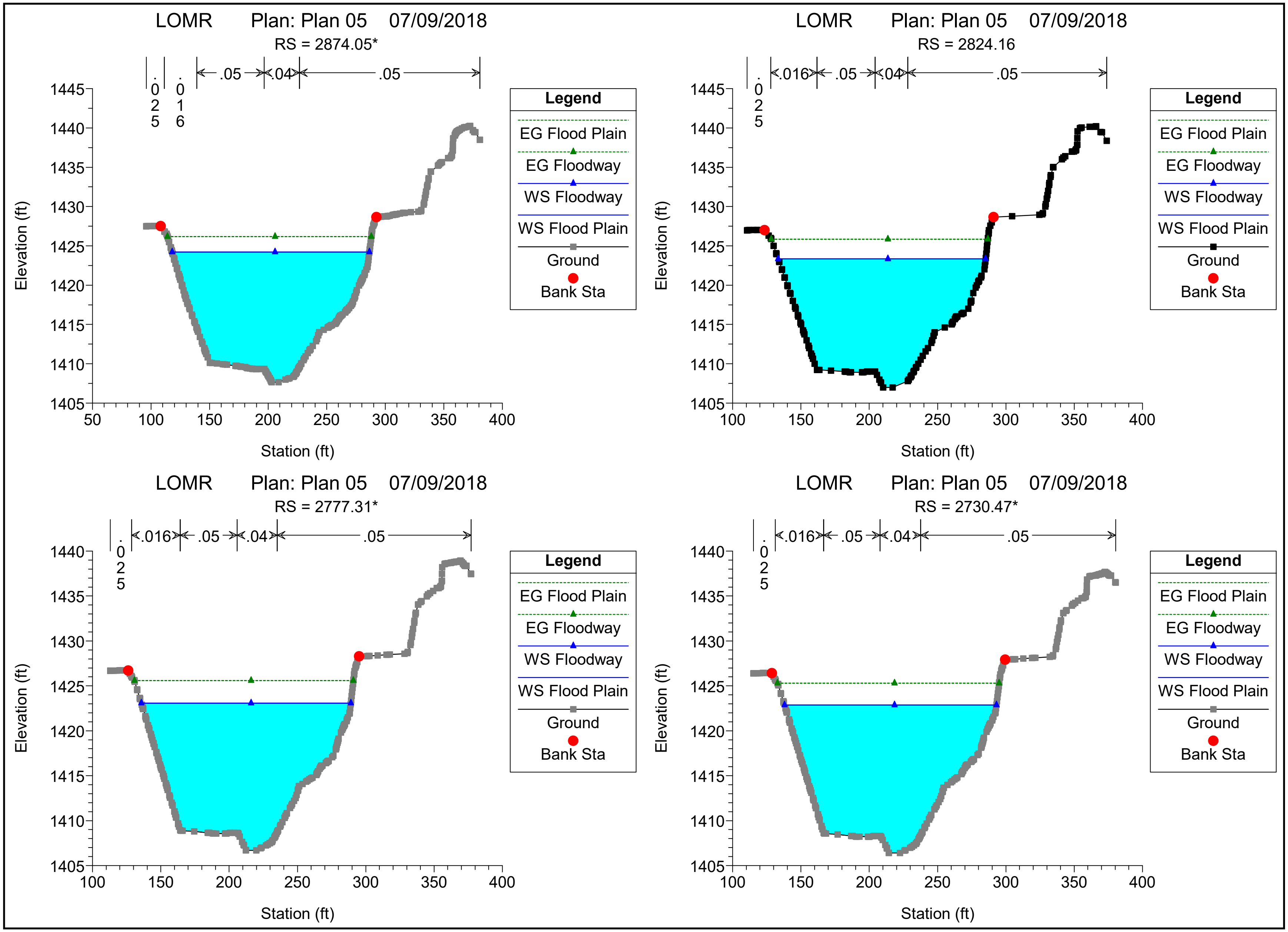
RS = 3123.51
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta



LOMR Plan: Plan 05 07/09/2018
RS = 3073.62*
.05 .04 .05 .05
.025 .016
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 3023.73*
.05 .04 .05 .05
.025 .016
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2973.84*
.05 .04 .05
.025 .016
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2923.94*
.05 .04 .05 .05
.025 .016
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta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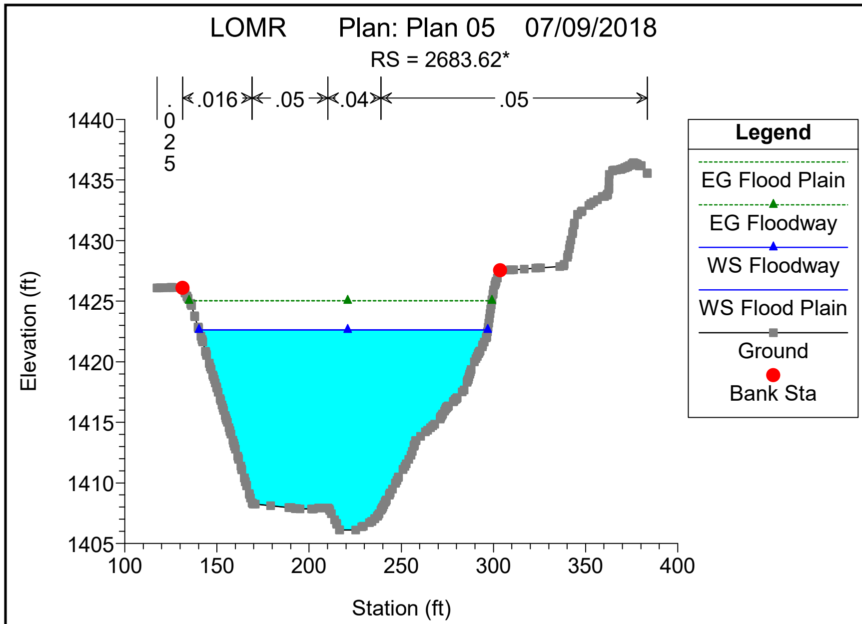
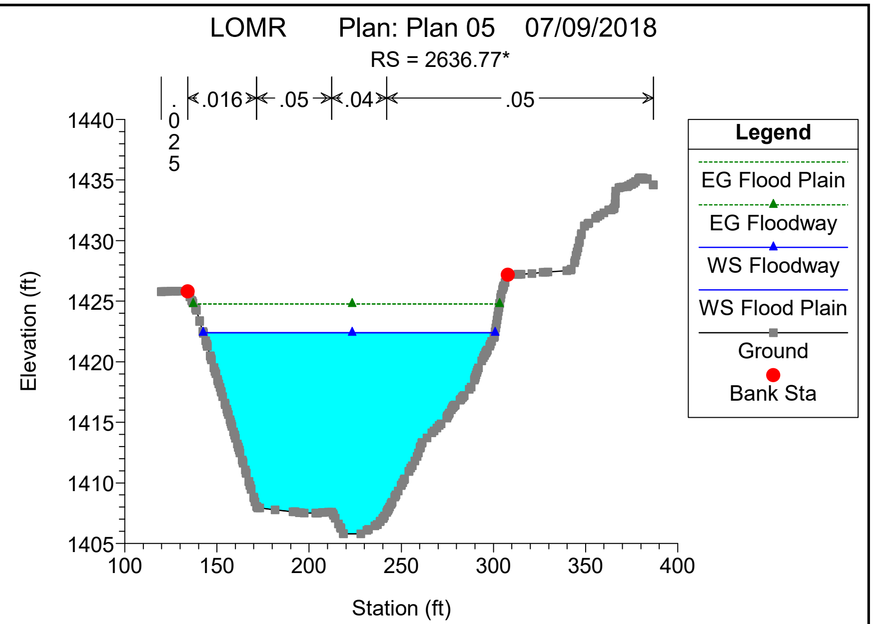
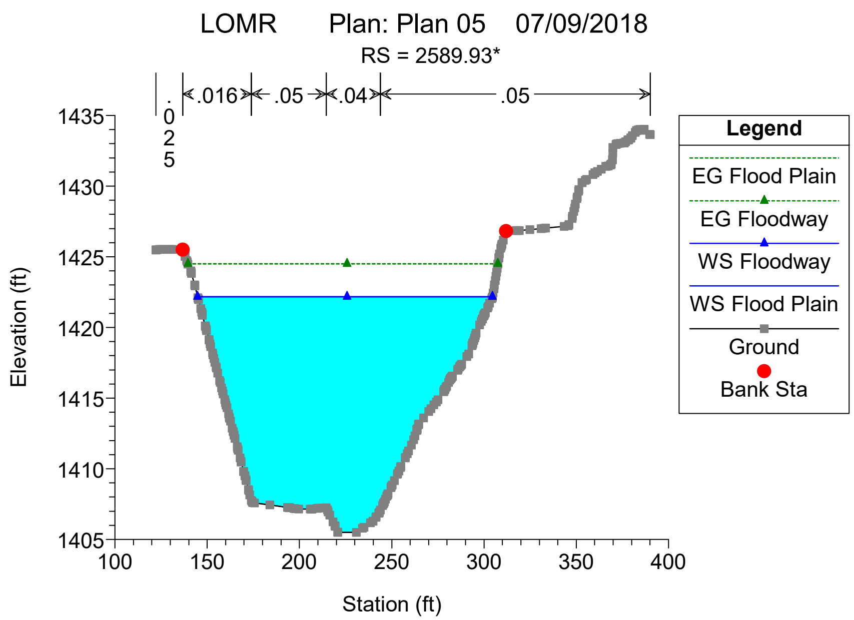
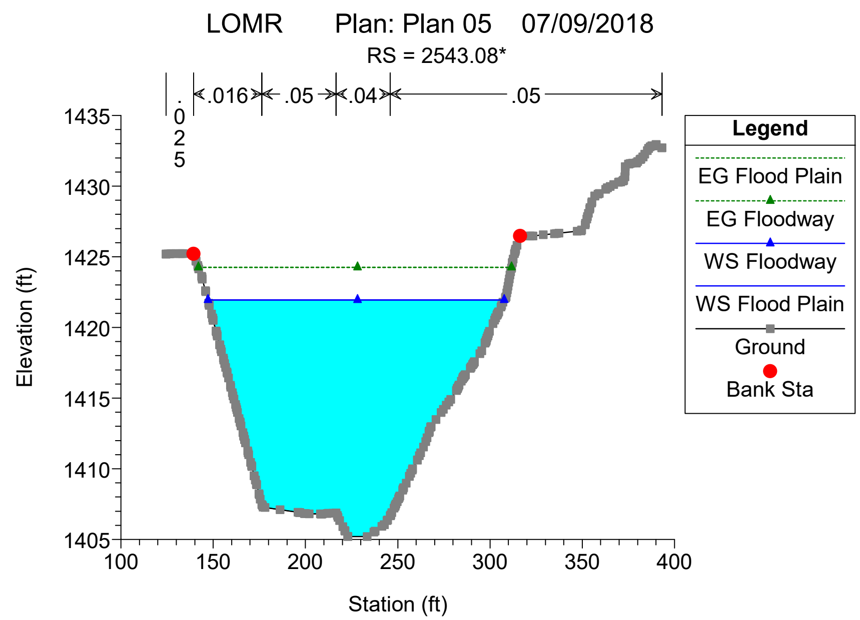
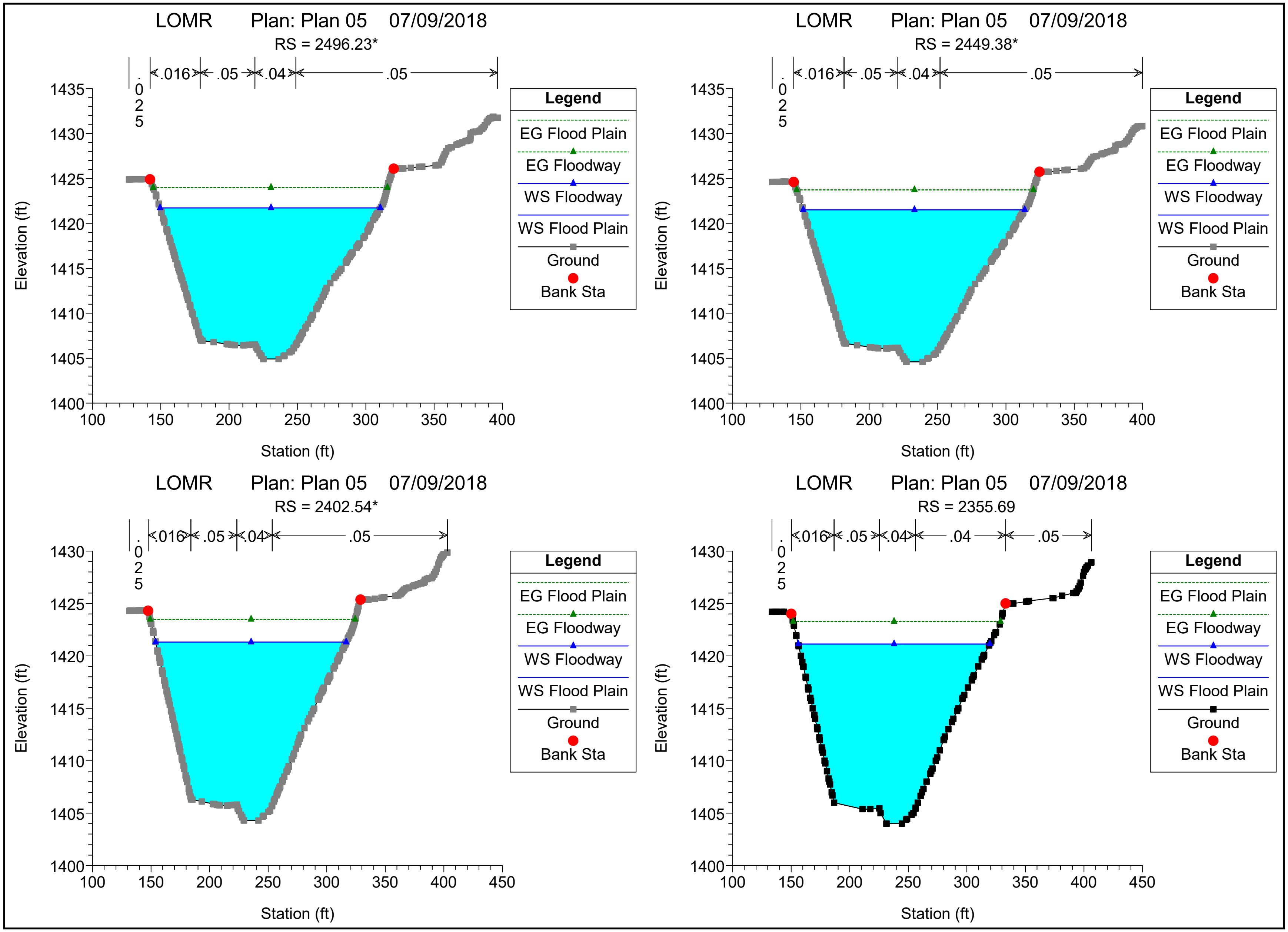
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2824.16
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2777.31*
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2730.47*
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 2683.62*
.025 .016 .05 .04 .05
Elevation (ft)
1440
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

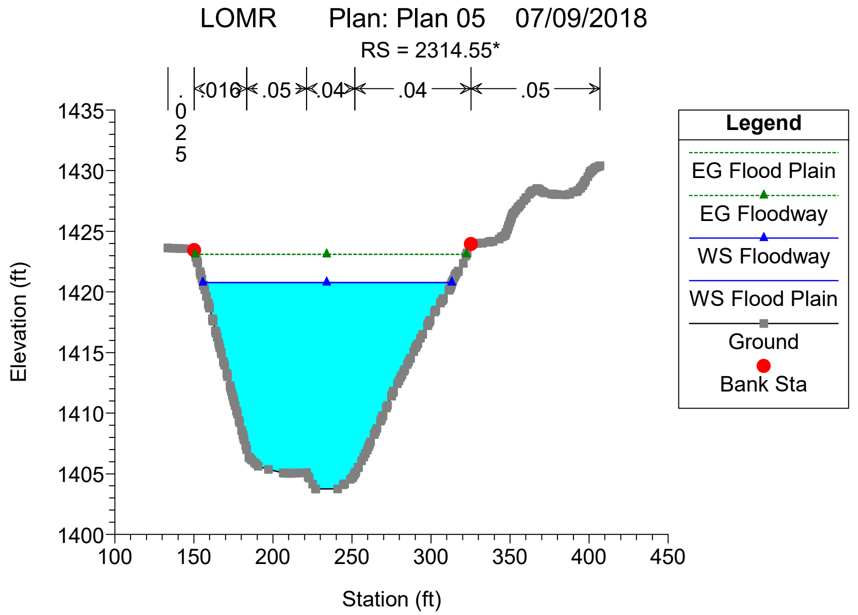

LOMR Plan: Plan 05 07/09/2018
RS = 2636.77*
.025 .016 .05 .04 .05
Elevation (ft)
1440
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

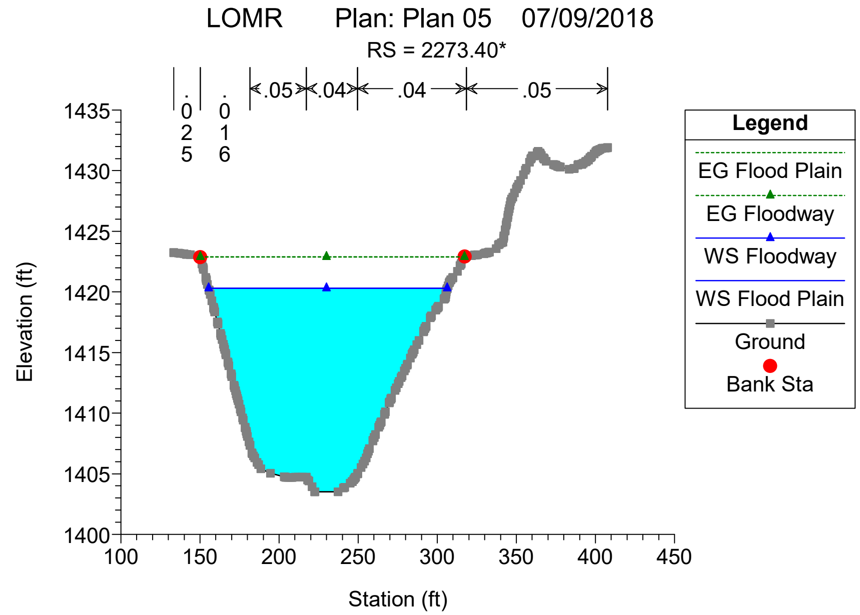

LOMR Plan: Plan 05 07/09/2018
RS = 2589.93*
.025 .016 .05 .04 .05
Elevation (ft)
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

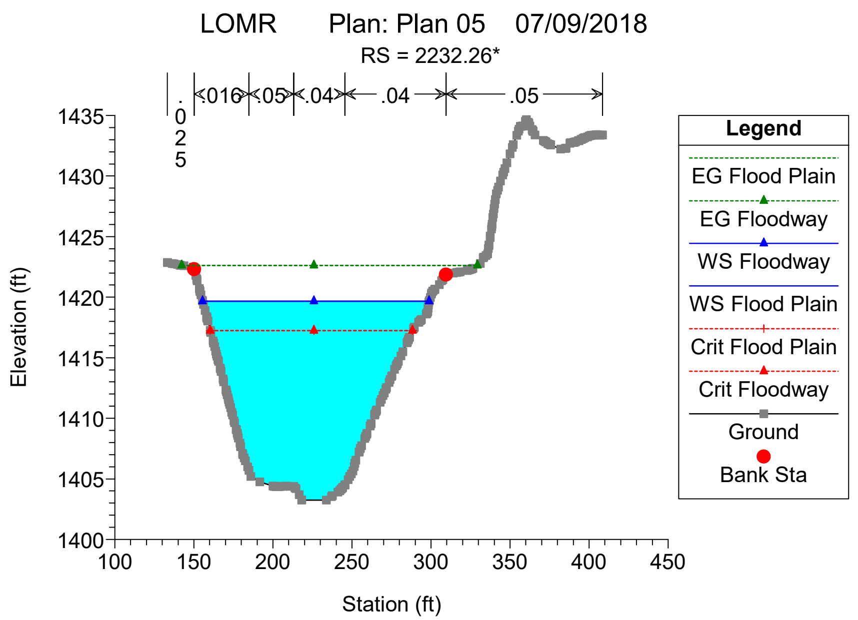

LOMR Plan: Plan 05 07/09/2018
RS = 2543.08*
.025 .016 .05 .04 .05
Elevation (ft)
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

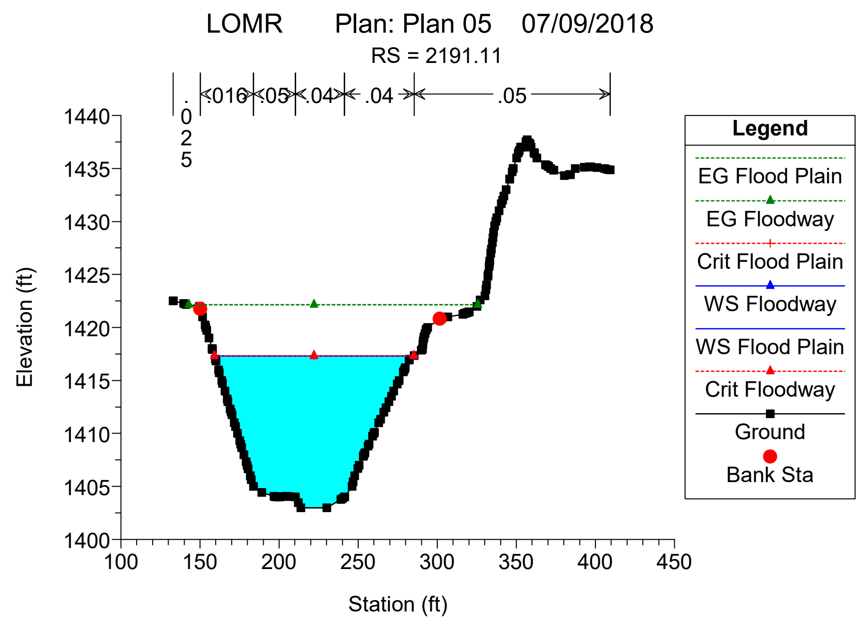


LOMR Plan: Plan 05 07/09/2018
RS = 2496.23*
.025
.016
.05
.04
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMR Plan: Plan 05 07/09/2018
RS = 2449.38*
Elevation (ft)
Station (ft)
LOMR Plan: Plan 05 07/09/2018
RS = 2402.54*
Elevation (ft)
Station (ft)
LOMR Plan: Plan 05 07/09/2018
RS = 2355.69
.025
.016
.05
.04
.04
.05
Elevation (ft)
Station (ft)


LOMR Plan: Plan 05 07/09/2018
RS = 2314.55*
.025
.016
.05
.04
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 2273.40*
.025
.016
.05
.04
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 2232.26*
.025
.016
.05
.04
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 2191.11
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.05
.04
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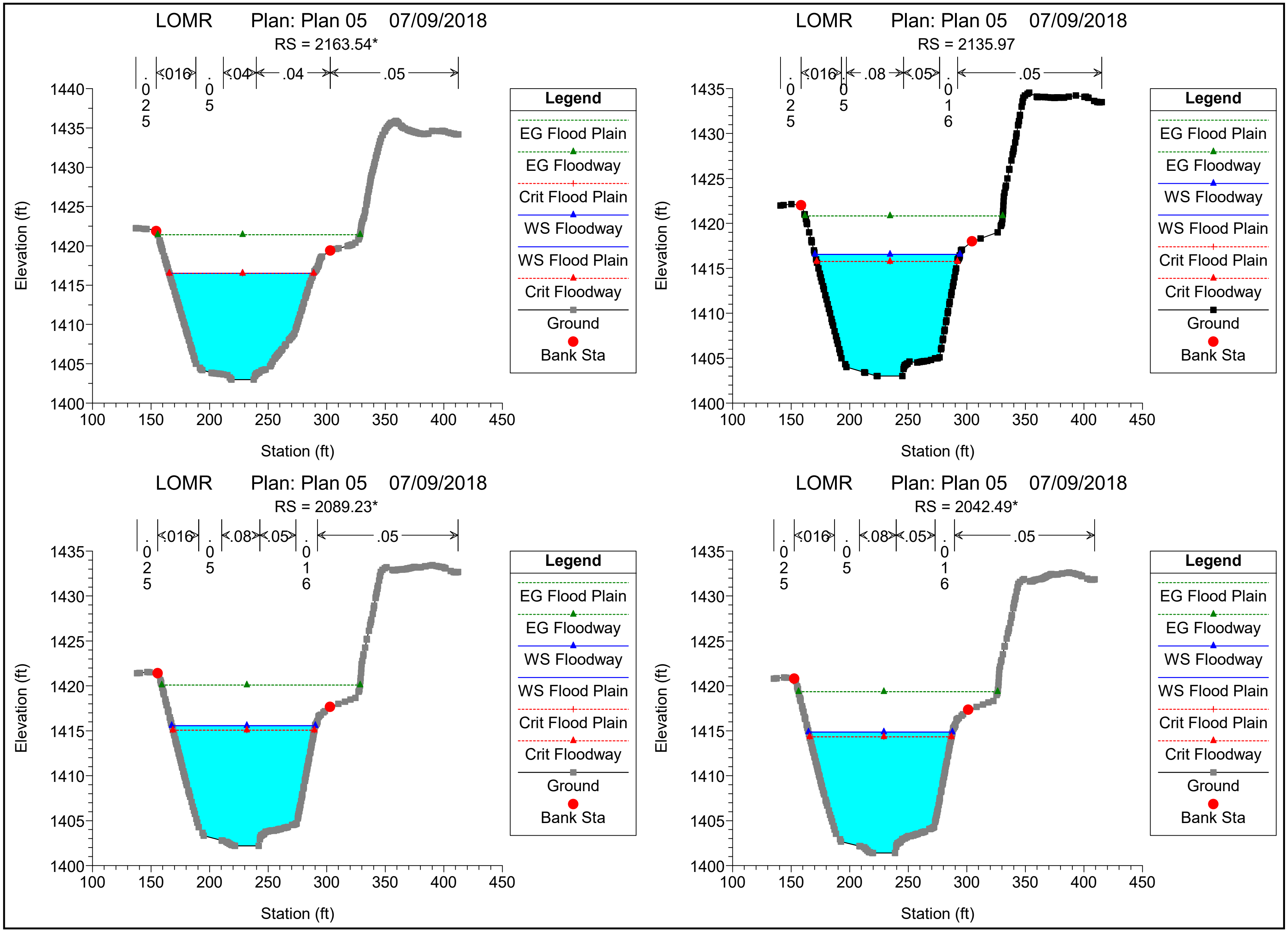
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
WS Floodway
WS Flood Plain
Crit Floodway
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 2163.54*
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.05
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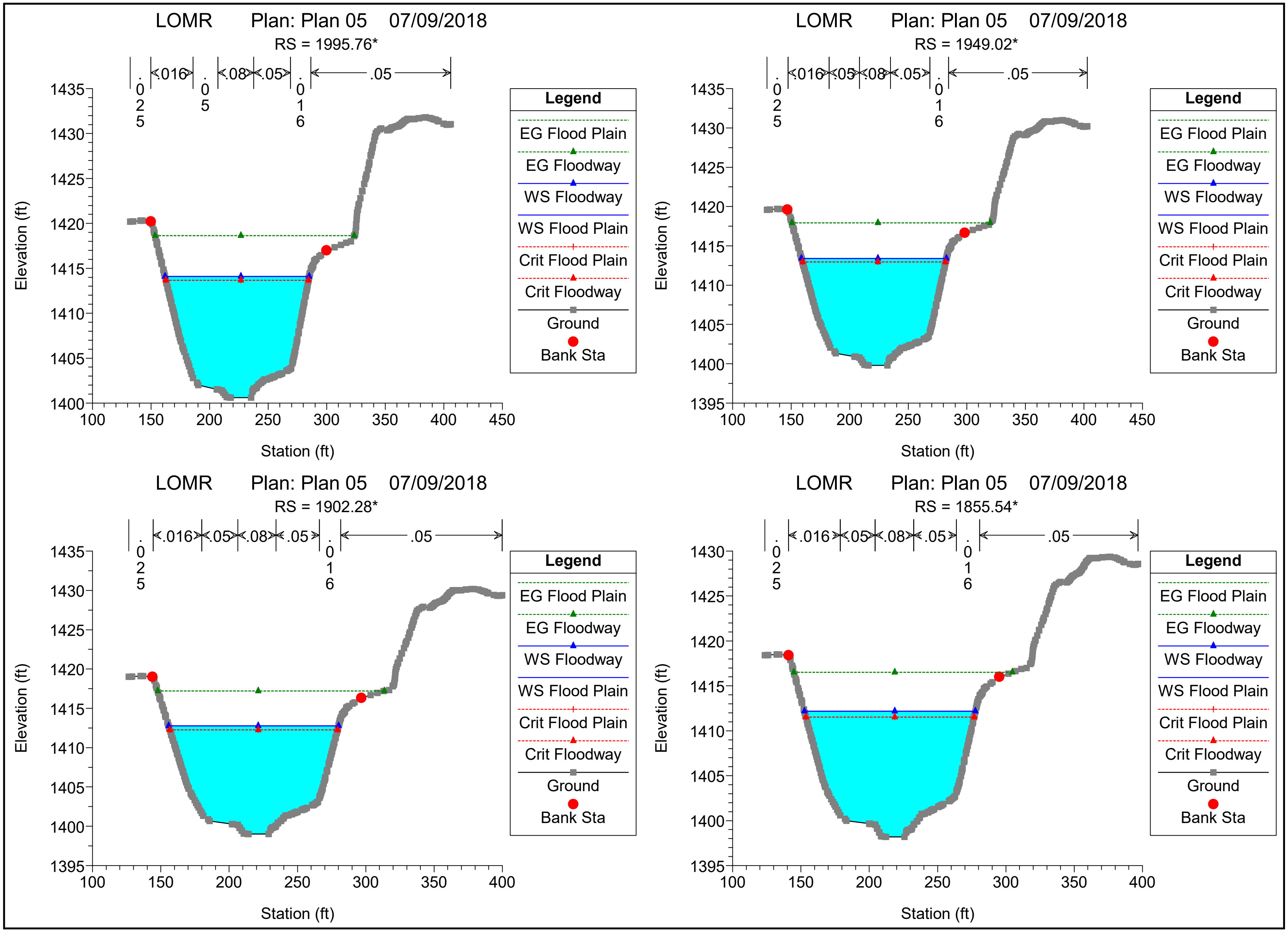
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
WS Floodway
WS Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2135.97
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2089.23*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 2042.49*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 1995.76*
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Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1949.02*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1902.28*
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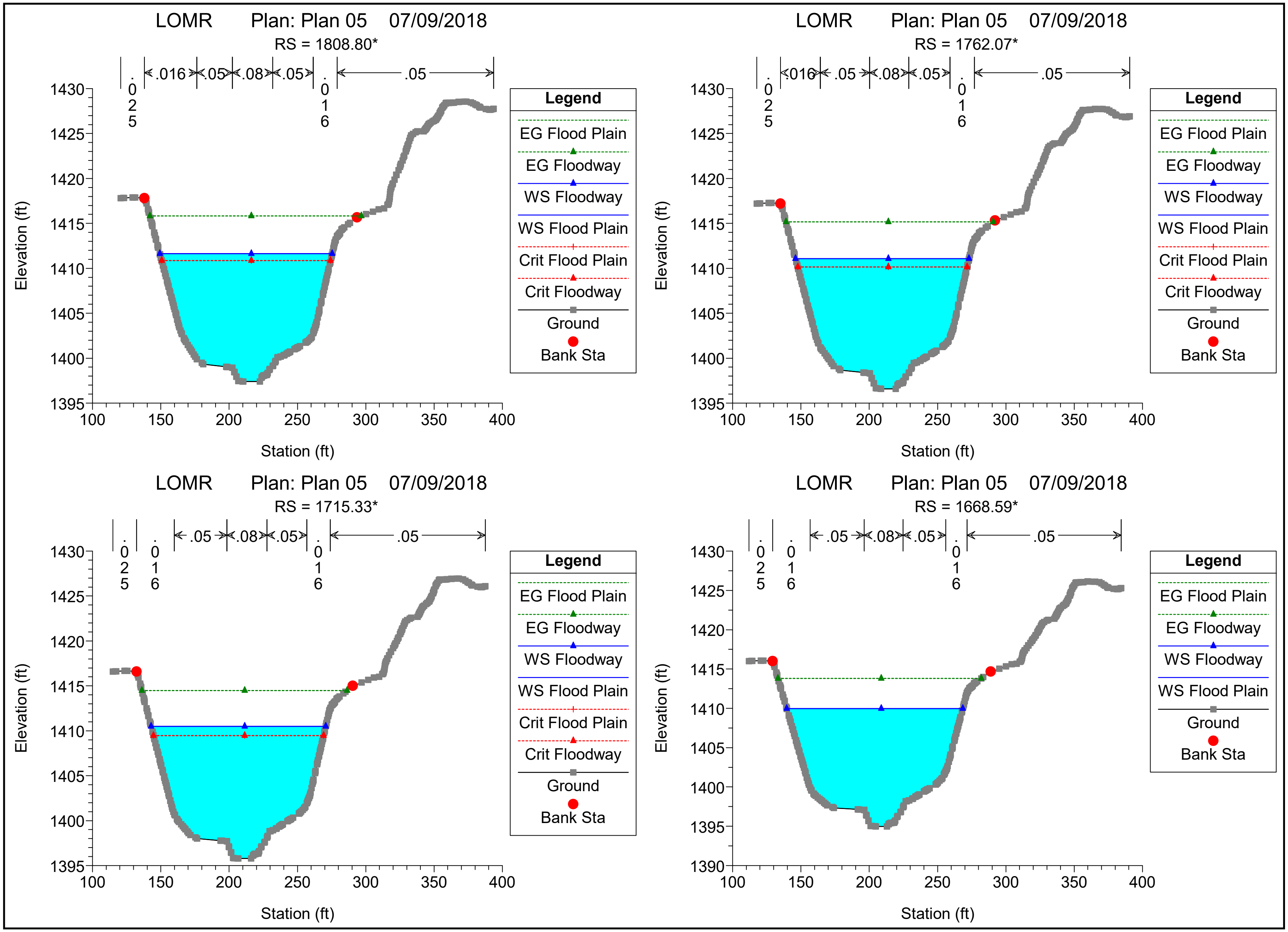
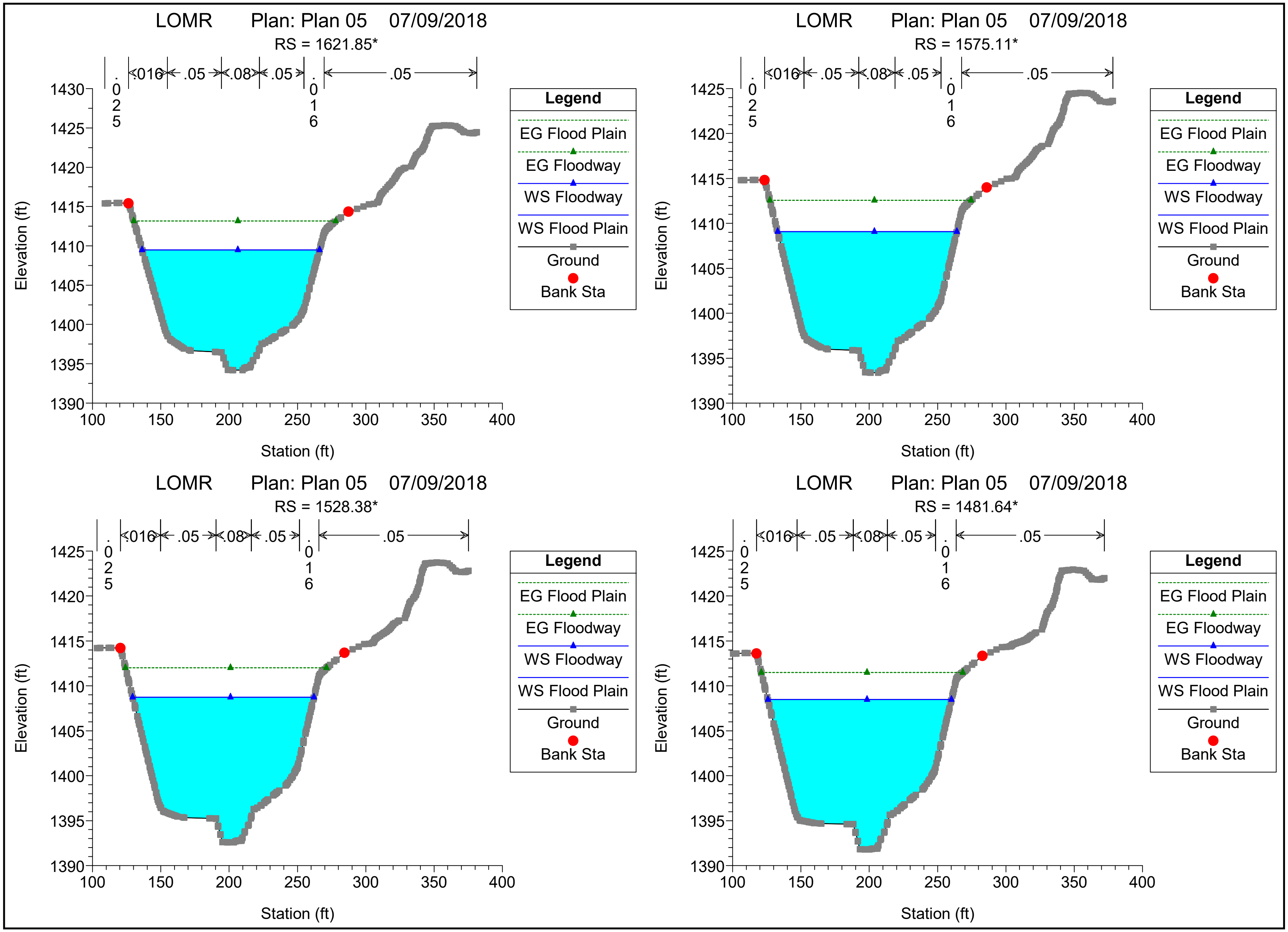
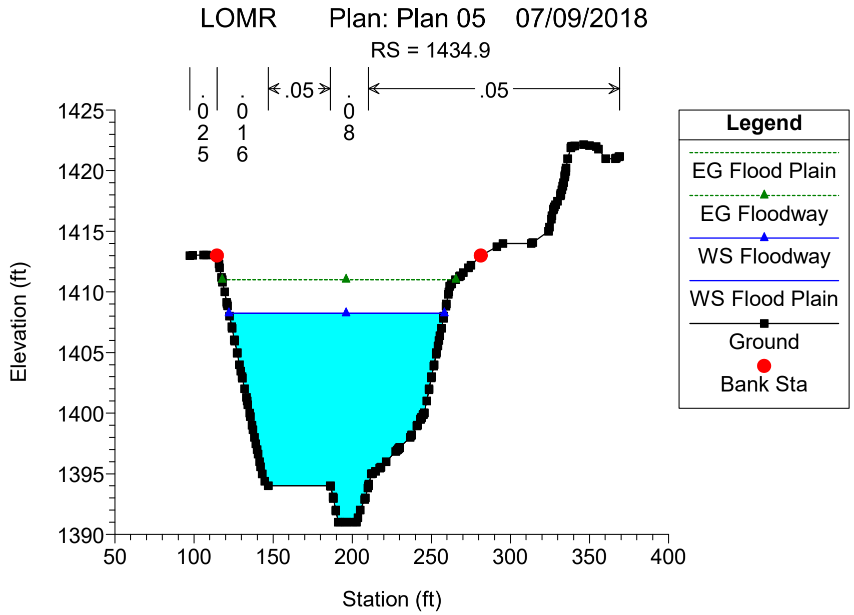
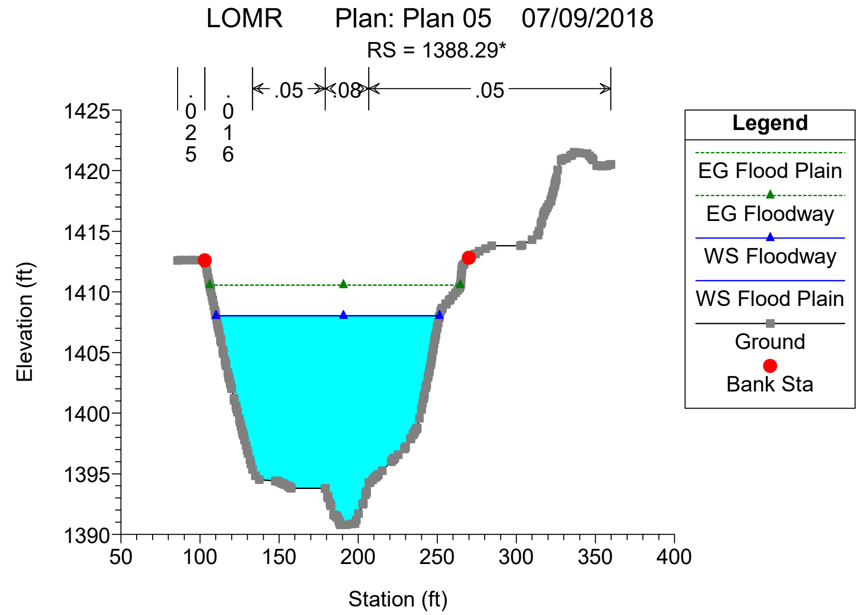
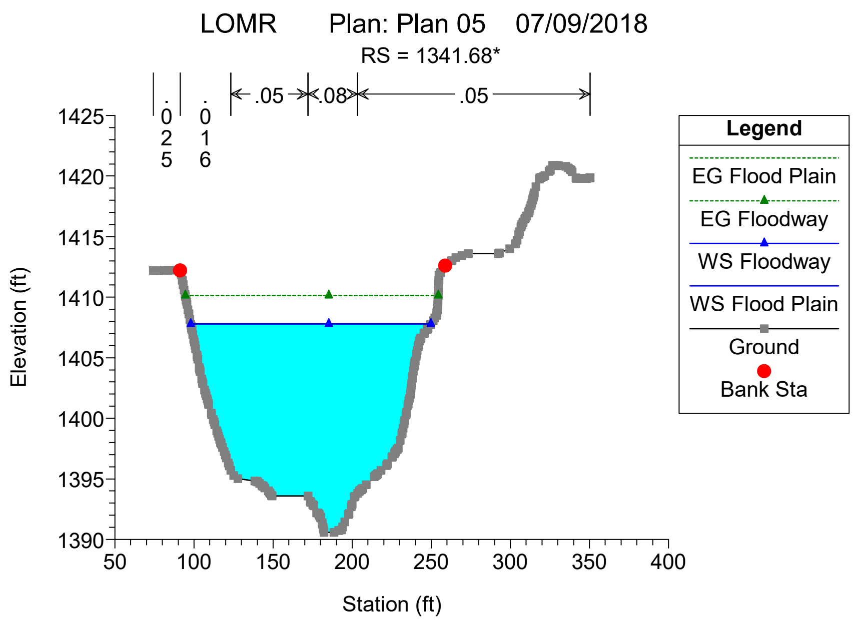
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1855.54*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 1808.80*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1762.07*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1715.33*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1668.59*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 1621.85*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 1575.11*
LOMR Plan: Plan 05 07/09/2018
RS = 1528.38*
LOMR Plan: Plan 05 07/09/2018
RS = 1481.64*


LOMR Plan: Plan 05 07/09/2018
RS = 1434.9
.025
.016
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1425
1420
1415
1410
1405
1400
1395
1390
50
100
150
200
250
300
350
400


LOMR Plan: Plan 05 07/09/2018
RS = 1388.29*
.025
.016
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1425
1420
1415
1410
1405
1400
1395
1390
50
100
150
200
250
300
350
400


LOMR Plan: Plan 05 07/09/2018
RS = 1341.68*
.025
.016
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1425
1420
1415
1410
1405
1400
1395
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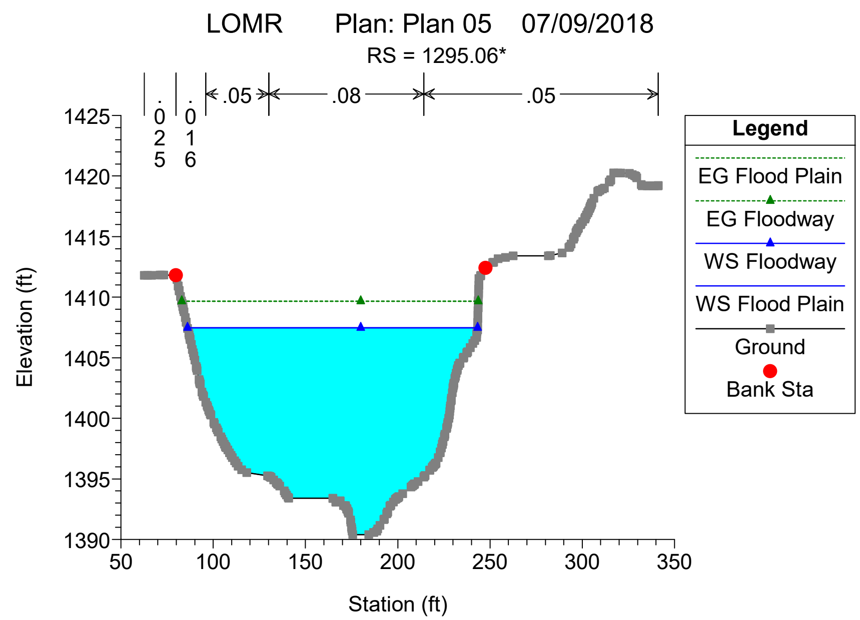
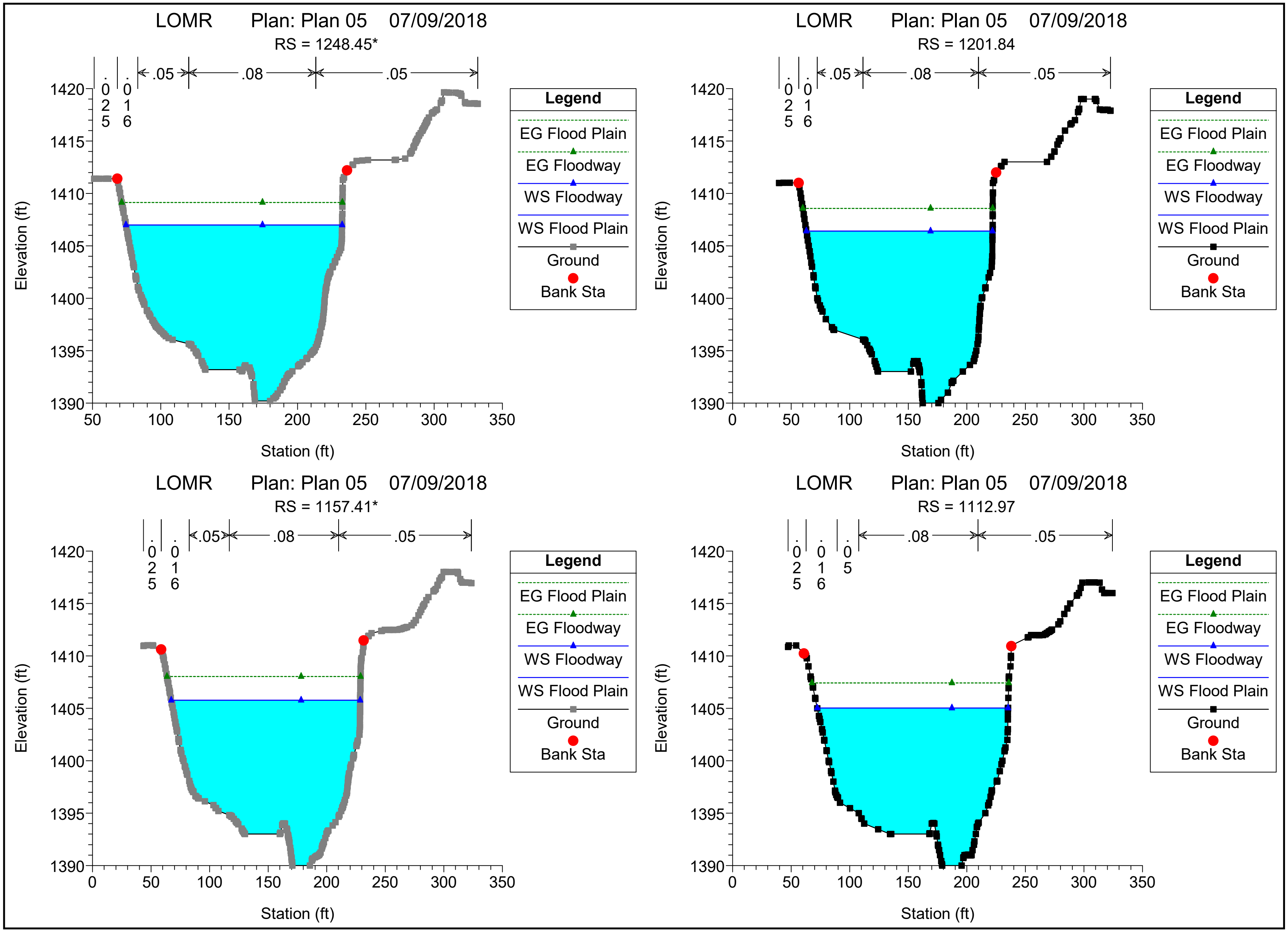
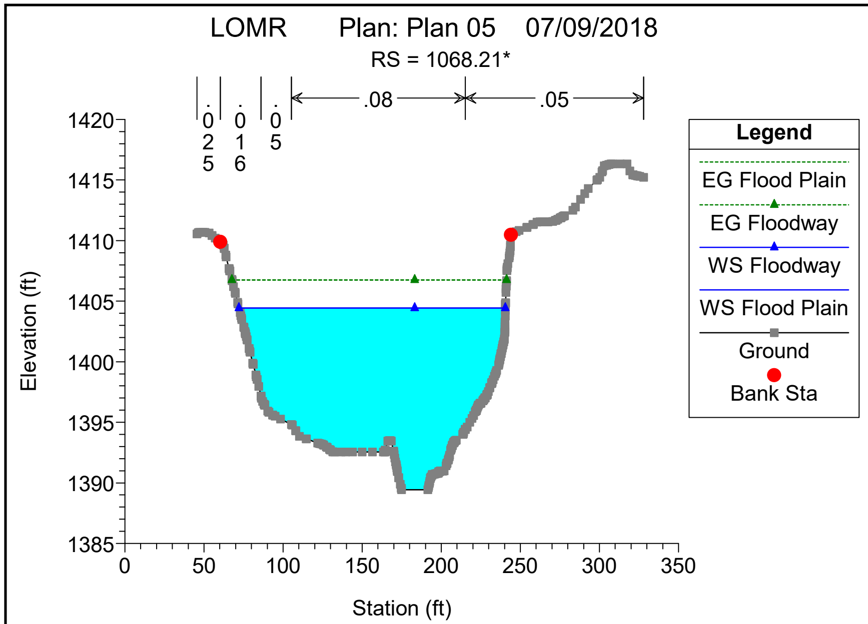
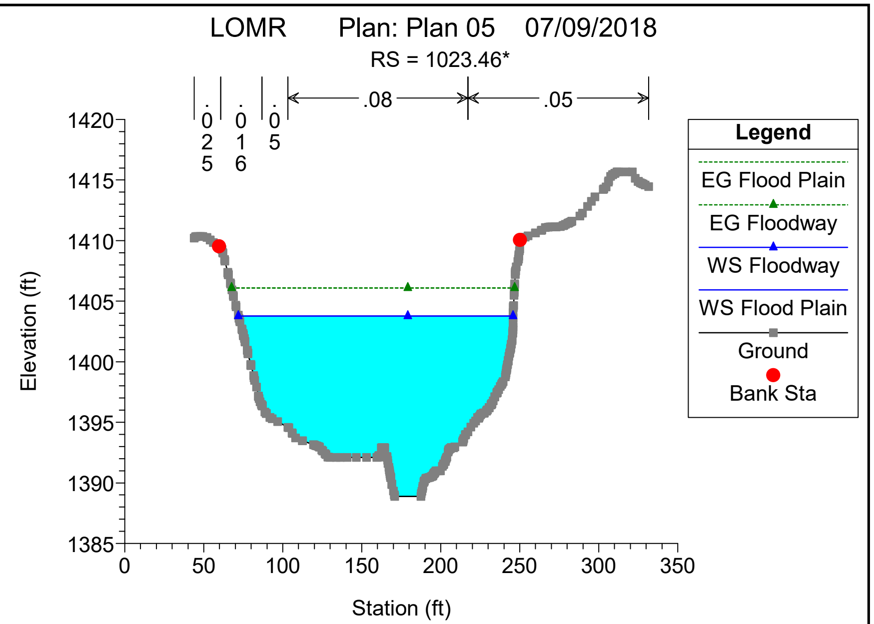
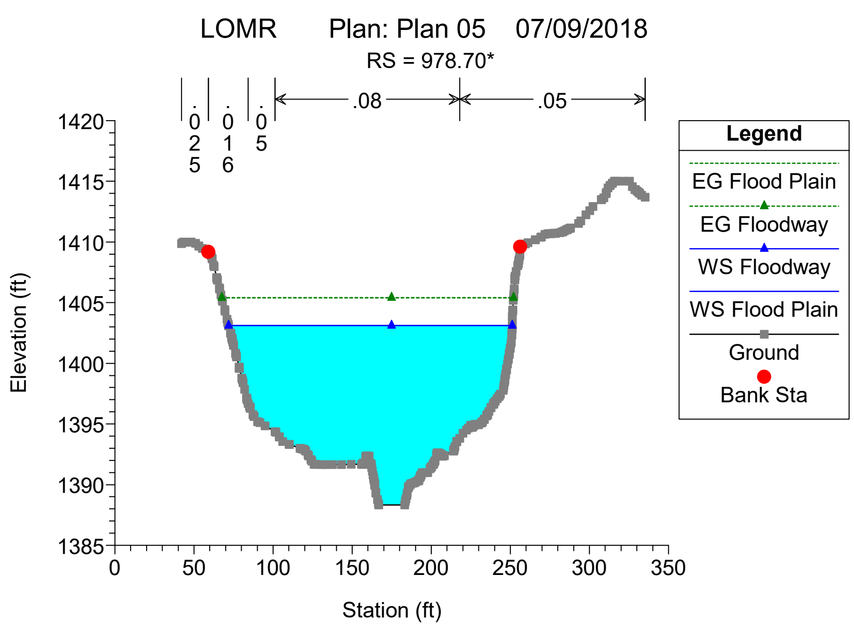
50
100
150
200
250
300
350
400

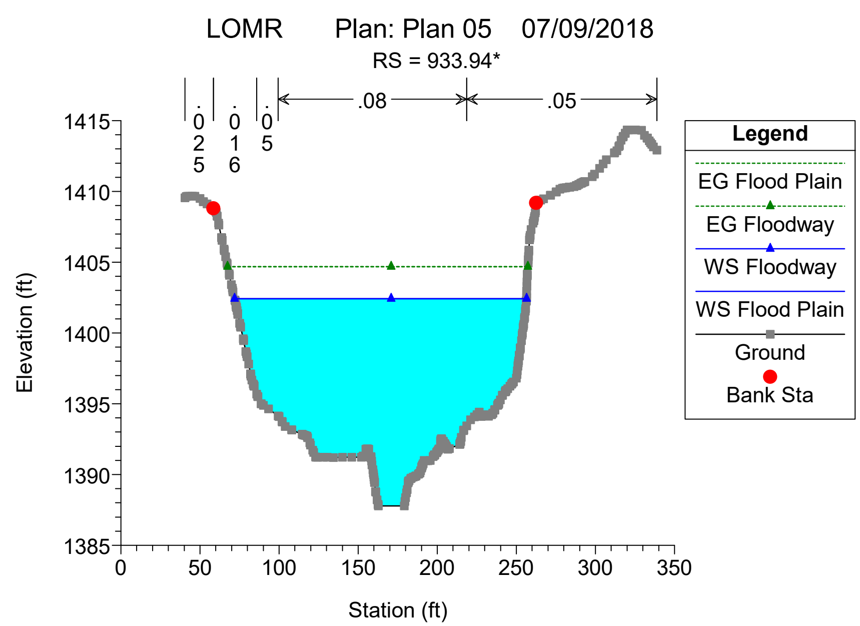

LOMR Plan: Plan 05 07/09/2018
RS = 1295.06*
.025
.016
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1425
1420
1415
1410
1405
1400
1395
1390
50
100
150
200
250
300
350

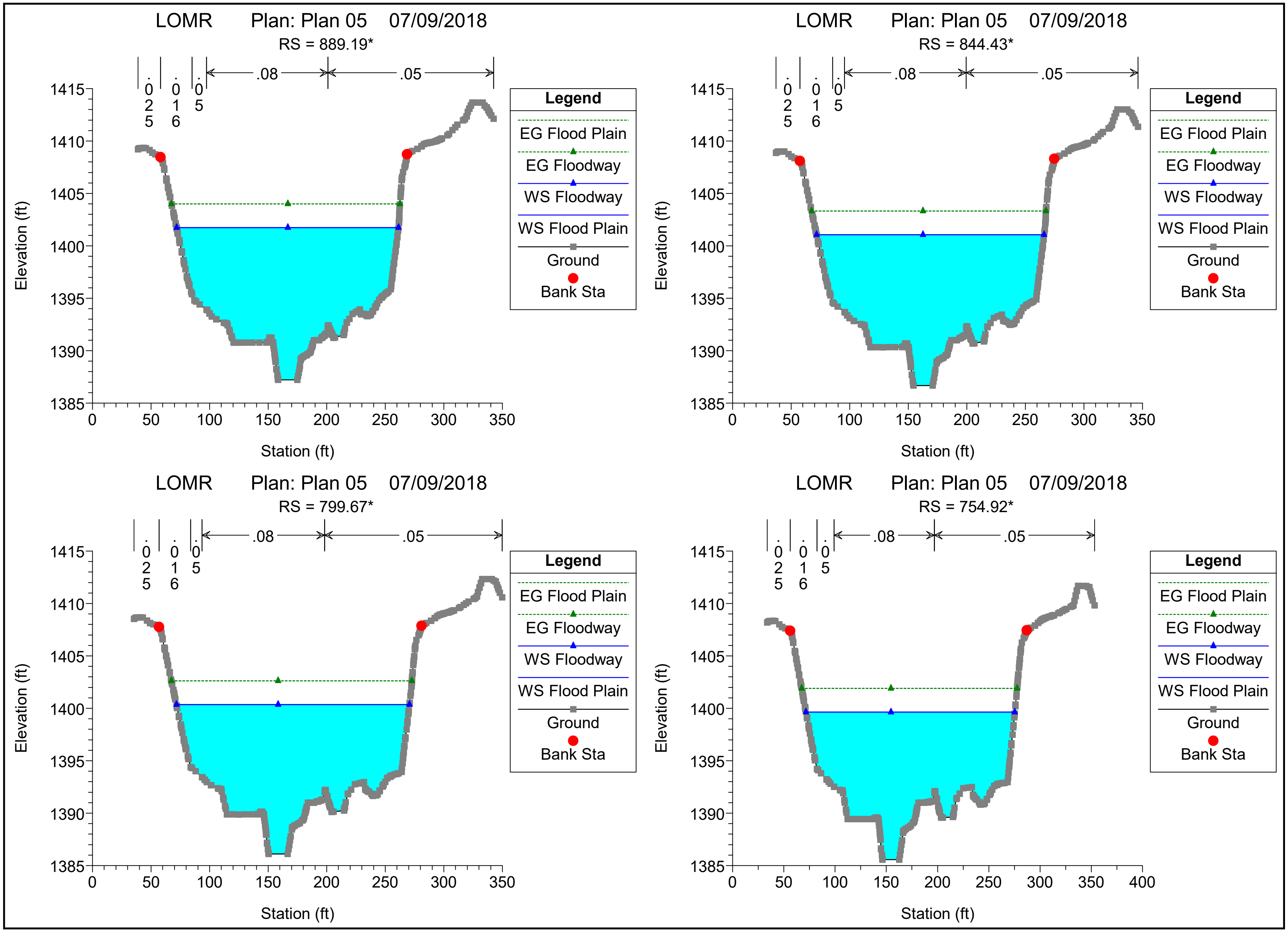

LOMR Plan: Plan 05 07/09/2018
RS = 1248.45*
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMR Plan: Plan 05 07/09/2018
RS = 1201.84
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMR Plan: Plan 05 07/09/2018
RS = 1157.41*
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMR Plan: Plan 05 07/09/2018
RS = 1112.97
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

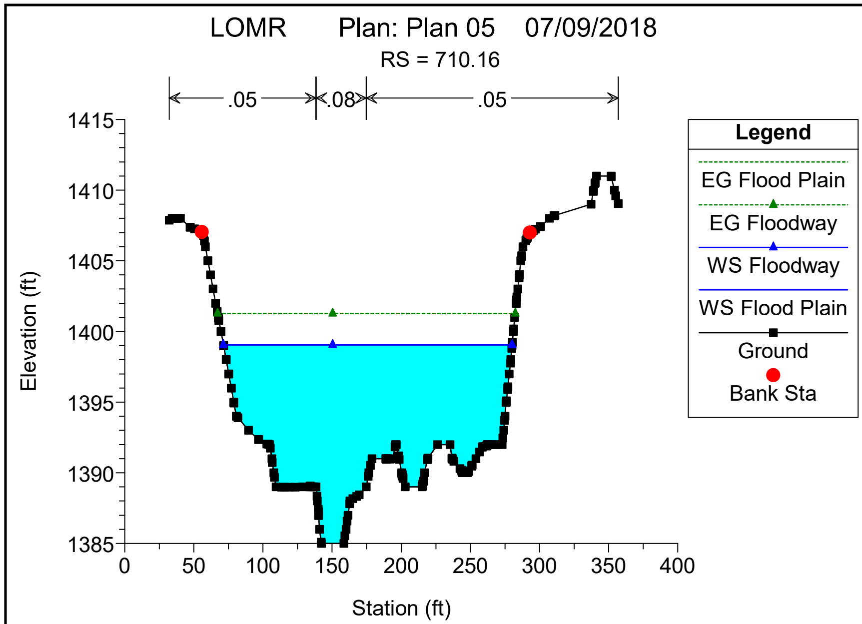

LOMR Plan: Plan 05 07/09/2018
RS = 1068.21*
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

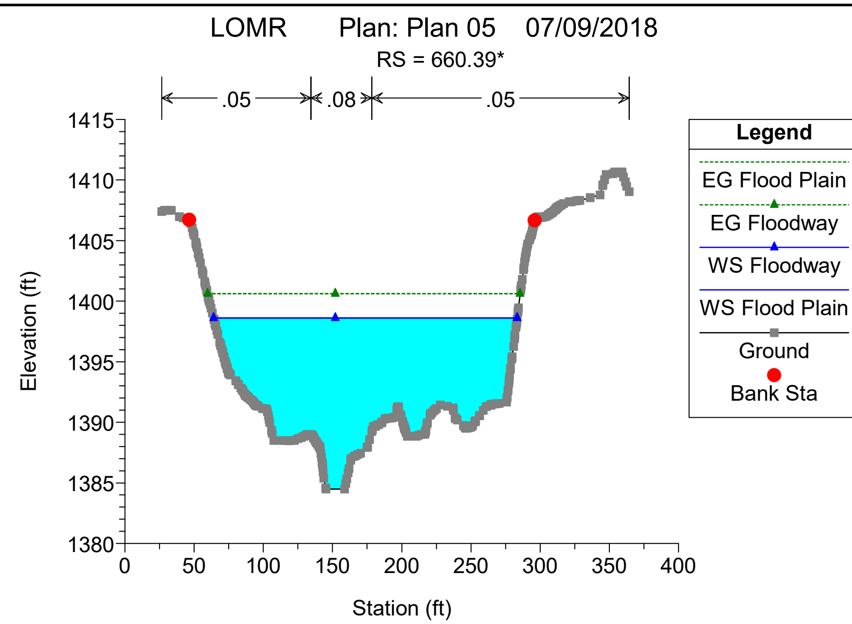

LOMR Plan: Plan 05 07/09/2018
RS = 1023.46*
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

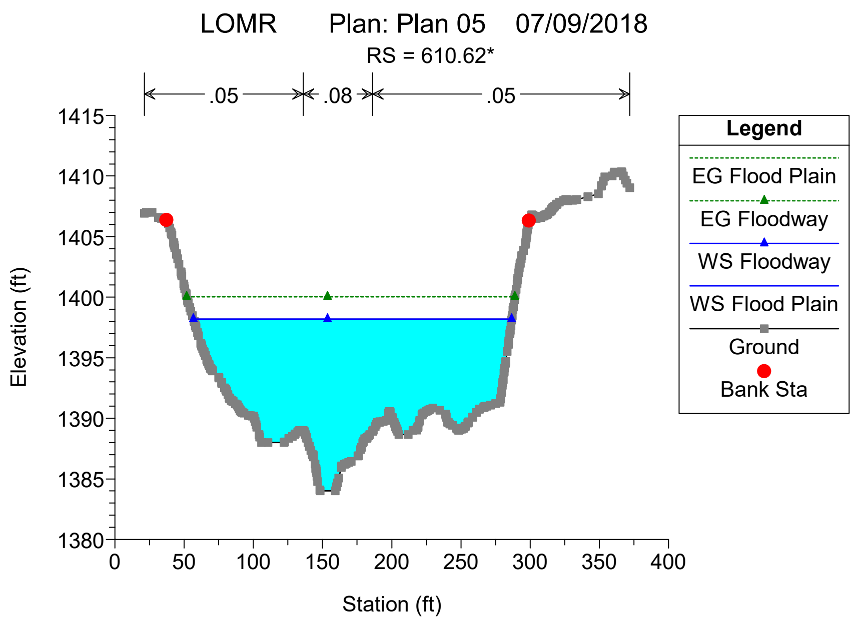

LOMR Plan: Plan 05 07/09/2018
RS = 978.70*
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

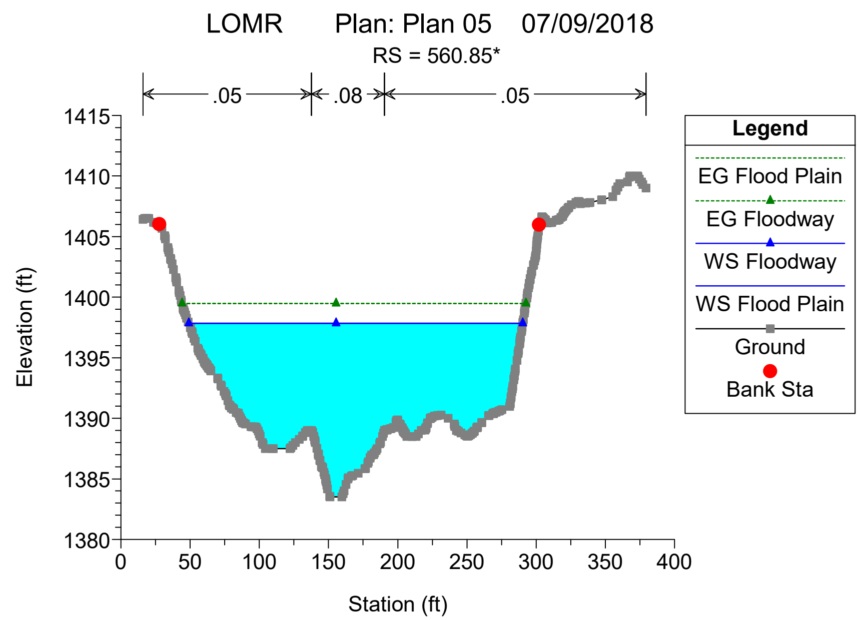

LOMR Plan: Plan 05 07/09/2018
RS = 933.94*
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

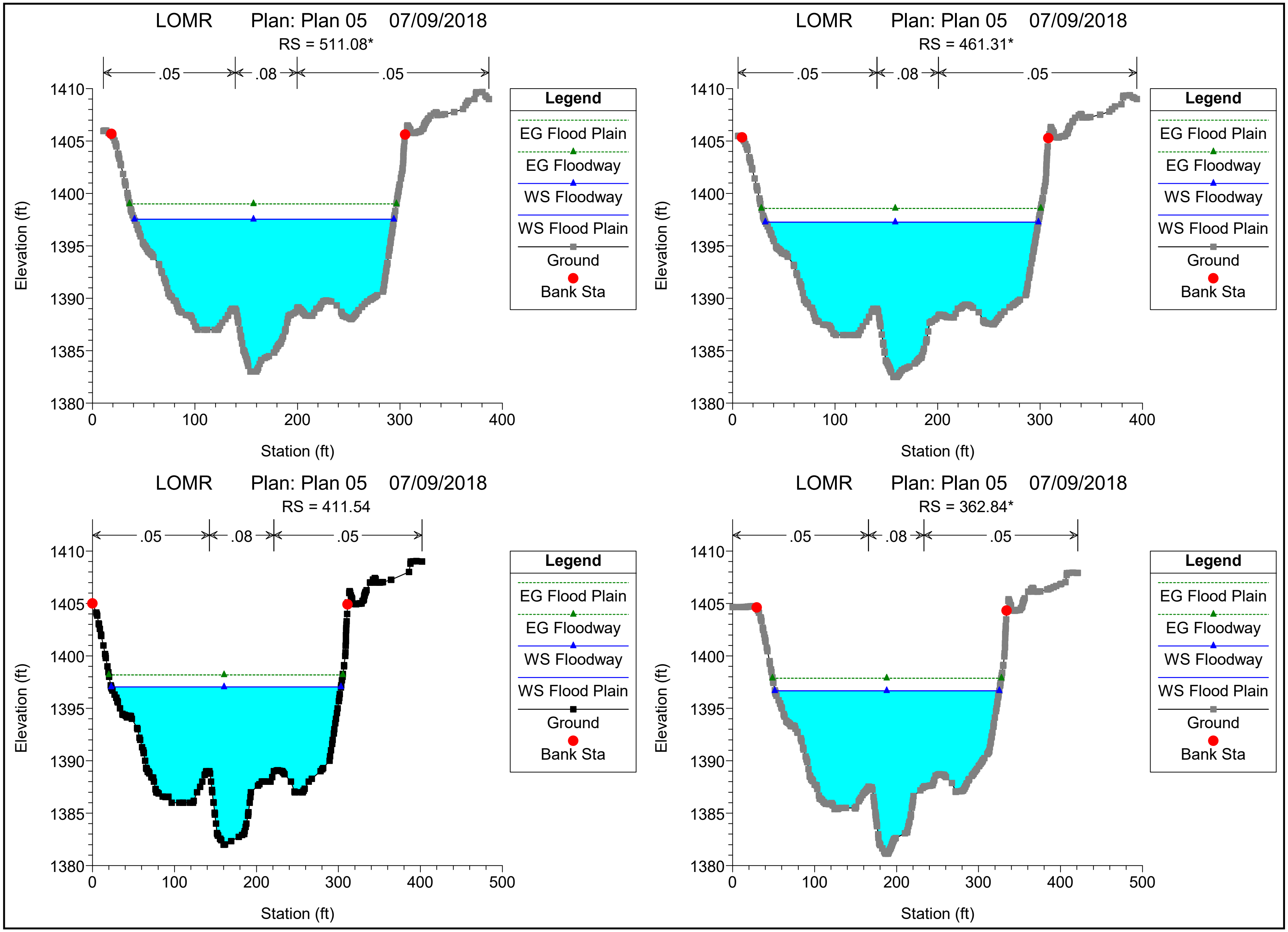

LOMR Plan: Plan 05 07/09/2018
RS = 889.19*
.025 .016 .05 .08 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 844.43*
.025 .016 .05 .08 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 799.67*
.025 .016 .05 .08 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 754.92*
.025 .016 .05 .08 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

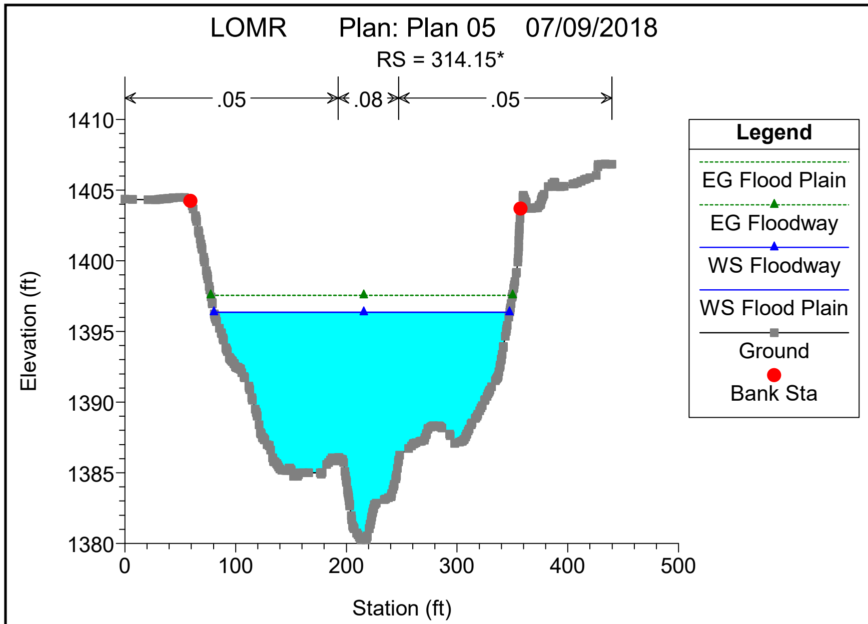

LOMR Plan: Plan 05 07/09/2018
RS = 710.16
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1415
1410
1405
1400
1395
1390
1385
0
50
100
150
200
250
300
350
400
Station (ft)

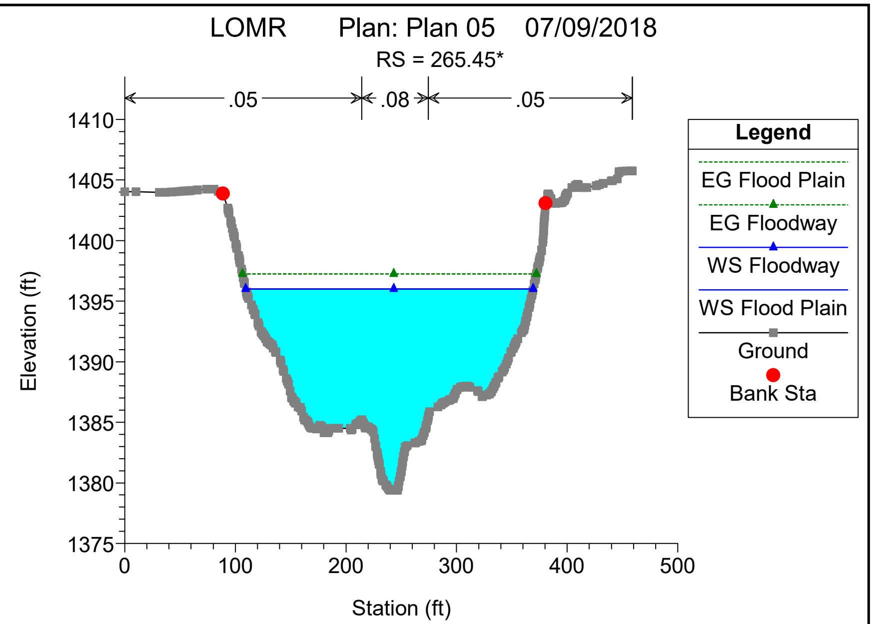

LOMR Plan: Plan 05 07/09/2018
RS = 660.39*
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1415
1410
1405
1400
1395
1390
1385
1380
0
50
100
150
200
250
300
350
400
Station (ft)


LOMR Plan: Plan 05 07/09/2018
RS = 610.62*
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1415
1410
1405
1400
1395
1390
1385
1380
0
50
100
150
200
250
300
350
400
Station (ft)


LOMR Plan: Plan 05 07/09/2018
RS = 560.85*
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1415
1410
1405
1400
1395
1390
1385
1380
0
50
100
150
200
250
300
350
400
Station (ft)


LOMR Plan: Plan 05 07/09/2018
RS = 511.08*
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 461.31*
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 411.54
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMR Plan: Plan 05 07/09/2018
RS = 362.84*
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 314.15*
.05
.08
.05
Elevation (ft)
1410
1405
1400
1395
1390
1385
1380
0
100
200
300
400
500
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 265.45*
.05
.08
.05
Elevation (ft)
1410
1405
1400
1395
1390
1385
1380
1375
0
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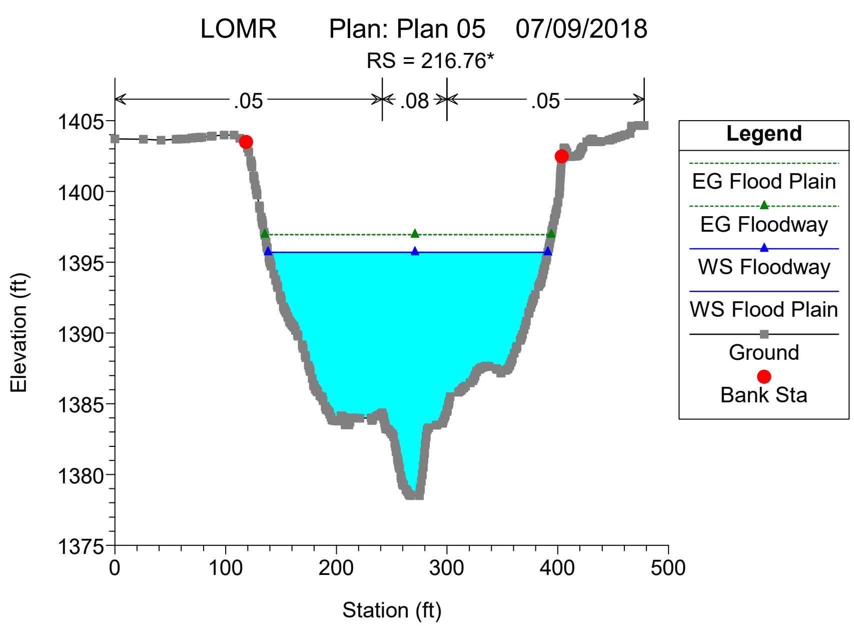
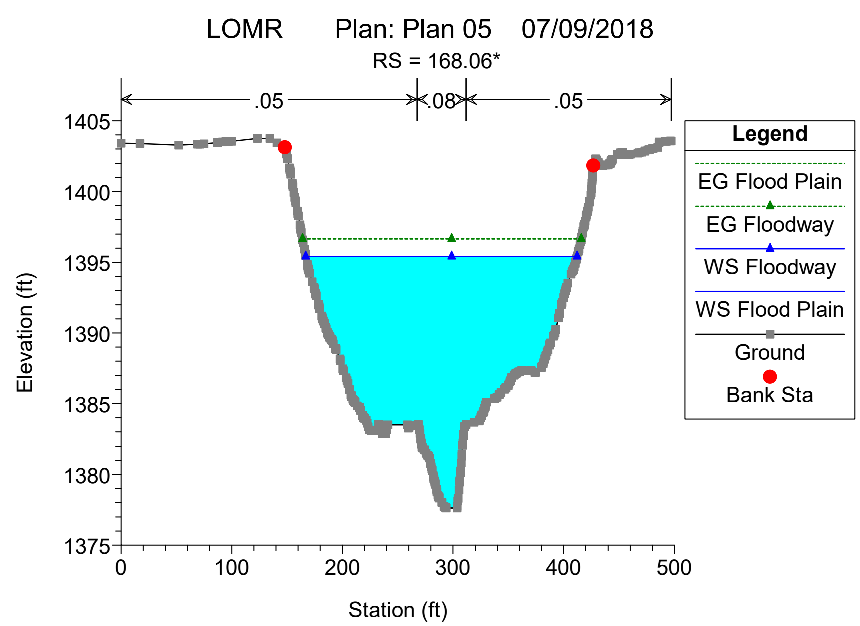
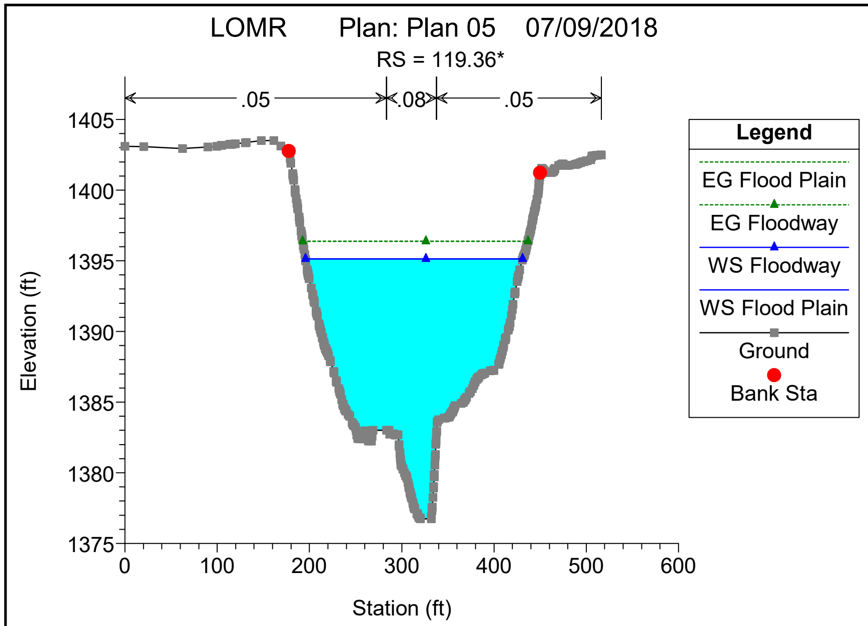
200
300
400
500
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 216.76*
.05
.08
.05
Elevation (ft)
1405
1400
1395
1390
1385
1380
1375
0
100
200
300
400
500
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 168.06*
.05
.08
.05
Elevation (ft)
1405
1400
1395
1390
1385
1380
1375
0
100
200
300
400
500
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 119.36*
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.08
.05
1405
1400
1395
1390
1385
1380
1375
Elevation (ft)
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100
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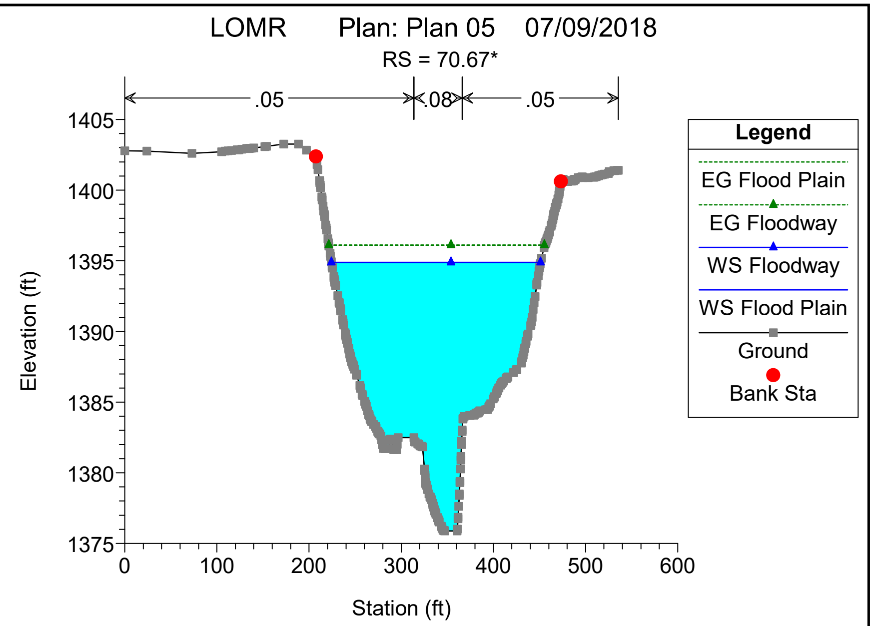
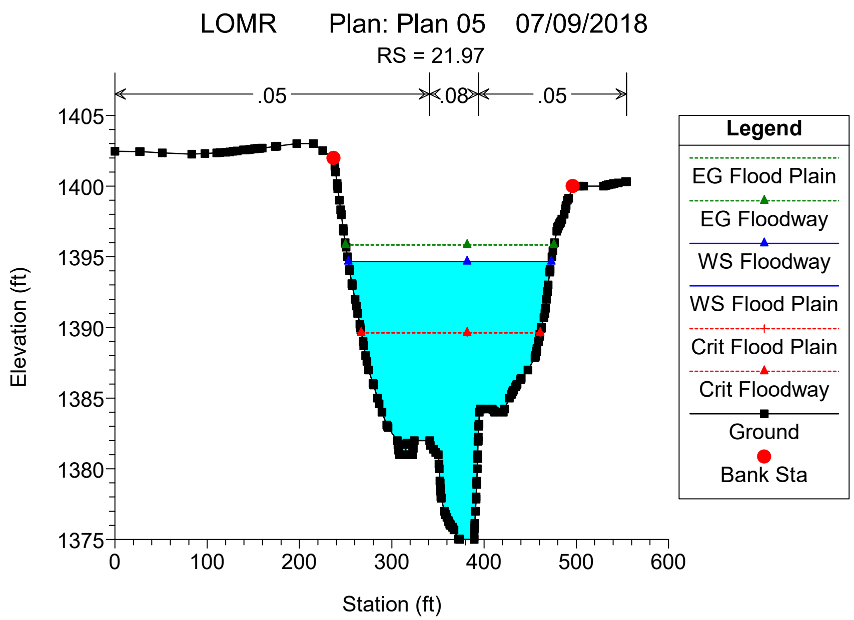
300
400
500
600
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 70.67*
.05
.08
.05
1405
1400
1395
1390
1385
1380
1375
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMR Plan: Plan 05 07/09/2018
RS = 21.97
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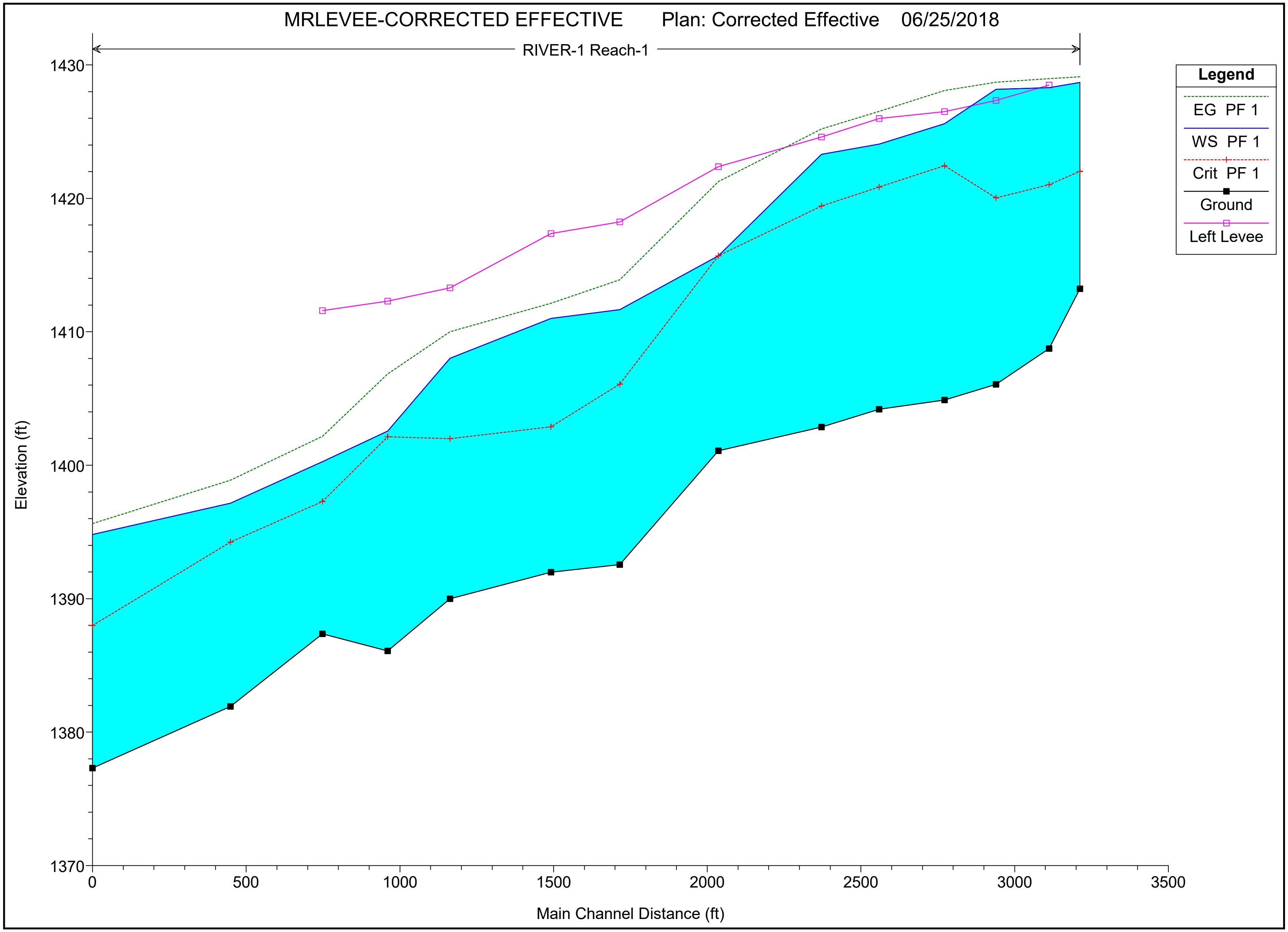
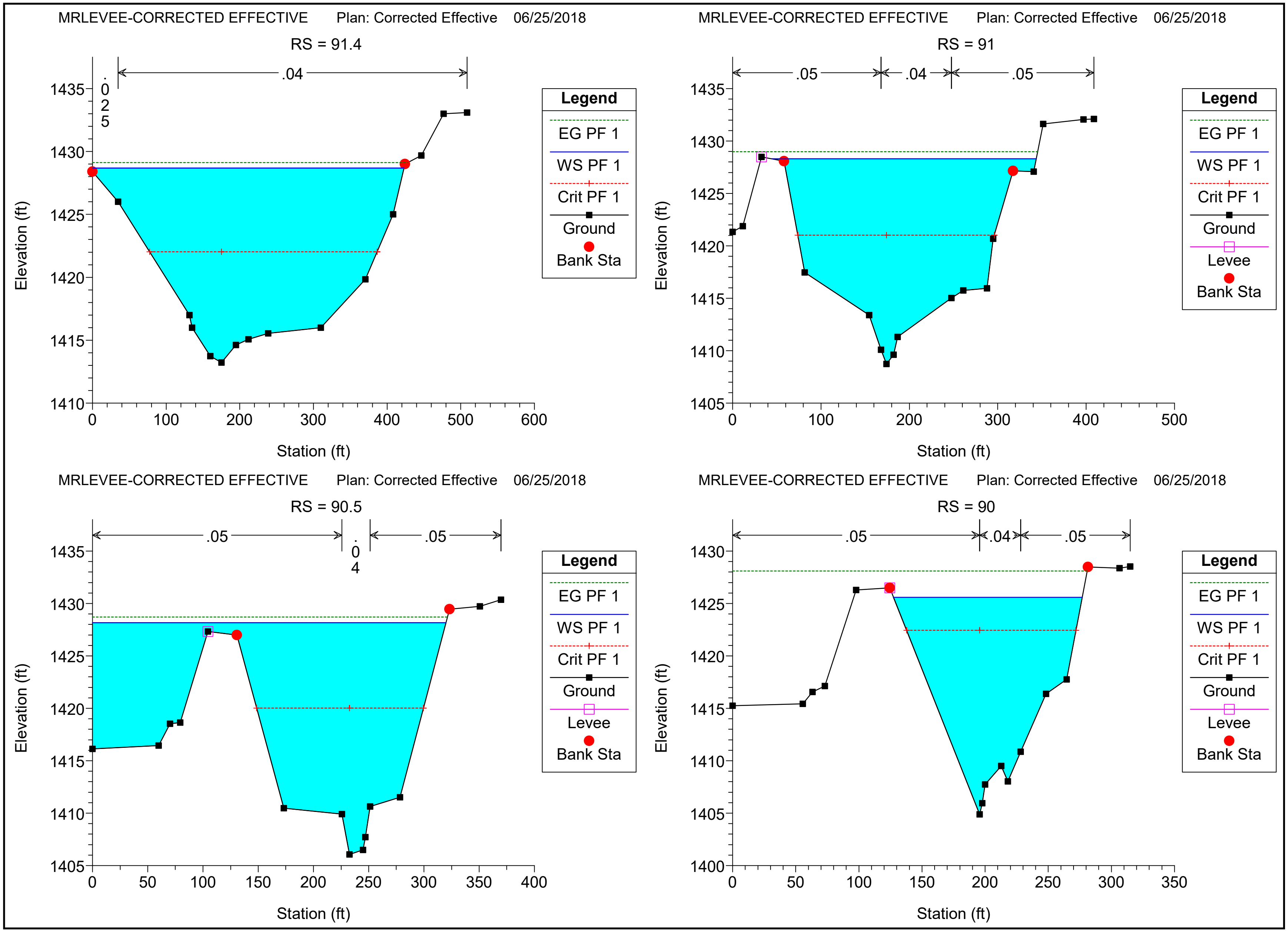
.08
.05
1405
1400
1395
1390
1385
1380
1375
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

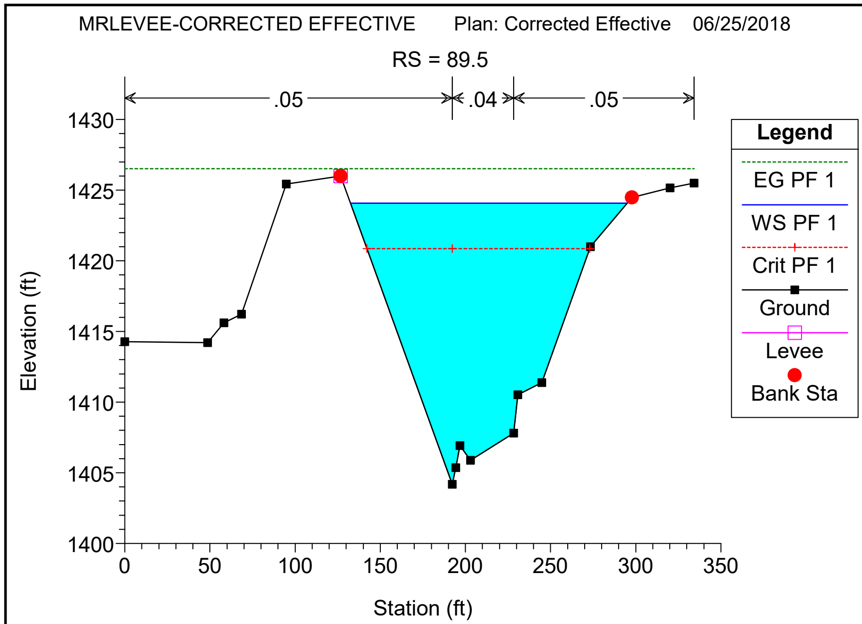
HEC-RAS Model: Corrected Effective Model

HEC-RAS Plan: COR River: RIVER-1 Reach: Reach-1 Profile: PF 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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	91.4	PF 1	21400.00	1413.22	1428.68	1422.02	1429.11	0.000896	5.24	4083.33	422.87	0.30
Reach-1	91	PF 1	21400.00	1408.74	1428.30	1421.02	1428.98	0.001345	6.60	3269.21	299.04	0.33
Reach-1	90.5	PF 1	21400.00	1406.06	1428.18	1420.02	1428.70	0.001251	6.15	3758.11	319.93	0.29
Reach-1	90	PF 1	21400.00	1404.89	1425.59	1422.45	1428.09	0.007057	12.68	1688.19	149.53	0.67
Reach-1	89.5	PF 1	21400.00	1404.19	1424.07	1420.85	1426.52	0.007561	12.56	1703.85	162.36	0.68
Reach-1	89	PF 1	21400.00	1402.86	1423.30	1419.43	1425.21	0.005064	11.08	1931.61	172.47	0.58
Reach-1	88	PF 1	21400.00	1401.09	1415.69	1415.69	1421.26	0.035619	18.93	1130.59	101.42	1.00
Reach-1	87.4	PF 1	21400.00	1392.56	1411.66	1406.07	1413.90	0.008833	12.01	1781.62	121.54	0.55
Reach-1	87	PF 1	21400.00	1391.98	1410.99	1402.88	1412.14	0.004817	8.59	2490.06	158.75	0.38
Reach-1	86.4	PF 1	21400.00	1390.00	1408.02	1401.99	1410.00	0.008508	11.30	1894.11	125.54	0.51
Reach-1	86	PF 1	21400.00	1386.09	1402.56	1402.13	1406.85	0.029318	16.61	1288.54	132.29	0.94
Reach-1	85.4	PF 1	21400.00	1387.36	1400.27	1397.28	1402.17	0.012969	11.07	1932.59	190.76	0.61
Reach-1	85	PF 1	21400.00	1381.93	1397.15	1394.24	1398.87	0.009184	10.52	2033.52	217.13	0.61
Reach-1	84	PF 1	21400.00	1377.30	1394.82	1387.98	1395.63	0.005003	7.28	2951.23	231.43	0.35


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RIVER-1 Reach-1
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Left Levee
Elevation (ft)
1430
1420
1410
1400
1390
1380
1370
0
500
1000
1500
2000
2500
3000
3500
Main Channel Distance (ft)


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 91.4
.025
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 91
.05
.04
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 90.5
.05
.04
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 90
.05
.04
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
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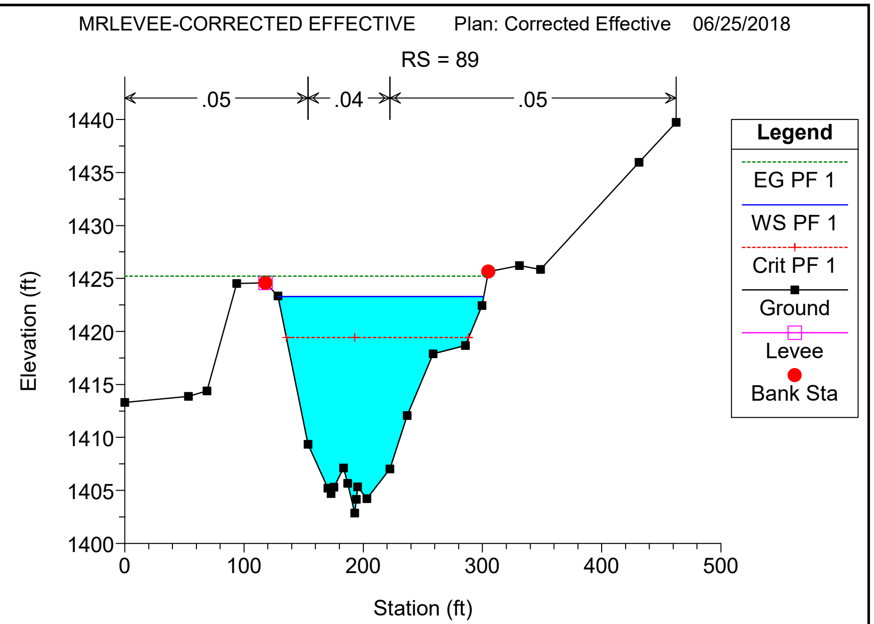
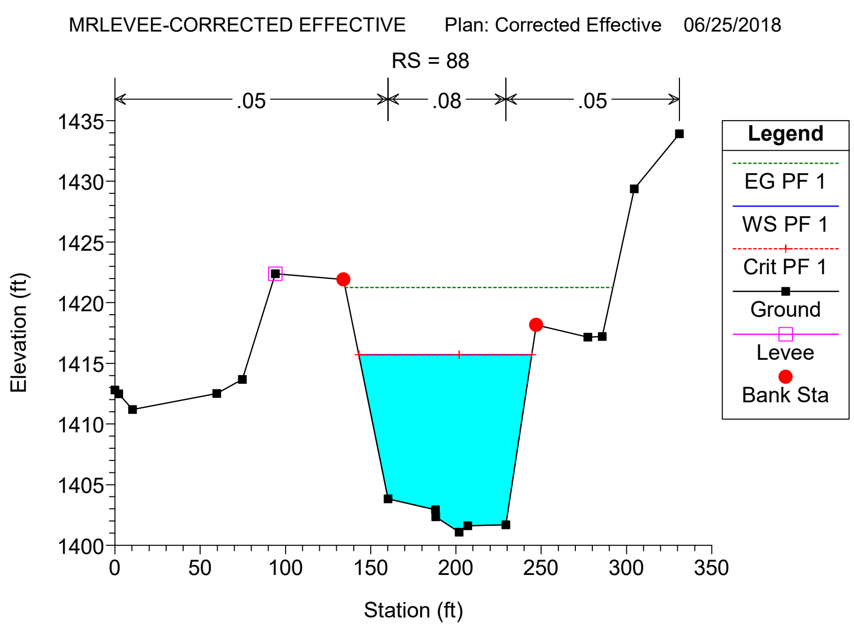
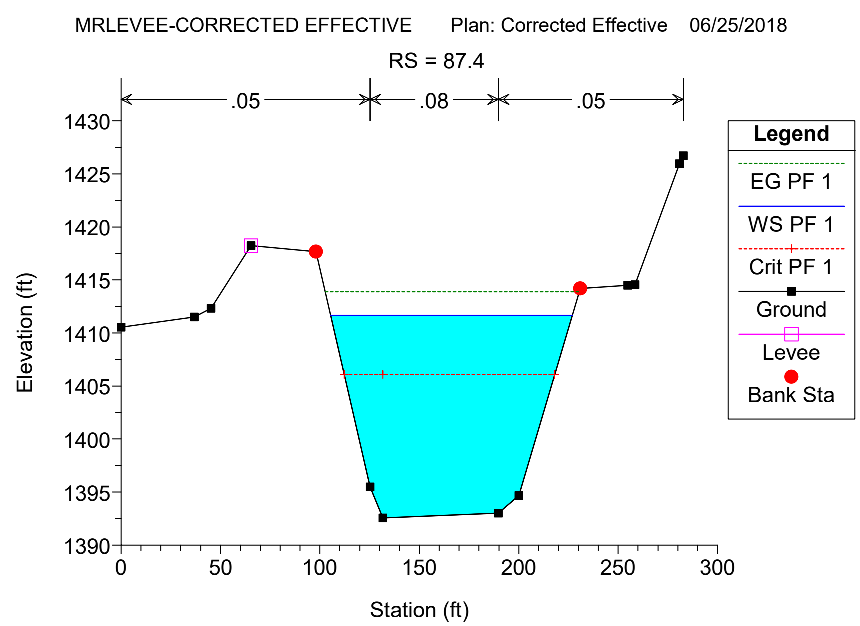
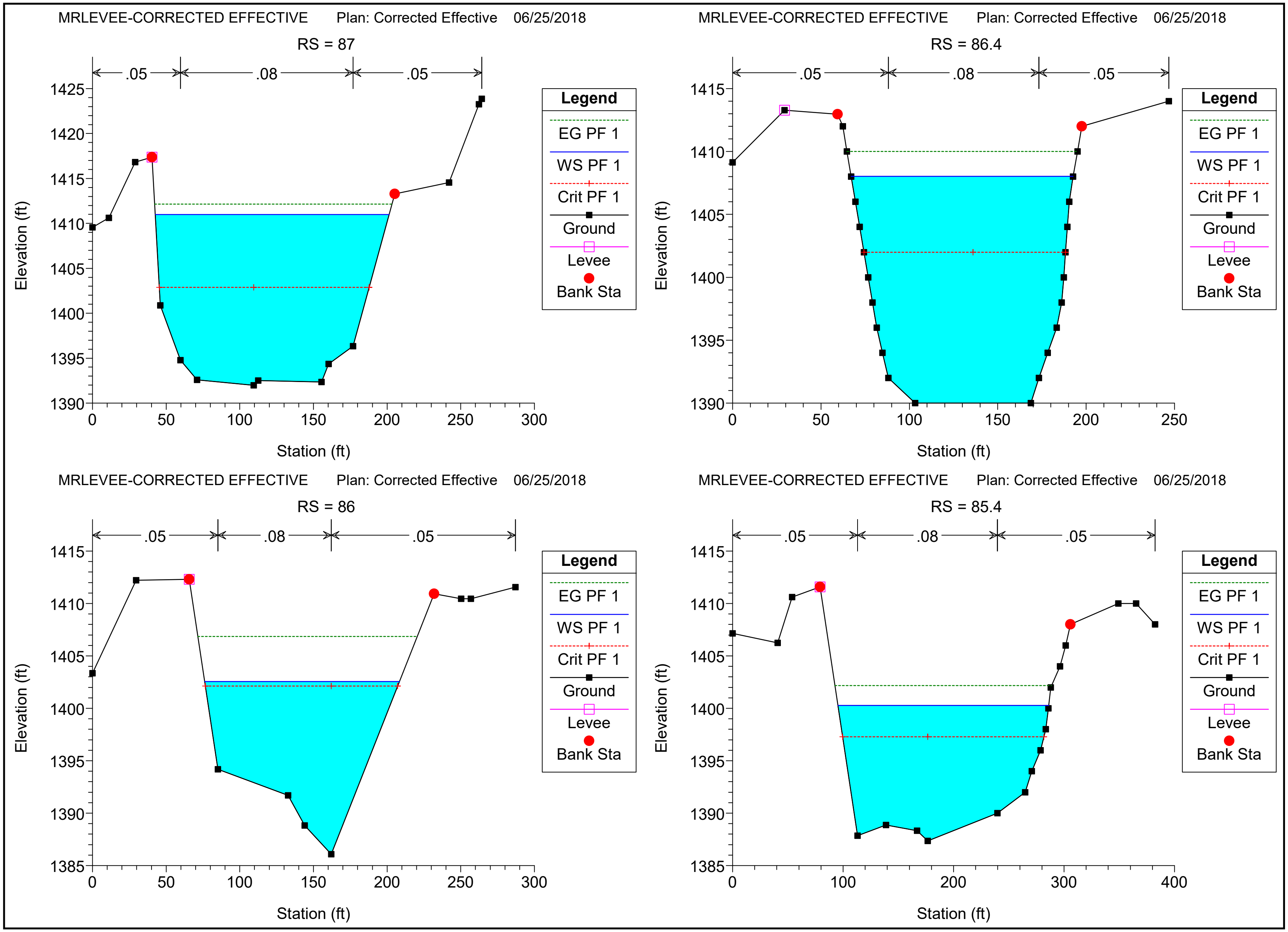
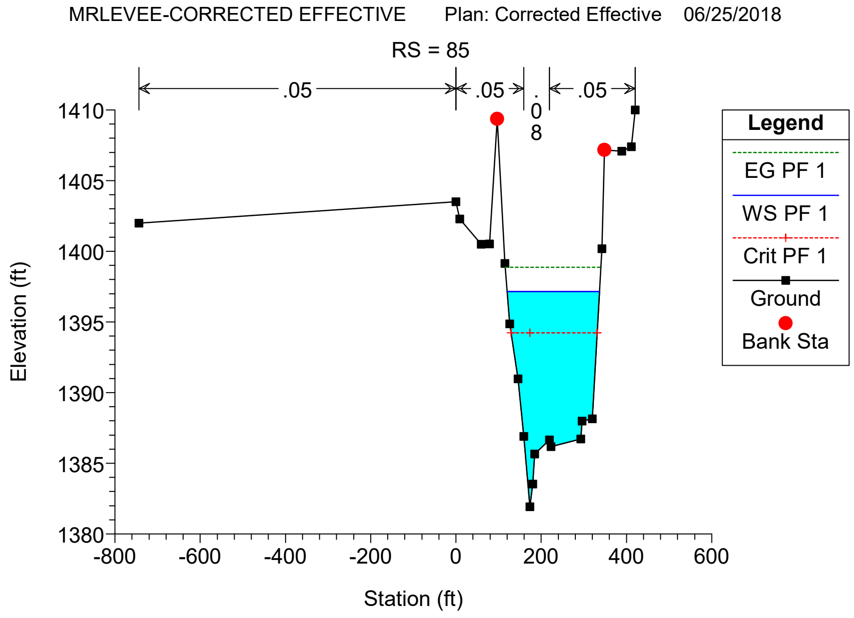
.05 .04 .05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

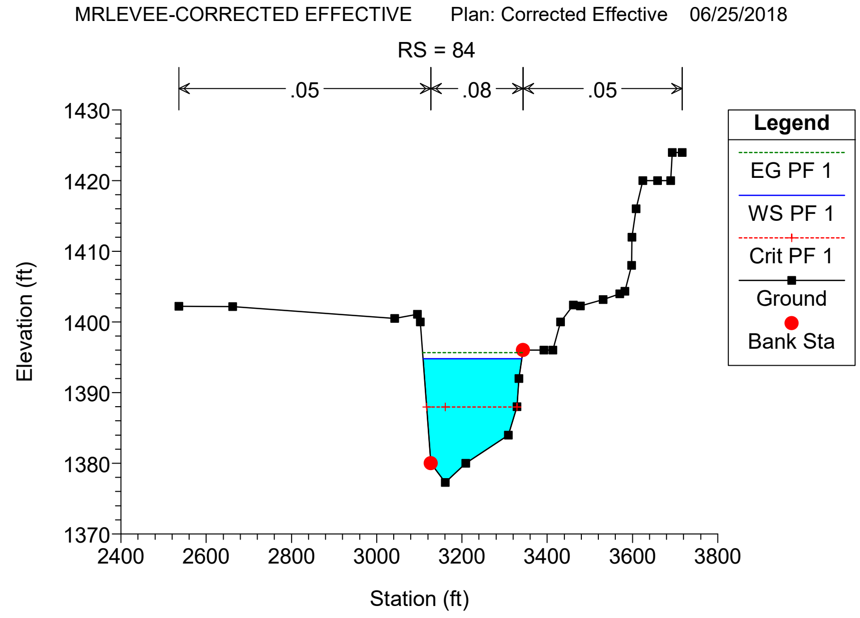

MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 89
.05 .04 .05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 88
.05 .08 .05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 87.4
.05 .08 .05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 87
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 86.4
MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 86
MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 85.4


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 85
.05
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
1410
1405
1400
1395
1390
1385
1380
-800
-600
-400
-200
0
200
400
600
Station (ft)


MRLEVEE-CORRECTED EFFECTIVE Plan: Corrected Effective 06/25/2018
RS = 84
.05
.08
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
1430
1420
1410
1400
1390
1380
1370
2400
2600
2800
3000
3200
3400
3600
3800
Station (ft)

HEC-RAS Model: Mixed Flow Regime

HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2

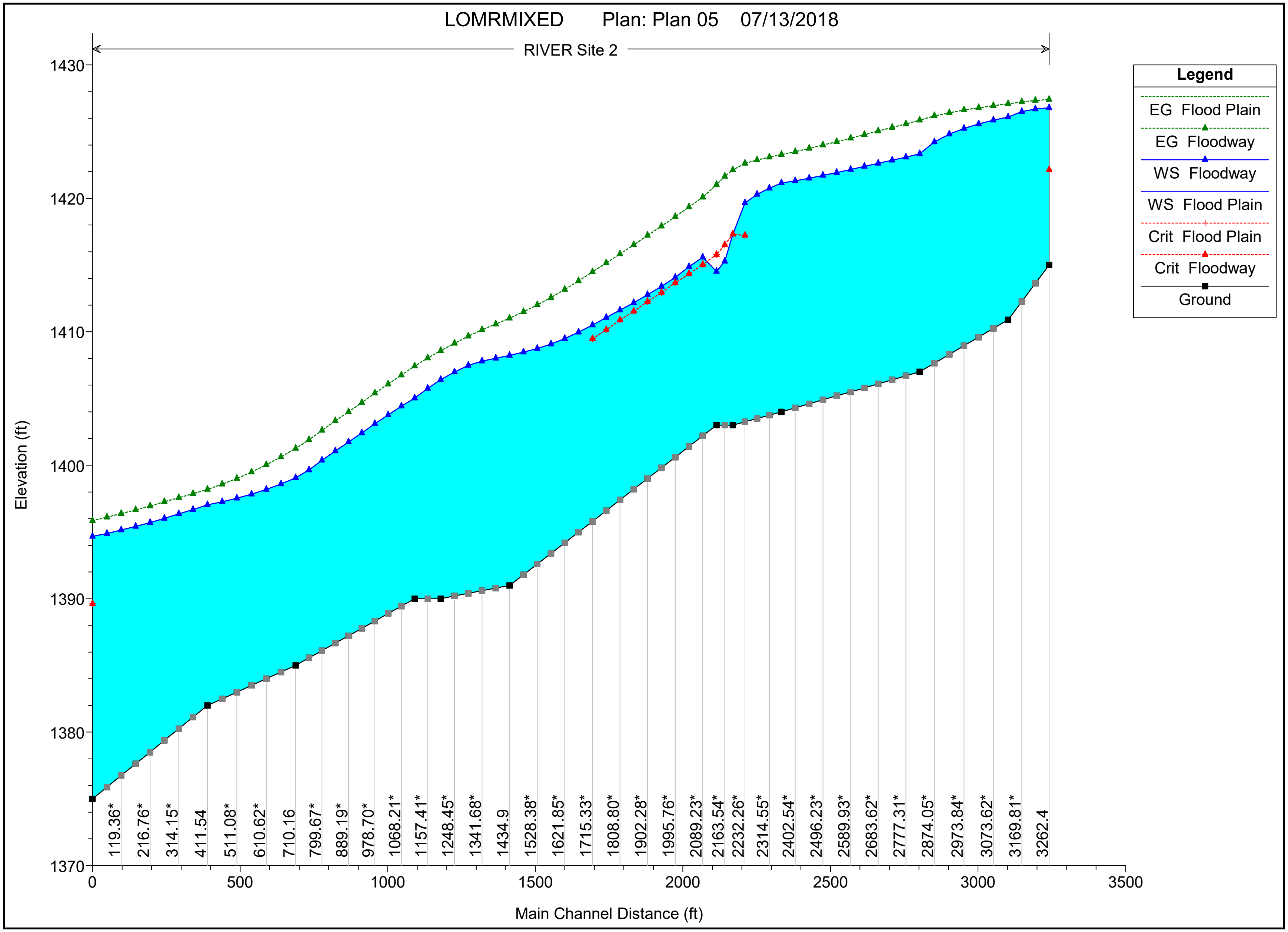
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	3262.4	Flood Plain	21400.00	1415.00	1426.78	1422.13	1427.41	0.001715	6.39	3346.60	391.20	0.39
Site 2	3262.4	Floodway	21400.00	1415.00	1426.78	1422.13	1427.41	0.001715	6.39	3346.60	391.20	0.39
Site 2	3216.10*	Flood Plain	21400.00	1413.63	1426.69		1427.33	0.002074	6.41	3336.40	367.92	0.38
Site 2	3216.10*	Floodway	21400.00	1413.63	1426.69		1427.33	0.002074	6.41	3336.40	367.92	0.38
Site 2	3169.81*	Flood Plain	21400.00	1412.27	1426.49		1427.22	0.002053	6.85	3122.00	312.15	0.38
Site 2	3169.81*	Floodway	21400.00	1412.27	1426.49		1427.22	0.002053	6.85	3122.00	312.15	0.38
Site 2	3123.51	Flood Plain	21400.00	1410.90	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43
Site 2	3123.51	Floodway	21400.00	1410.90	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43
Site 2	3073.62*	Flood Plain	21400.00	1410.25	1425.85		1426.95	0.002741	8.39	2550.19	231.79	0.45
Site 2	3073.62*	Floodway	21400.00	1410.25	1425.85		1426.95	0.002741	8.39	2550.19	231.79	0.45
Site 2	3023.73*	Flood Plain	21400.00	1409.60	1425.57		1426.79	0.002965	8.86	2415.55	216.27	0.47
Site 2	3023.73*	Floodway	21400.00	1409.60	1425.57		1426.79	0.002965	8.86	2415.55	216.27	0.47
Site 2	2973.84*	Flood Plain	21400.00	1408.95	1425.23		1426.62	0.003334	9.44	2266.58	200.39	0.49
Site 2	2973.84*	Floodway	21400.00	1408.95	1425.23		1426.62	0.003334	9.44	2266.58	200.39	0.49
Site 2	2923.94*	Flood Plain	21400.00	1408.30	1424.80		1426.42	0.003815	10.19	2100.33	184.52	0.53
Site 2	2923.94*	Floodway	21400.00	1408.30	1424.80		1426.42	0.003815	10.19	2100.33	184.52	0.53
Site 2	2874.05*	Flood Plain	21400.00	1407.65	1424.22		1426.17	0.004647	11.20	1910.09	168.45	0.59
Site 2	2874.05*	Floodway	21400.00	1407.65	1424.22		1426.17	0.004647	11.20	1910.09	168.45	0.59
Site 2	2824.16	Flood Plain	21400.00	1407.00	1423.33		1425.86	0.005803	12.75	1679.07	151.80	0.68
Site 2	2824.16	Floodway	21400.00	1407.00	1423.33		1425.86	0.005803	12.75	1679.07	151.80	0.68
Site 2	2777.31*	Flood Plain	21400.00	1406.70	1423.09		1425.58	0.005638	12.65	1691.78	153.45	0.67
Site 2	2777.31*	Floodway	21400.00	1406.70	1423.09		1425.58	0.005638	12.65	1691.78	153.45	0.67
Site 2	2730.47*	Flood Plain	21400.00	1406.40	1422.86		1425.30	0.005567	12.55	1705.06	155.10	0.67
Site 2	2730.47*	Floodway	21400.00	1406.40	1422.86		1425.30	0.005567	12.55	1705.06	155.10	0.67
Site 2	2683.62*	Flood Plain	21400.00	1406.10	1422.62		1425.03	0.005515	12.46	1717.99	156.70	0.66
Site 2	2683.62*	Floodway	21400.00	1406.10	1422.62		1425.03	0.005515	12.46	1717.99	156.70	0.66
Site 2	2636.77*	Flood Plain	21400.00	1405.80	1422.39		1424.77	0.005435	12.36	1731.08	158.28	0.66
Site 2	2636.77*	Floodway	21400.00	1405.80	1422.39		1424.77	0.005435	12.36	1731.08	158.28	0.66
Site 2	2589.93*	Flood Plain	21400.00	1405.50	1422.16		1424.50	0.005376	12.27	1744.17	159.80	0.65
Site 2	2589.93*	Floodway	21400.00	1405.50	1422.16		1424.50	0.005376	12.27	1744.17	159.80	0.65
Site 2	2543.08*	Flood Plain	21400.00	1405.20	1421.94		1424.24	0.005275	12.18	1757.64	160.61	0.65
Site 2	2543.08*	Floodway	21400.00	1405.20	1421.94		1424.24	0.005275	12.18	1757.64	160.61	0.65
Site 2	2496.23*	Flood Plain	21400.00	1404.90	1421.72		1423.99	0.005150	12.08	1772.01	161.31	0.64
Site 2	2496.23*	Floodway	21400.00	1404.90	1421.72		1423.99	0.005150	12.08	1772.01	161.31	0.64
Site 2	2449.38*	Flood Plain	21400.00	1404.60	1421.51		1423.74	0.005012	11.97	1787.50	162.13	0.64
Site 2	2449.38*	Floodway	21400.00	1404.60	1421.51		1423.74	0.005012	11.97	1787.50	162.13	0.64
Site 2	2402.54*	Flood Plain	21400.00	1404.30	1421.31		1423.49	0.004896	11.86	1804.01	162.78	0.63
Site 2	2402.54*	Floodway	21400.00	1404.30	1421.31		1423.49	0.004896	11.86	1803.99	162.78	0.63
Site 2	2355.69	Flood Plain	21400.00	1404.00	1421.14		1423.27	0.003839	11.71	1827.04	163.57	0.62
Site 2	2355.69	Floodway	21400.00	1404.00	1421.14		1423.27	0.003839	11.71	1827.06	163.57	0.62
Site 2	2314.55*	Flood Plain	21400.00	1403.75	1420.77		1423.09	0.004284	12.22	1750.71	157.63	0.65
Site 2	2314.55*	Floodway	21400.00	1403.75	1420.77		1423.09	0.004283	12.22	1750.75	157.63	0.65
Site 2	2273.40*	Flood Plain	21400.00	1403.50	1420.29		1422.87	0.004843	12.89	1660.63	150.87	0.68
Site 2	2273.40*	Floodway	21400.00	1403.50	1420.29		1422.87	0.004842	12.89	1660.64	150.87	0.68
Site 2	2232.26*	Flood Plain	21400.00	1403.25	1419.65	1417.23	1422.62	0.005424	13.82	1548.21	143.28	0.74
Site 2	2232.26*	Floodway	21400.00	1403.25	1419.65	1417.23	1422.62	0.005423	13.82	1548.25	143.28	0.74
Site 2	2191.11	Flood Plain	21400.00	1403.00	1417.32	1417.32	1422.13	0.010390	17.60	1215.68	126.08	1.00
Site 2	2191.11	Floodway	21400.00	1403.00	1417.32	1417.32	1422.13	0.010392	17.61	1215.55	126.07	1.00
Site 2	2163.54*	Flood Plain	21400.00	1403.00	1415.29	1416.51	1421.64	0.015300	20.21	1058.72	117.87	1.19
Site 2	2163.54*	Floodway	21400.00	1403.00	1415.29	1416.51	1421.64	0.015300	20.21	1058.72	117.87	1.19
Site 2	2135.97	Flood Plain	21400.00	1403.00	1414.52	1415.78	1421.02	0.032885	20.47	1045.67	115.90	1.20
Site 2	2135.97	Floodway	21400.00	1403.00	1414.52	1415.78	1421.02	0.032885	20.47	1045.67	115.90	1.20
Site 2	2089.23*	Flood Plain	21400.00	1402.20	1415.59	1415.03	1420.08	0.015107	17.00	1259.04	122.57	0.93

HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2 (Continued)

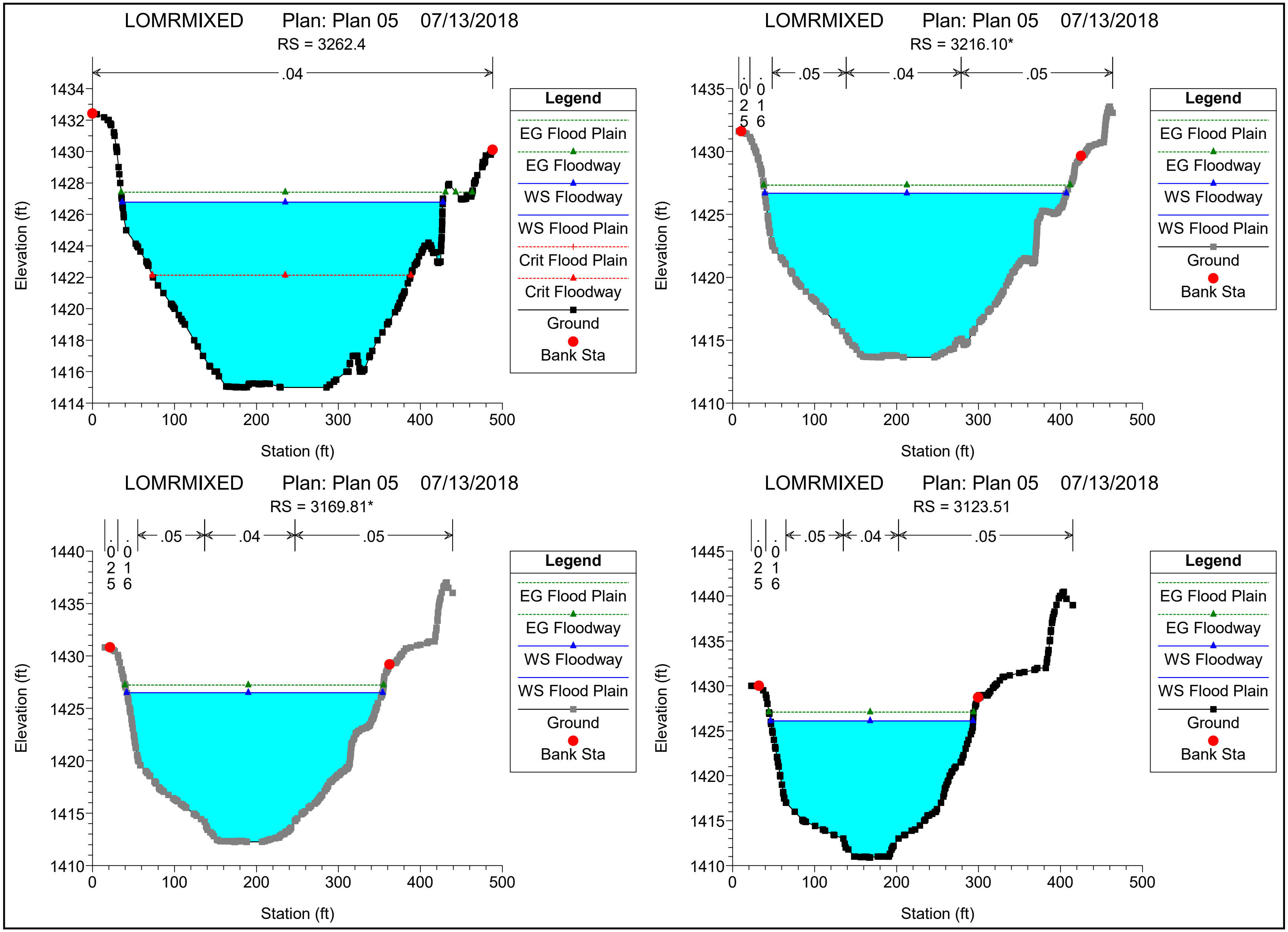
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	2089.23*	Floodway	21400.00	1402.20	1415.59	1415.03	1420.08	0.015107	17.00	1259.04	122.57	0.93
Site 2	2042.49*	Flood Plain	21400.00	1401.40	1414.87	1414.34	1419.36	0.015327	17.00	1259.07	123.04	0.94
Site 2	2042.49*	Floodway	21400.00	1401.40	1414.87	1414.34	1419.36	0.015327	17.00	1259.07	123.04	0.94
Site 2	1995.76*	Flood Plain	21400.00	1400.60	1414.08	1413.66	1418.63	0.015116	17.11	1250.87	123.18	0.95
Site 2	1995.76*	Floodway	21400.00	1400.60	1414.08	1413.66	1418.63	0.015116	17.11	1250.87	123.18	0.95
Site 2	1949.02*	Flood Plain	21400.00	1399.80	1413.41	1412.93	1417.92	0.014696	17.04	1255.81	123.73	0.94
Site 2	1949.02*	Floodway	21400.00	1399.80	1413.41	1412.94	1417.92	0.014696	17.04	1255.81	123.73	0.94
Site 2	1902.28*	Flood Plain	21400.00	1399.00	1412.77	1412.26	1417.22	0.014605	16.91	1265.25	124.40	0.93
Site 2	1902.28*	Floodway	21400.00	1399.00	1412.77	1412.26	1417.22	0.014605	16.91	1265.25	124.40	0.93
Site 2	1855.54*	Flood Plain	21400.00	1398.20	1412.17	1411.54	1416.52	0.013993	16.73	1279.49	125.19	0.92
Site 2	1855.54*	Floodway	21400.00	1398.20	1412.17	1411.54	1416.52	0.013993	16.73	1279.49	125.19	0.92
Site 2	1808.80*	Flood Plain	21400.00	1397.40	1411.63	1410.87	1415.84	0.013512	16.46	1300.18	126.13	0.90
Site 2	1808.80*	Floodway	21400.00	1397.40	1411.63	1410.87	1415.84	0.013512	16.46	1300.18	126.13	0.90
Site 2	1762.07*	Flood Plain	21400.00	1396.59	1411.07	1410.14	1415.16	0.013879	16.21	1320.37	127.03	0.89
Site 2	1762.07*	Floodway	21400.00	1396.59	1411.07	1410.14	1415.16	0.013879	16.21	1320.37	127.03	0.89
Site 2	1715.33*	Flood Plain	21400.00	1395.79	1410.51	1409.48	1414.48	0.013667	15.99	1338.30	127.89	0.87
Site 2	1715.33*	Floodway	21400.00	1395.79	1410.51	1409.48	1414.48	0.013667	15.99	1338.30	127.89	0.87
Site 2	1668.59*	Flood Plain	21400.00	1394.99	1409.97		1413.82	0.013127	15.73	1360.40	128.81	0.85
Site 2	1668.59*	Floodway	21400.00	1394.99	1409.97		1413.82	0.013127	15.73	1360.40	128.81	0.85
Site 2	1621.85*	Flood Plain	21400.00	1394.19	1409.49		1413.18	0.012272	15.40	1389.41	129.91	0.83
Site 2	1621.85*	Floodway	21400.00	1394.19	1409.49		1413.18	0.012272	15.40	1389.41	129.91	0.83
Site 2	1575.11*	Flood Plain	21400.00	1393.39	1409.08		1412.57	0.011131	14.98	1428.38	131.21	0.80
Site 2	1575.11*	Floodway	21400.00	1393.39	1409.08		1412.57	0.011131	14.98	1428.38	131.21	0.80
Site 2	1528.38*	Flood Plain	21400.00	1392.59	1408.75		1412.01	0.010087	14.49	1477.05	132.71	0.77
Site 2	1528.38*	Floodway	21400.00	1392.59	1408.75		1412.01	0.010087	14.49	1477.05	132.71	0.77
Site 2	1481.64*	Flood Plain	21400.00	1391.79	1408.47		1411.50	0.008803	13.94	1534.67	134.39	0.73
Site 2	1481.64*	Floodway	21400.00	1391.79	1408.47		1411.50	0.008803	13.94	1534.67	134.39	0.73
Site 2	1434.9	Flood Plain	21400.00	1390.99	1408.23		1411.02	0.008447	13.40	1597.58	136.18	0.69
Site 2	1434.9	Floodway	21400.00	1390.99	1408.23		1411.02	0.008447	13.40	1597.58	136.18	0.69
Site 2	1388.29*	Flood Plain	21400.00	1390.79	1408.02		1410.57	0.007947	12.82	1669.87	141.46	0.66
Site 2	1388.29*	Floodway	21400.00	1390.79	1408.02		1410.57	0.007947	12.82	1669.87	141.46	0.66
Site 2	1341.68*	Flood Plain	21400.00	1390.59	1407.80		1410.15	0.007640	12.29	1741.43	151.82	0.64
Site 2	1341.68*	Floodway	21400.00	1390.59	1407.80		1410.15	0.007640	12.29	1741.43	151.82	0.64
Site 2	1295.06*	Flood Plain	21400.00	1390.40	1407.48		1409.68	0.011086	11.90	1798.73	157.20	0.62
Site 2	1295.06*	Floodway	21400.00	1390.40	1407.48		1409.68	0.011086	11.90	1798.73	157.20	0.62
Site 2	1248.45*	Flood Plain	21400.00	1390.20	1406.98		1409.14	0.011510	11.77	1817.68	158.17	0.61
Site 2	1248.45*	Floodway	21400.00	1390.20	1406.98		1409.14	0.011510	11.77	1817.68	158.17	0.61
Site 2	1201.84	Flood Plain	21400.00	1390.00	1406.41		1408.58	0.012173	11.81	1811.80	158.94	0.62
Site 2	1201.84	Floodway	21400.00	1390.00	1406.41		1408.58	0.012173	11.81	1811.80	158.94	0.62
Site 2	1157.41*	Flood Plain	21400.00	1390.00	1405.76		1408.03	0.012372	12.07	1772.94	161.29	0.64
Site 2	1157.41*	Floodway	21400.00	1390.00	1405.76		1408.03	0.012372	12.07	1772.94	161.29	0.64
Site 2	1112.97	Flood Plain	21400.00	1390.00	1405.03		1407.43	0.014200	12.42	1723.67	162.87	0.67
Site 2	1112.97	Floodway	21400.00	1390.00	1405.03		1407.43	0.014200	12.42	1723.67	162.87	0.67
Site 2	1068.21*	Flood Plain	21400.00	1389.44	1404.42		1406.76	0.014791	12.28	1742.84	168.38	0.67
Site 2	1068.21*	Floodway	21400.00	1389.44	1404.42		1406.76	0.014791	12.28	1742.84	168.38	0.67
Site 2	1023.46*	Flood Plain	21400.00	1388.89	1403.78		1406.08	0.014994	12.18	1756.44	173.86	0.68
Site 2	1023.46*	Floodway	21400.00	1388.89	1403.78		1406.08	0.014994	12.18	1756.44	173.86	0.68
Site 2	978.70*	Flood Plain	21400.00	1388.33	1403.11		1405.40	0.015452	12.12	1765.45	179.29	0.68
Site 2	978.70*	Floodway	21400.00	1388.33	1403.11		1405.40	0.015452	12.12	1765.45	179.29	0.68
Site 2	933.94*	Flood Plain	21400.00	1387.78	1402.42		1404.69	0.015862	12.10	1768.13	184.50	0.69
Site 2	933.94*	Floodway	21400.00	1387.78	1402.42		1404.69	0.015862	12.10	1768.13	184.50	0.69
Site 2	889.19*	Flood Plain	21400.00	1387.22	1401.73		1404.00	0.015039	12.08	1772.18	189.46	0.70
Site 2	889.19*	Floodway	21400.00	1387.22	1401.73		1404.00	0.015039	12.08	1772.18	189.46	0.70

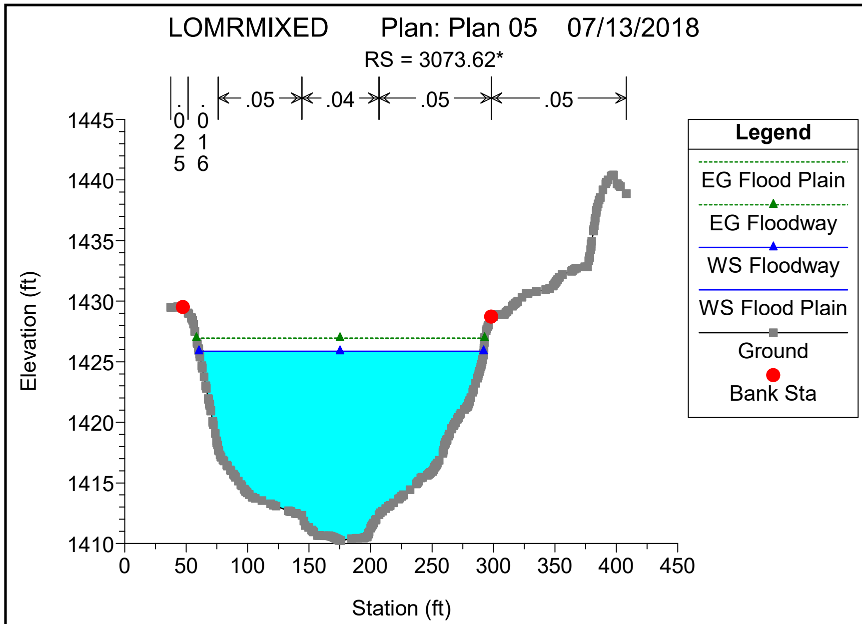
HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2 (Continued)

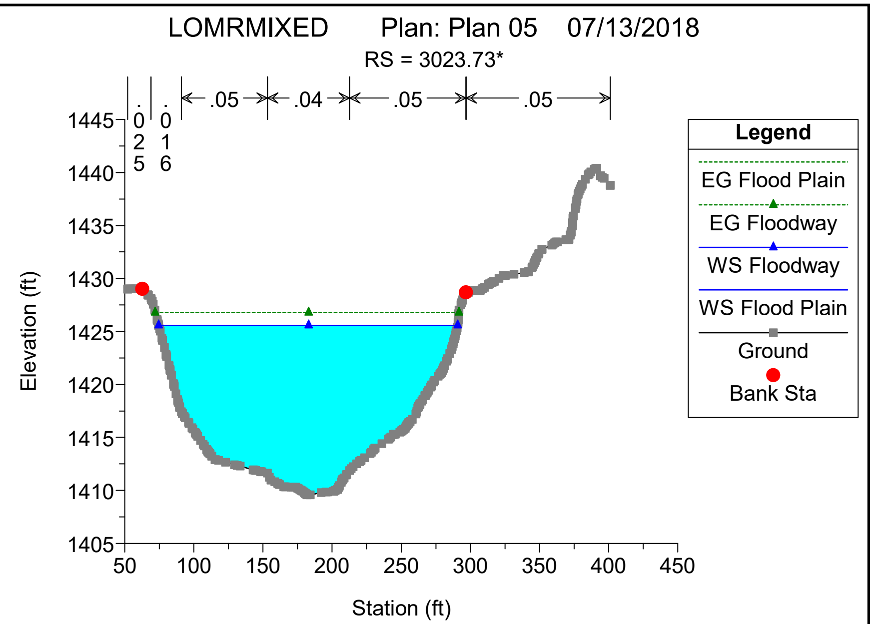
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	844.43*	Flood Plain	21400.00	1386.67	1401.06		1403.32	0.015253	12.04	1778.12	194.29	0.70
Site 2	844.43*	Floodway	21400.00	1386.67	1401.06		1403.32	0.015253	12.04	1778.12	194.29	0.70
Site 2	799.67*	Flood Plain	21400.00	1386.11	1400.37		1402.62	0.015774	12.03	1778.54	199.06	0.71
Site 2	799.67*	Floodway	21400.00	1386.11	1400.37		1402.62	0.015774	12.03	1778.54	199.06	0.71
Site 2	754.92*	Flood Plain	21400.00	1385.56	1399.64		1401.91	0.016002	12.08	1771.25	203.76	0.72
Site 2	754.92*	Floodway	21400.00	1385.56	1399.64		1401.91	0.016002	12.08	1771.25	203.76	0.72
Site 2	710.16	Flood Plain	21400.00	1385.00	1399.06		1401.27	0.012213	11.93	1794.10	208.93	0.72
Site 2	710.16	Floodway	21400.00	1385.00	1399.06		1401.27	0.012213	11.93	1794.10	208.93	0.72
Site 2	660.39*	Flood Plain	21400.00	1384.50	1398.60		1400.63	0.011441	11.42	1873.20	219.30	0.69
Site 2	660.39*	Floodway	21400.00	1384.50	1398.60		1400.63	0.011440	11.42	1873.23	219.30	0.69
Site 2	610.62*	Flood Plain	21400.00	1384.00	1398.19		1400.03	0.010319	10.90	1963.96	230.02	0.66
Site 2	610.62*	Floodway	21400.00	1384.00	1398.19		1400.03	0.010318	10.90	1964.02	230.02	0.66
Site 2	560.85*	Flood Plain	21400.00	1383.50	1397.83		1399.49	0.009185	10.33	2070.75	241.27	0.62
Site 2	560.85*	Floodway	21400.00	1383.50	1397.83		1399.49	0.009184	10.33	2070.81	241.27	0.62
Site 2	511.08*	Flood Plain	21400.00	1383.00	1397.52		1399.01	0.008245	9.76	2192.62	253.25	0.58
Site 2	511.08*	Floodway	21400.00	1383.00	1397.53		1399.01	0.008244	9.76	2192.71	253.25	0.58
Site 2	461.31*	Flood Plain	21400.00	1382.50	1397.26		1398.57	0.007098	9.18	2332.26	266.44	0.55
Site 2	461.31*	Floodway	21400.00	1382.50	1397.27		1398.57	0.007097	9.18	2332.36	266.45	0.55
Site 2	411.54	Flood Plain	21400.00	1382.00	1397.04		1398.19	0.006482	8.60	2487.92	280.38	0.51
Site 2	411.54	Floodway	21400.00	1382.00	1397.04		1398.19	0.006480	8.60	2488.06	280.38	0.51
Site 2	362.84*	Flood Plain	21400.00	1381.12	1396.69		1397.87	0.006383	8.73	2450.72	273.74	0.51
Site 2	362.84*	Floodway	21400.00	1381.12	1396.69		1397.87	0.006382	8.73	2450.86	273.74	0.51
Site 2	314.15*	Flood Plain	21400.00	1380.25	1396.35		1397.56	0.006138	8.83	2422.75	266.95	0.52
Site 2	314.15*	Floodway	21400.00	1380.25	1396.35		1397.56	0.006137	8.83	2422.88	266.95	0.52
Site 2	265.45*	Flood Plain	21400.00	1379.38	1396.02		1397.26	0.006273	8.91	2402.04	260.04	0.52
Site 2	265.45*	Floodway	21400.00	1379.38	1396.02		1397.26	0.006272	8.91	2402.23	260.04	0.52
Site 2	216.76*	Flood Plain	21400.00	1378.50	1395.70		1396.95	0.006169	8.96	2387.59	252.79	0.51
Site 2	216.76*	Floodway	21400.00	1378.50	1395.70		1396.95	0.006168	8.96	2387.74	252.79	0.51
Site 2	168.06*	Flood Plain	21400.00	1377.62	1395.41		1396.66	0.005679	8.97	2385.70	245.07	0.51
Site 2	168.06*	Floodway	21400.00	1377.62	1395.41		1396.66	0.005678	8.97	2385.85	245.07	0.51
Site 2	119.36*	Flood Plain	21400.00	1376.75	1395.14		1396.38	0.005673	8.93	2395.09	235.49	0.49
Site 2	119.36*	Floodway	21400.00	1376.75	1395.14		1396.38	0.005672	8.93	2395.26	235.49	0.49
Site 2	70.67*	Flood Plain	21400.00	1375.88	1394.89		1396.11	0.005316	8.86	2416.42	226.90	0.48
Site 2	70.67*	Floodway	21400.00	1375.88	1394.89		1396.11	0.005315	8.86	2416.58	226.90	0.48
Site 2	21.97	Flood Plain	21400.00	1375.00	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46
Site 2	21.97	Floodway	21400.00	1375.00	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46

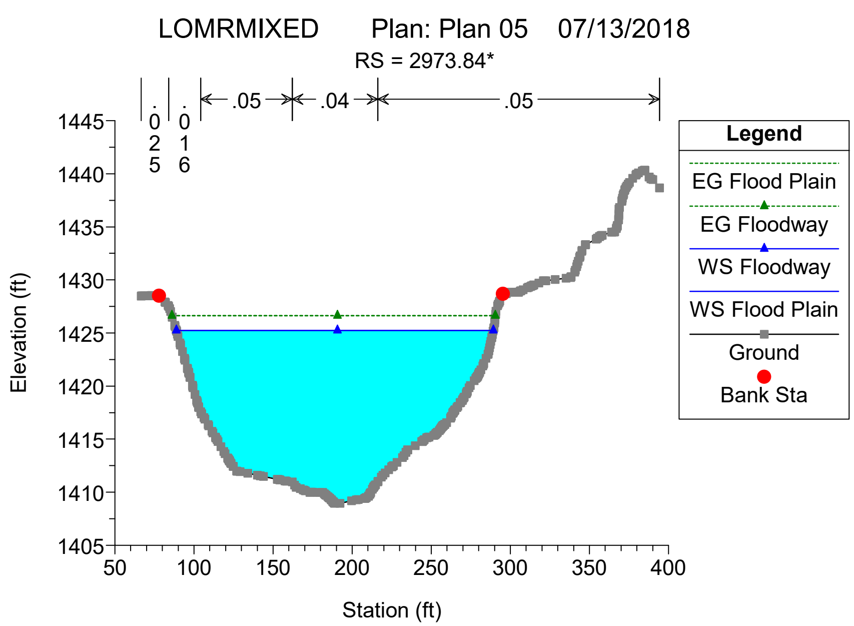


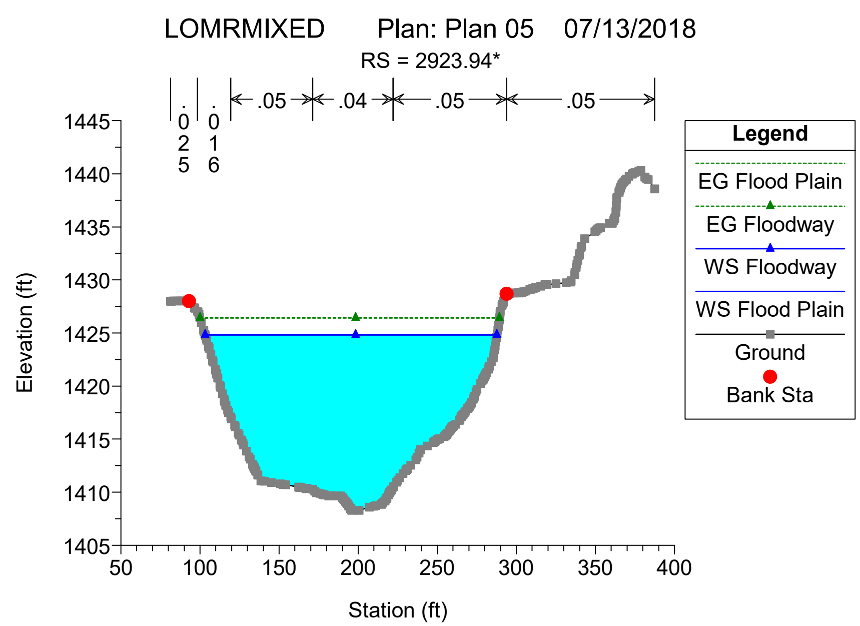
LOMRMIXED Plan: Plan 05 07/13/2018
RIVER Site 2
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Elevation (ft)
Main Channel Distance (ft)
1430
1420
1410
1400
1390
1380
1370
0
500
1000
1500
2000
2500
3000
3500
119.36*
216.76*
314.15*
411.54
511.08*
610.62*
710.16
799.67*
889.19*
978.70*
1068.21*
1157.41*
1248.45*
1341.68*
1434.9
1528.38*
1621.85*
1715.33*
1808.80*
1902.28*
1995.76*
2089.23*
2163.54*
2232.26*
2314.55*
2402.54*
2496.23*
2589.93*
2683.62*
2777.31*
2874.05*
2973.84*
3073.62*
3169.81*
3262.4

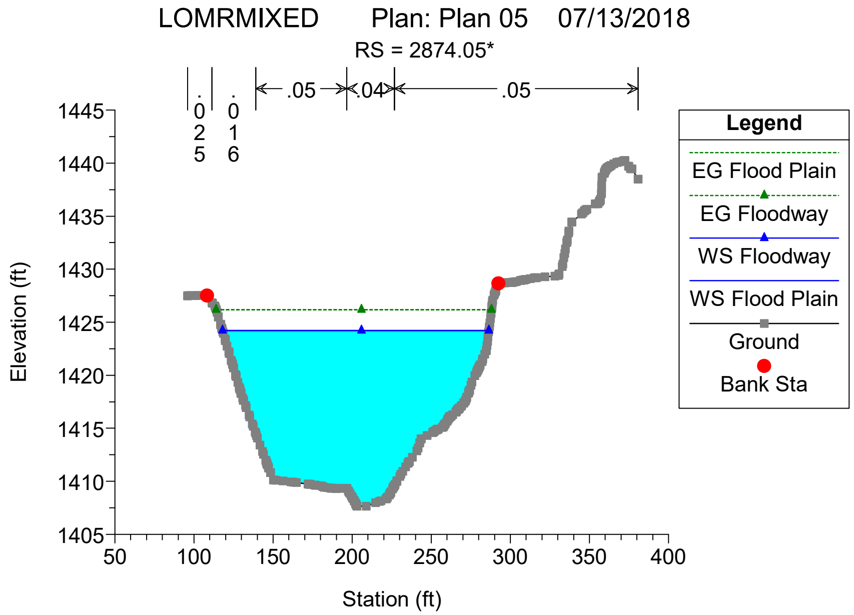

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 3262.4
.04
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 3216.10*
.025 .016 .05 .04 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 3169.81*
.025 .016 .05 .04 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 3123.51
.025 .016 .05 .04 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

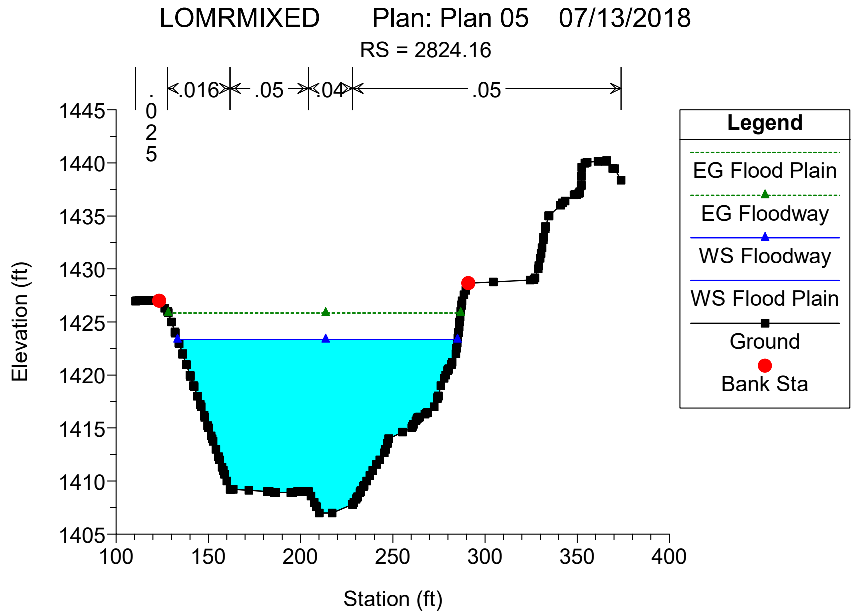

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 3073.62*
.025
.016
.05
.04
.05
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

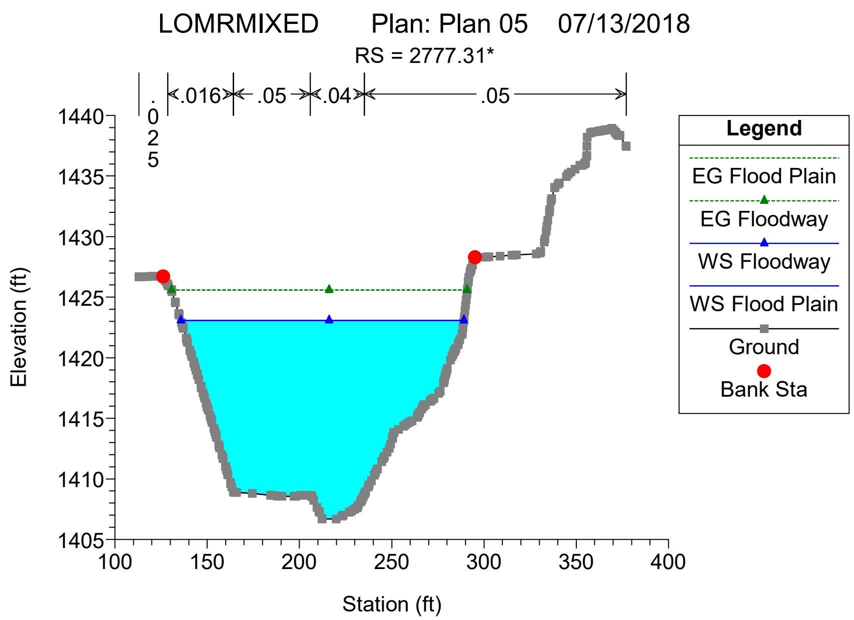

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 3023.73*
.025
.016
.05
.04
.05
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

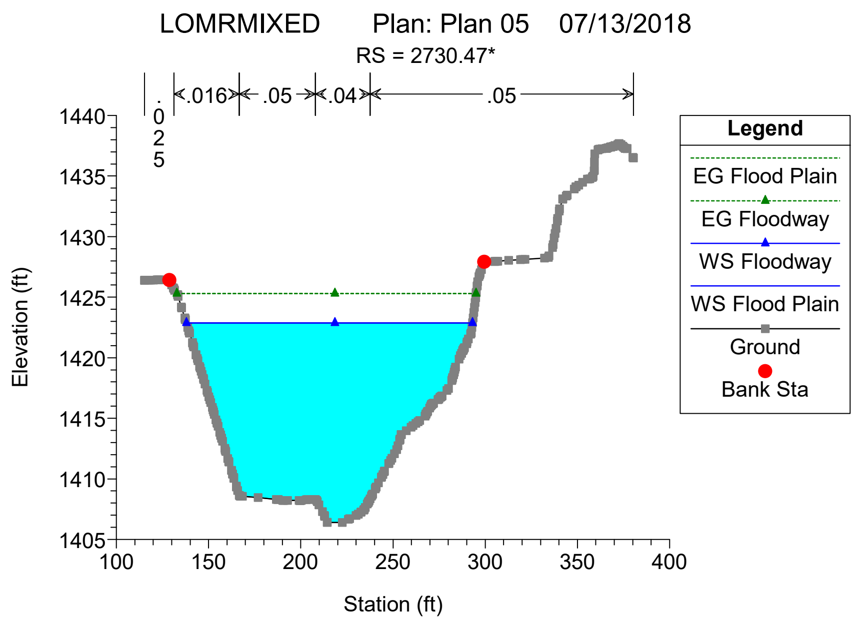

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2973.84*
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

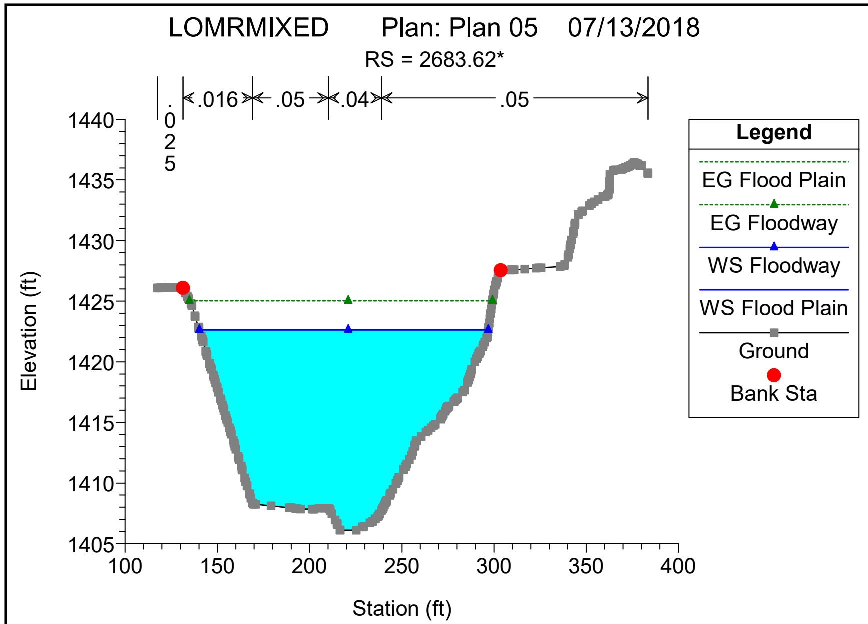

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2923.94*
.025
.016
.05
.04
.05
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

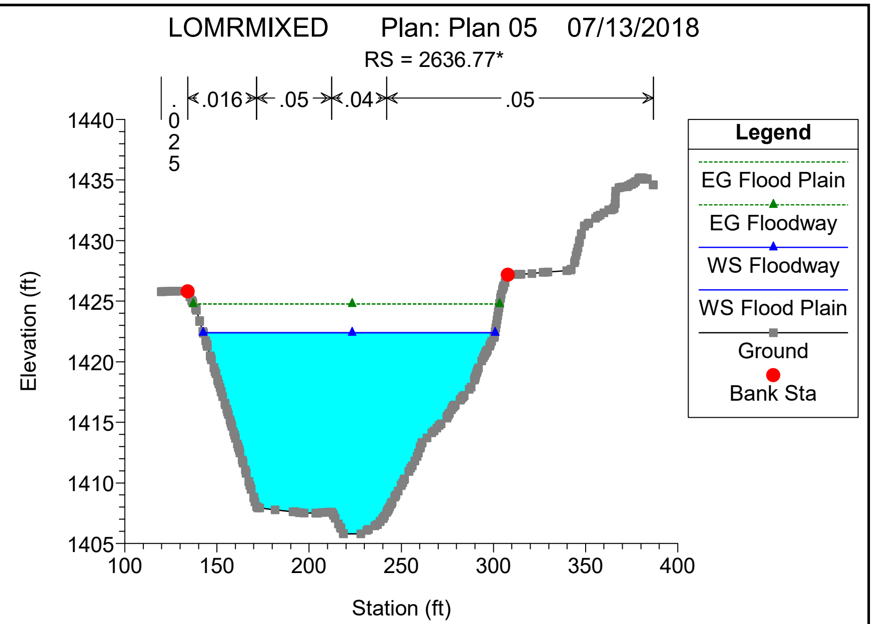

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2874.05*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

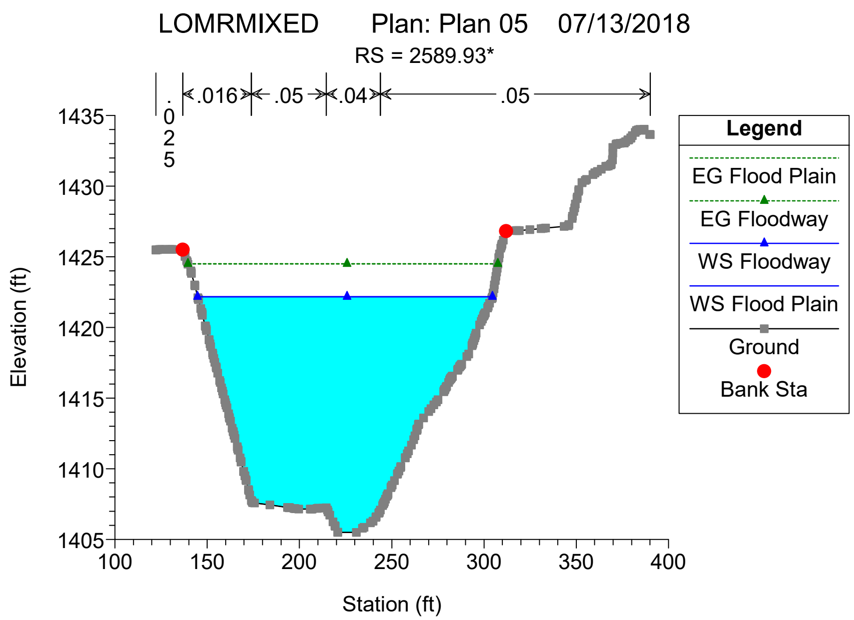

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2824.16
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

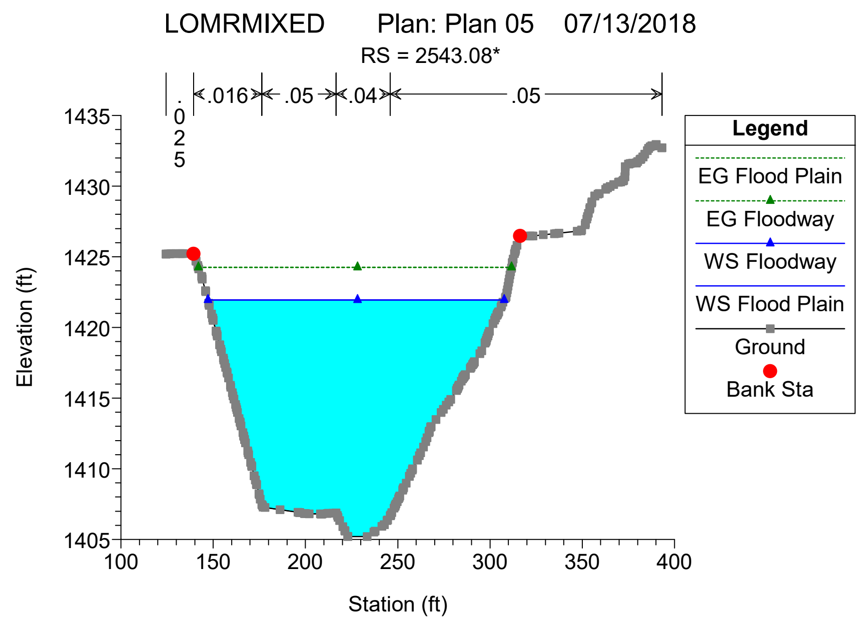

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2777.31*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

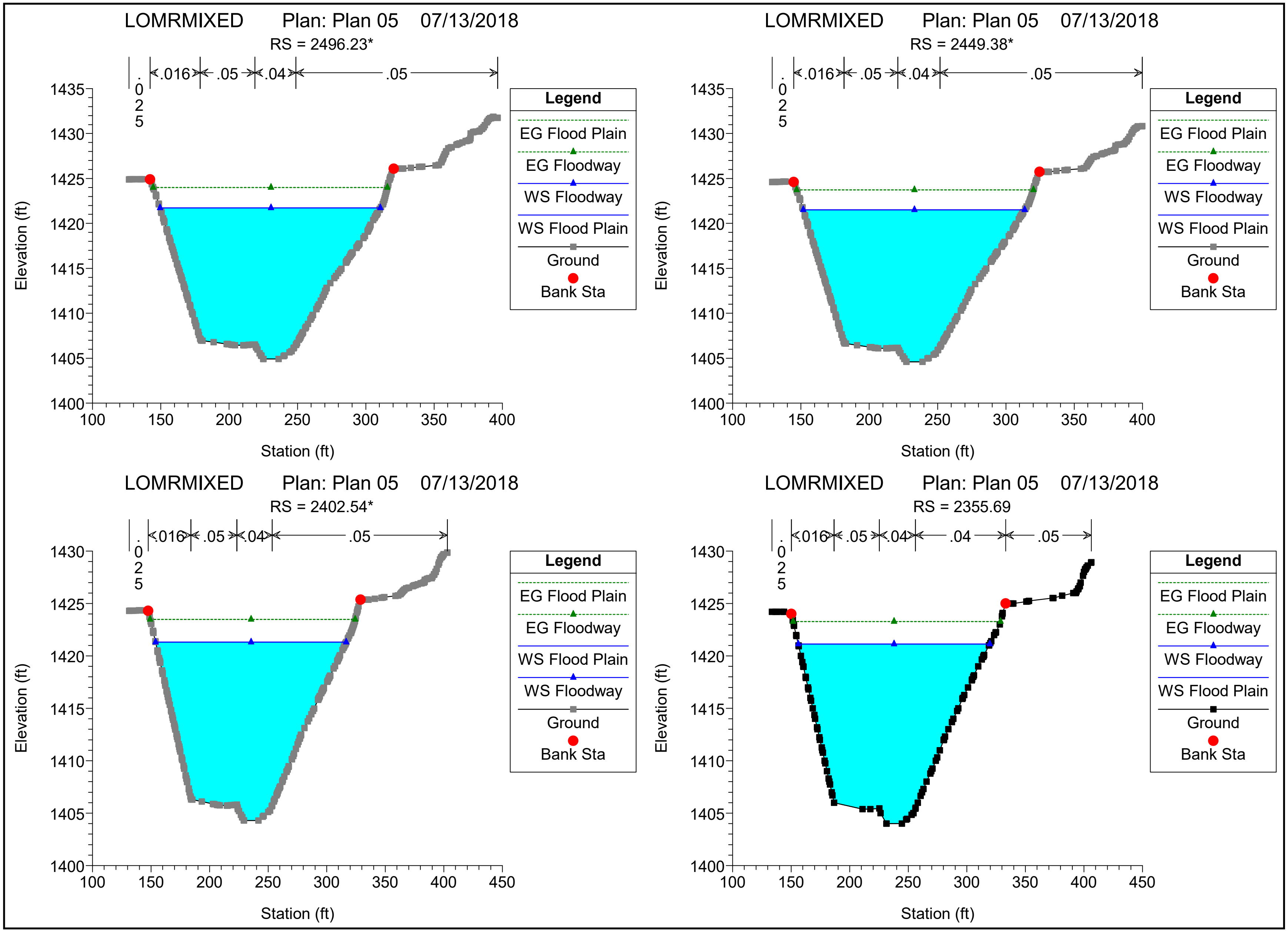

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2730.47*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

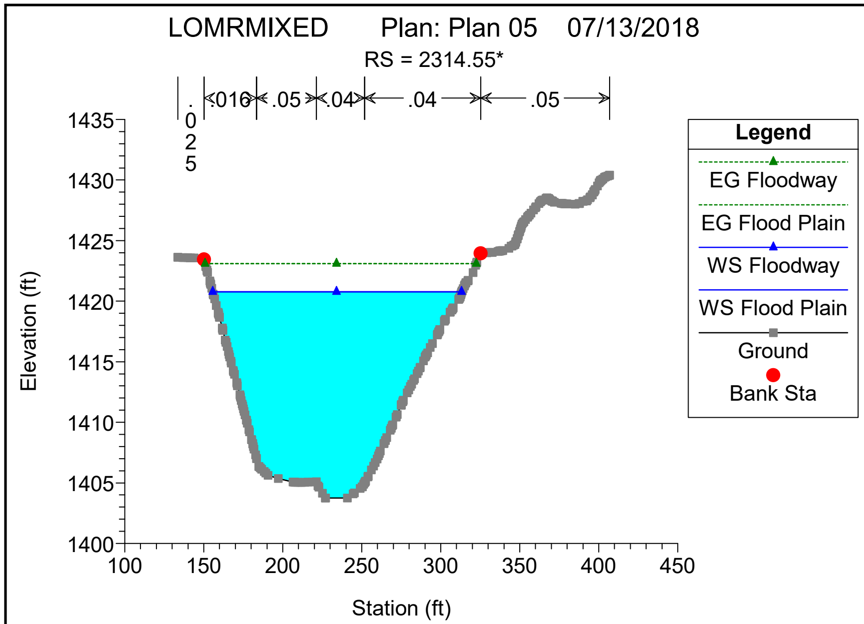

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2683.62*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1440
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)

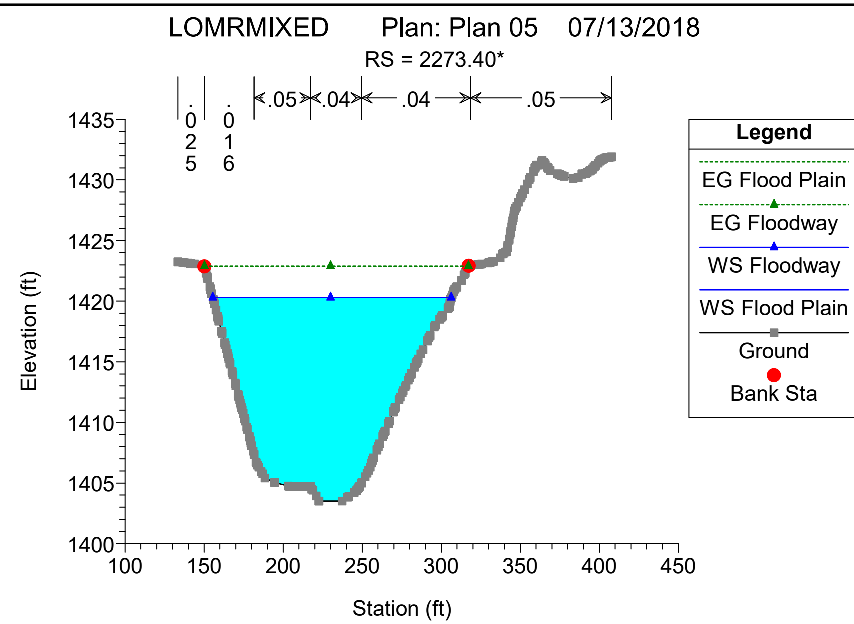

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2636.77*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1440
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)

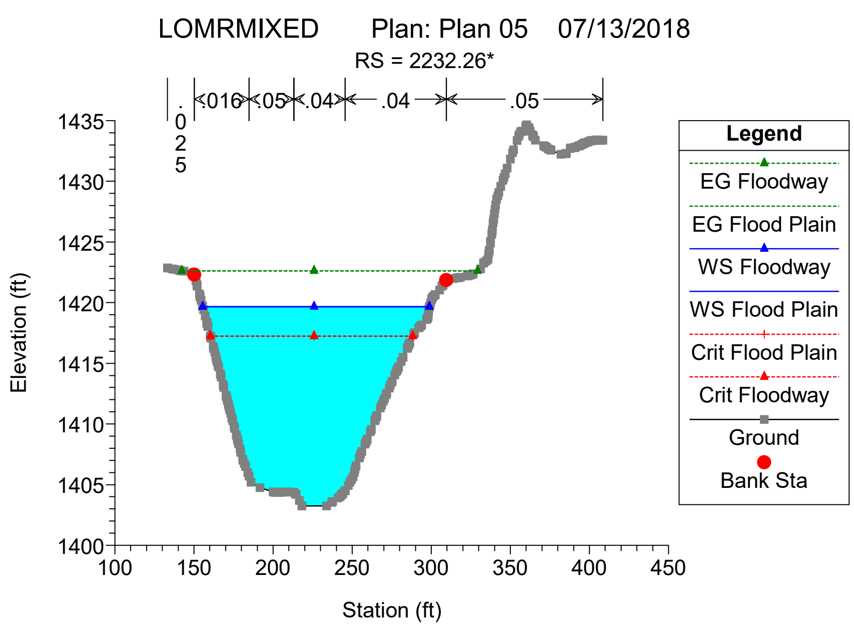

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2589.93*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)

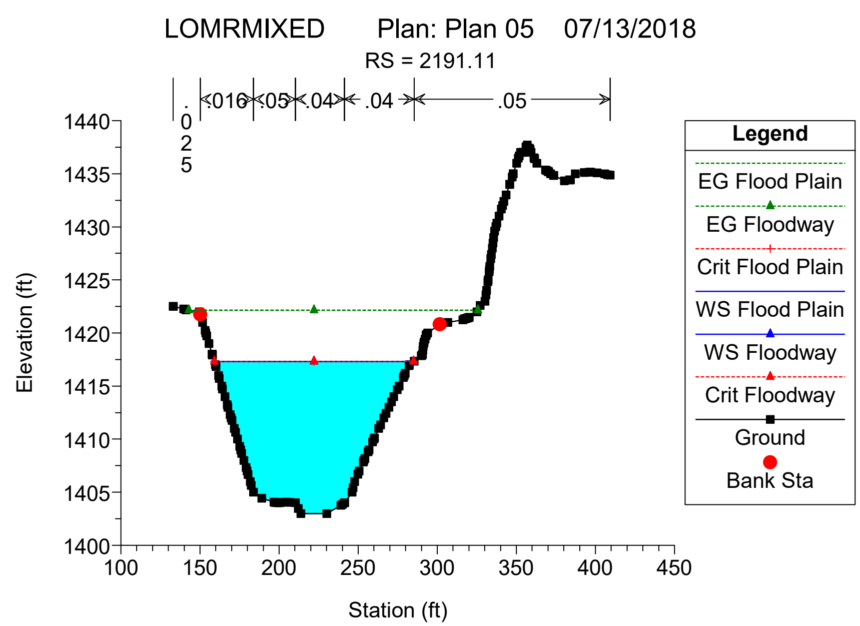

LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2543.08*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1435
1430
1425
1420
1415
1410
1405
100 150 200 250 300 350 400
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2496.23*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2449.38*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2402.54*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Flood Plain
WS Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2355.69
.025 .016 .05 .04 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2314.55*
.025
.016
.05
.04
.04
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1400
1405
1410
1415
1420
1425
1430
1435
100
150
200
250
300
350
400
450


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2273.40*
.025
.016
.05
.04
.04
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1400
1405
1410
1415
1420
1425
1430
1435
100
150
200
250
300
350
400
450


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2232.26*
.025
.016
.05
.04
.04
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
1400
1405
1410
1415
1420
1425
1430
1435
100
150
200
250
300
350
400
450


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 2191.11
.025
.016
.05
.04
.04
.05
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
WS Flood Plain
WS Floodway
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
1400
1405
1410
1415
1420
1425
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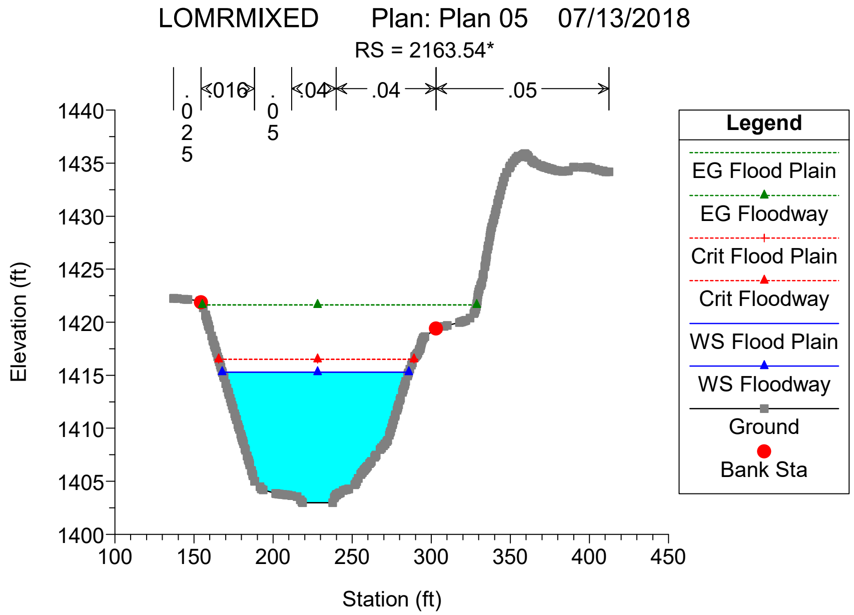
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RS = 2163.54*
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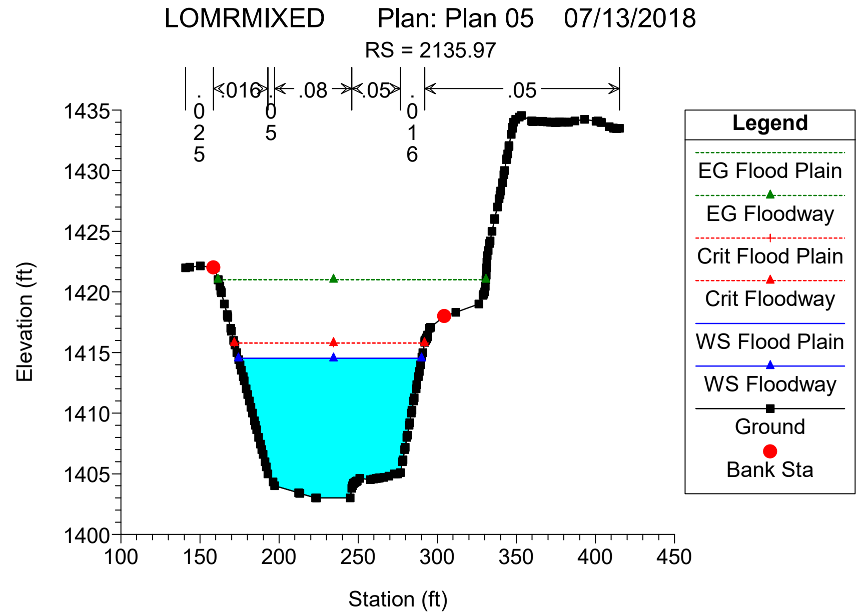
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
Crit Floodway
WS Flood Plain
WS Floodway
Ground
Bank Sta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RS = 2135.97
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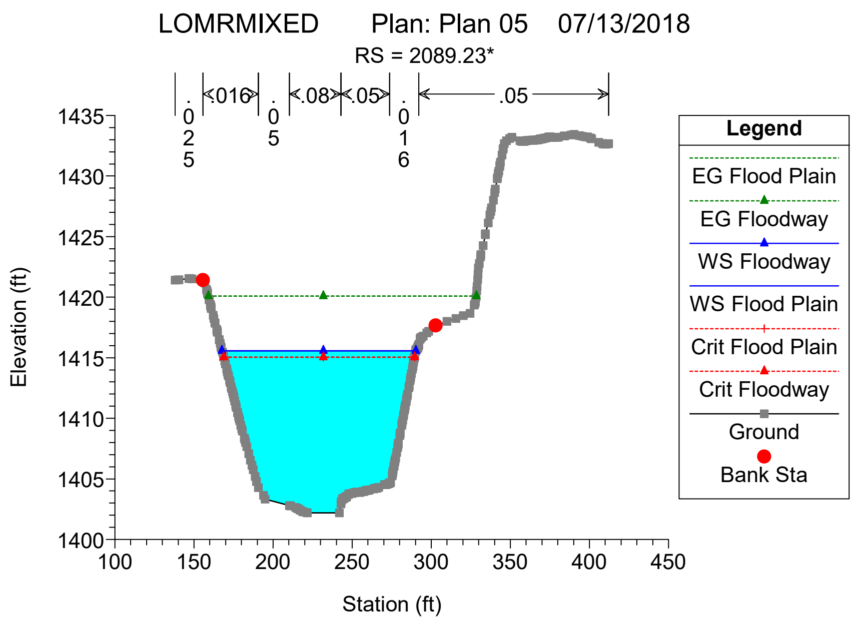
Station (ft)
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
Crit Floodway
WS Flood Plain
WS Floodway
Ground
Bank Sta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RS = 2089.23*
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Station (ft)
Legend
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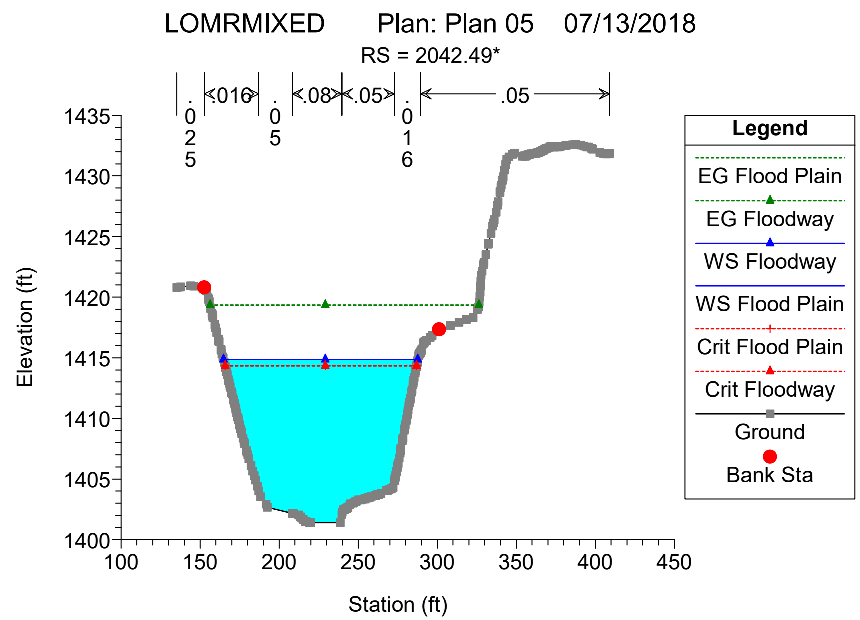
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta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RS = 2042.49*
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.08
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.016
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Station (ft)
Legend
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EG Floodway
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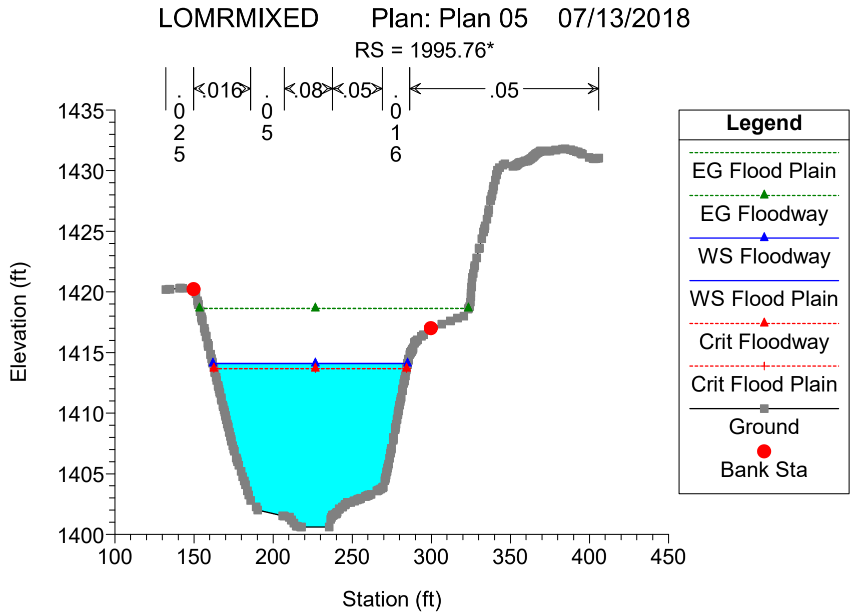
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta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RS = 1995.76*
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Elevation (ft)
Station (ft)
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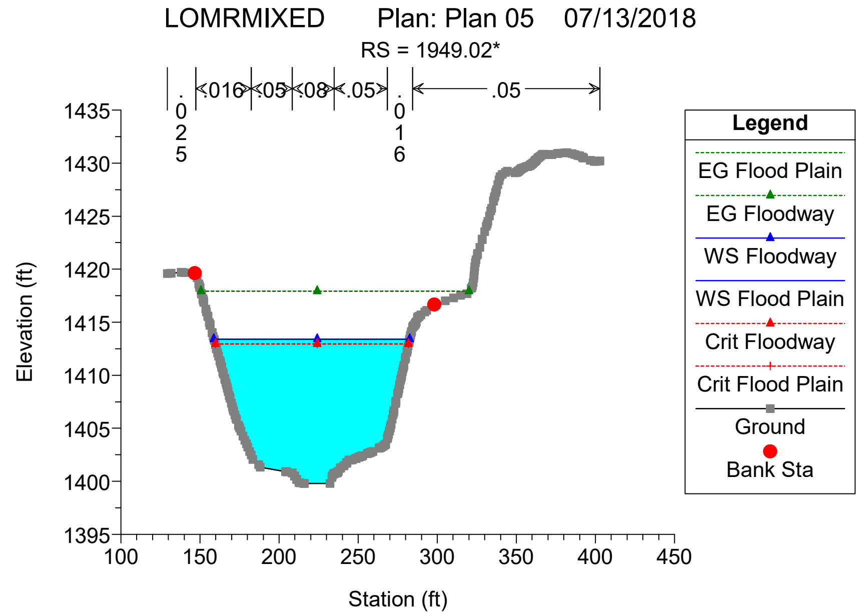
100 150 200 250 300 350 400 450
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Floodway
Crit Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1949.02*
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Station (ft)
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Legend
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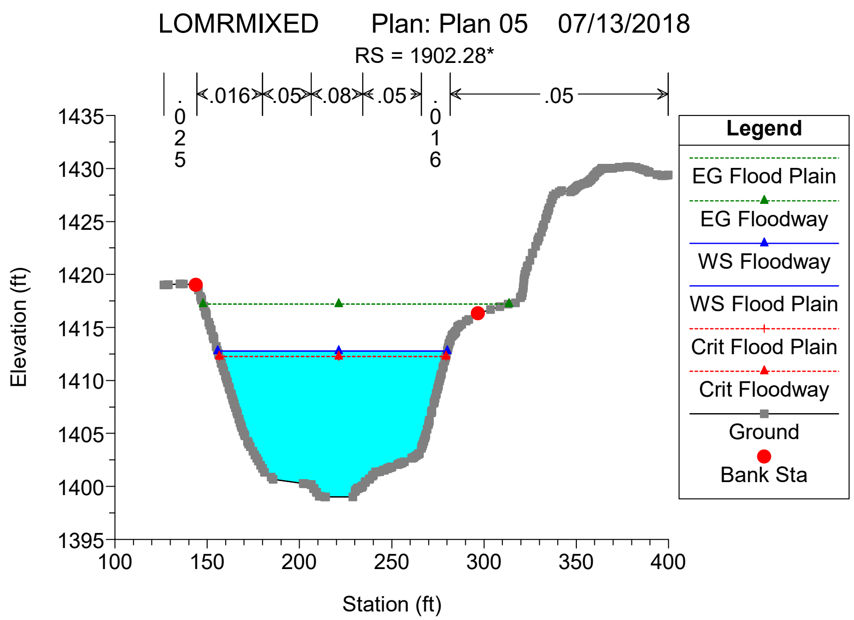
EG Floodway
WS Floodway
WS Flood Plain
Crit Floodway
Crit Flood Plain
Ground
Bank Sta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RS = 1902.28*
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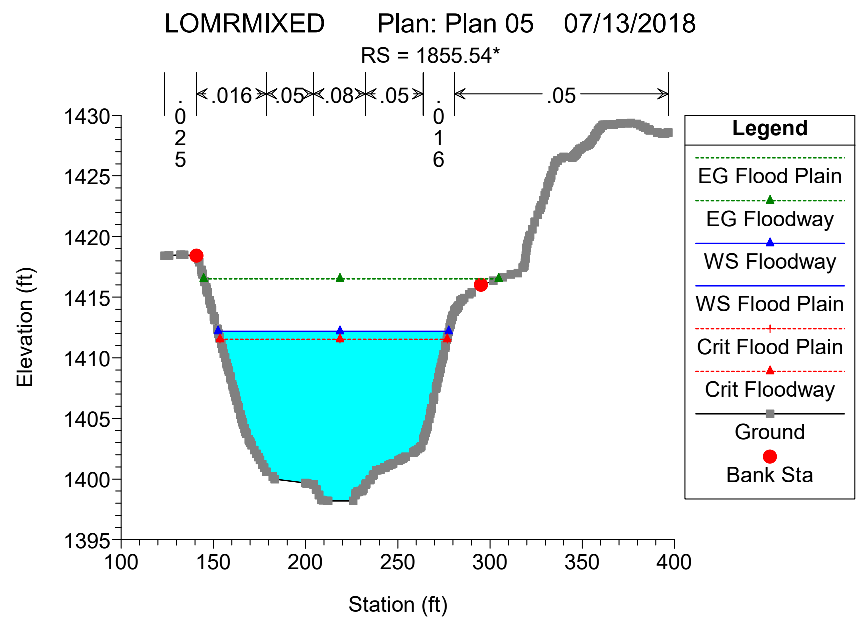
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1855.54*
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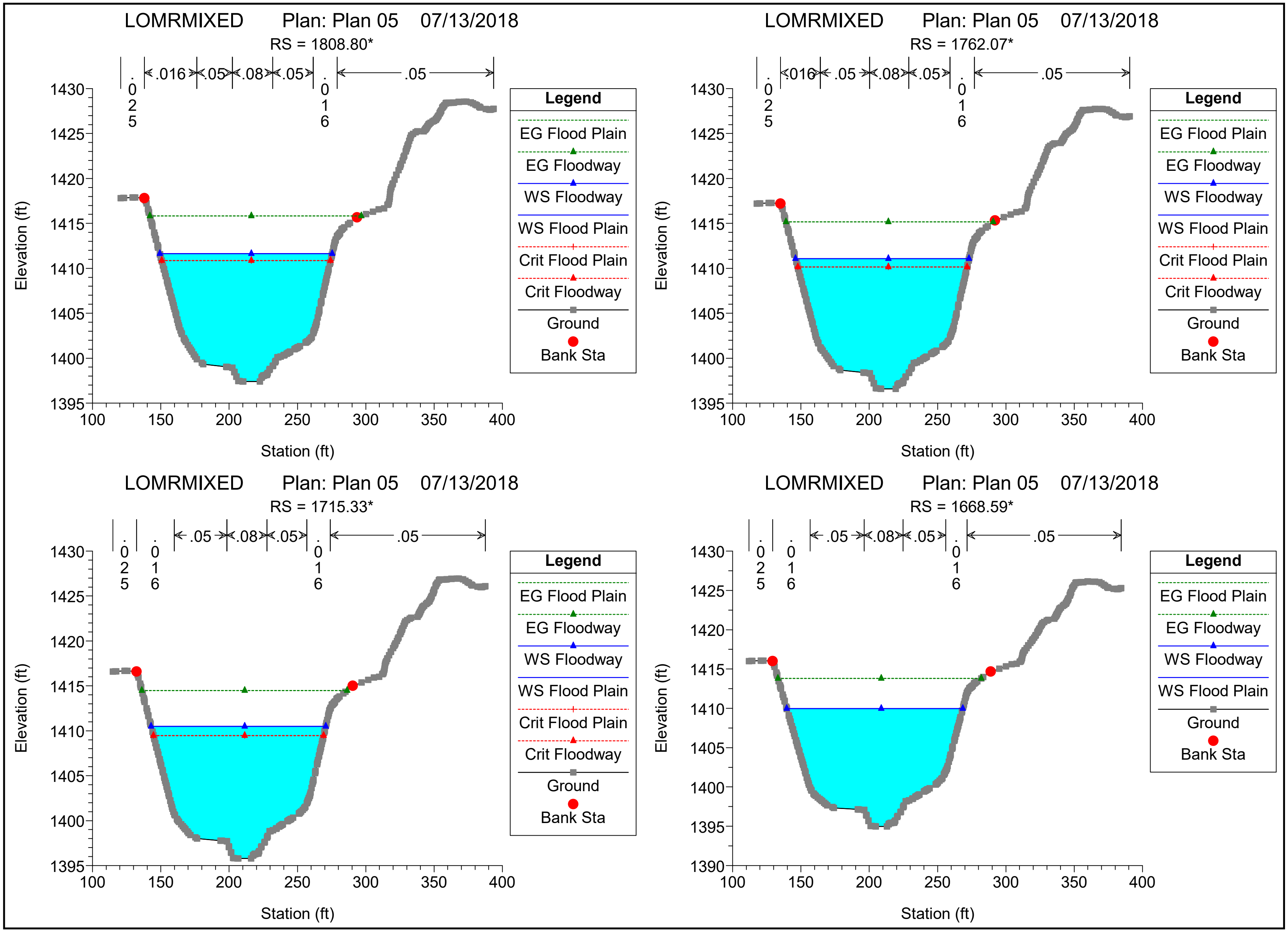
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta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RS = 1808.80*
.016 .05 .08 .05 .05
.025 .016
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1762.07*
.016 .05 .08 .05 .05
.025 .016
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1715.33*
.05 .08 .05 .05
.025 .016 .016
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1668.59*
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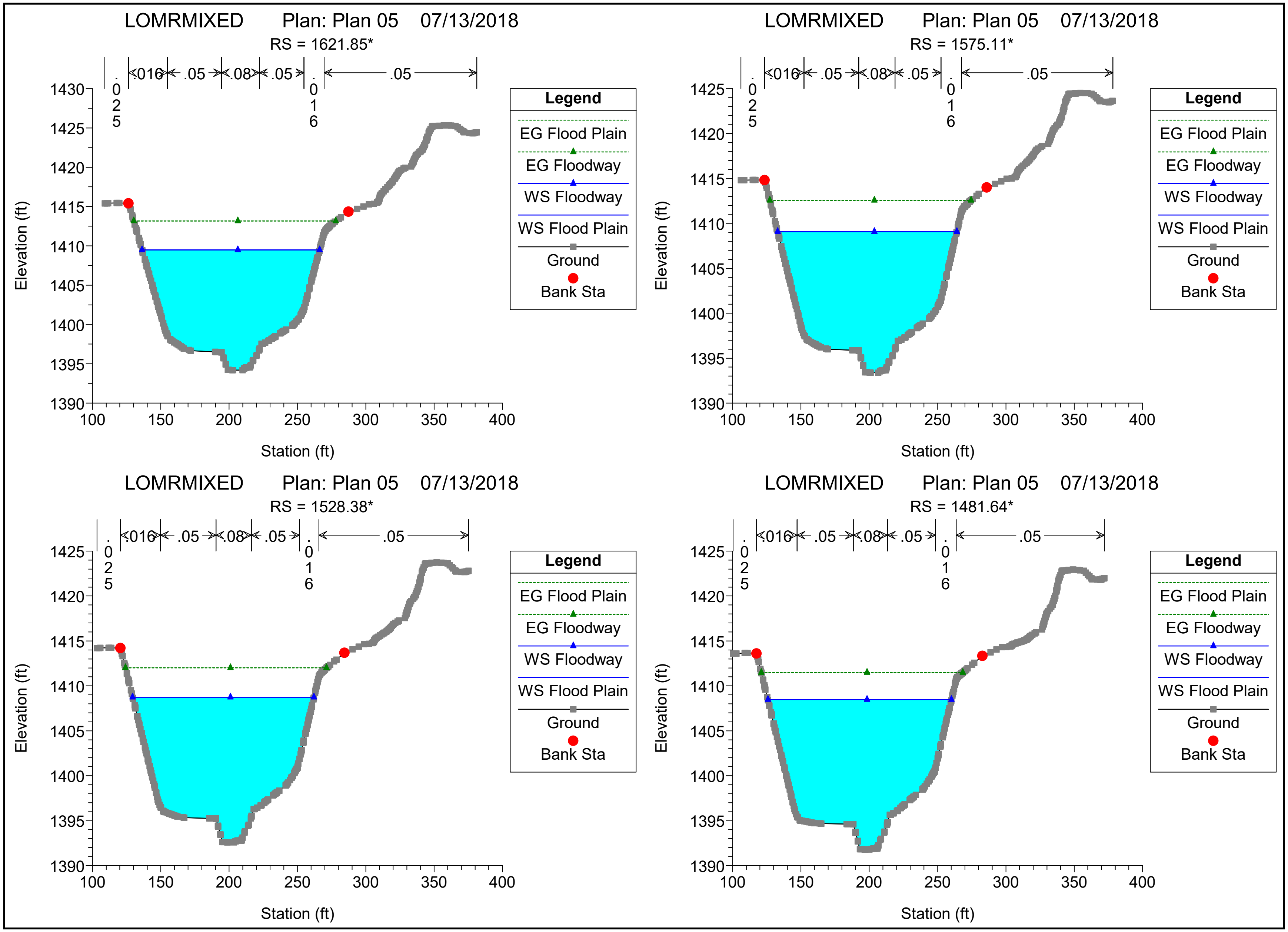
.025 .016 .016
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1621.85*
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.05
.08
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.016
.05
Elevation (ft)
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1425
1420
1415
1410
1405
1400
1395
1390
Station (ft)
100
150
200
250
300
350
400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1575.11*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
1425
1420
1415
1410
1405
1400
1395
1390
Station (ft)
100
150
200
250
300
350
400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1528.38*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
1425
1420
1415
1410
1405
1400
1395
1390
Station (ft)
100
150
200
250
300
350
400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1481.64*
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.016
.05
.08
.05
.016
.05
Elevation (ft)
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1415
1410
1405
1400
1395
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Station (ft)
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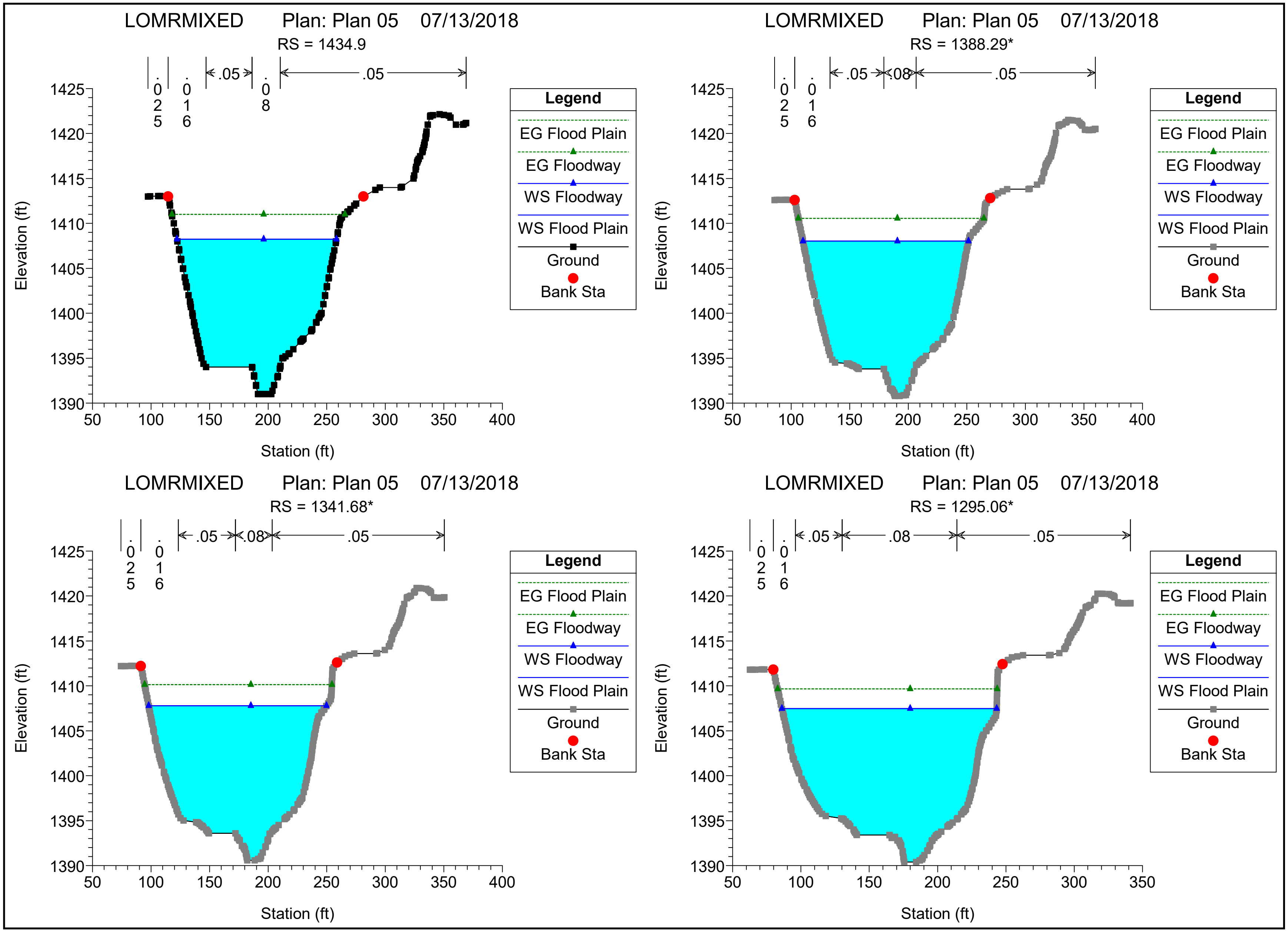
250
300
350
400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1434.9
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.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1388.29*
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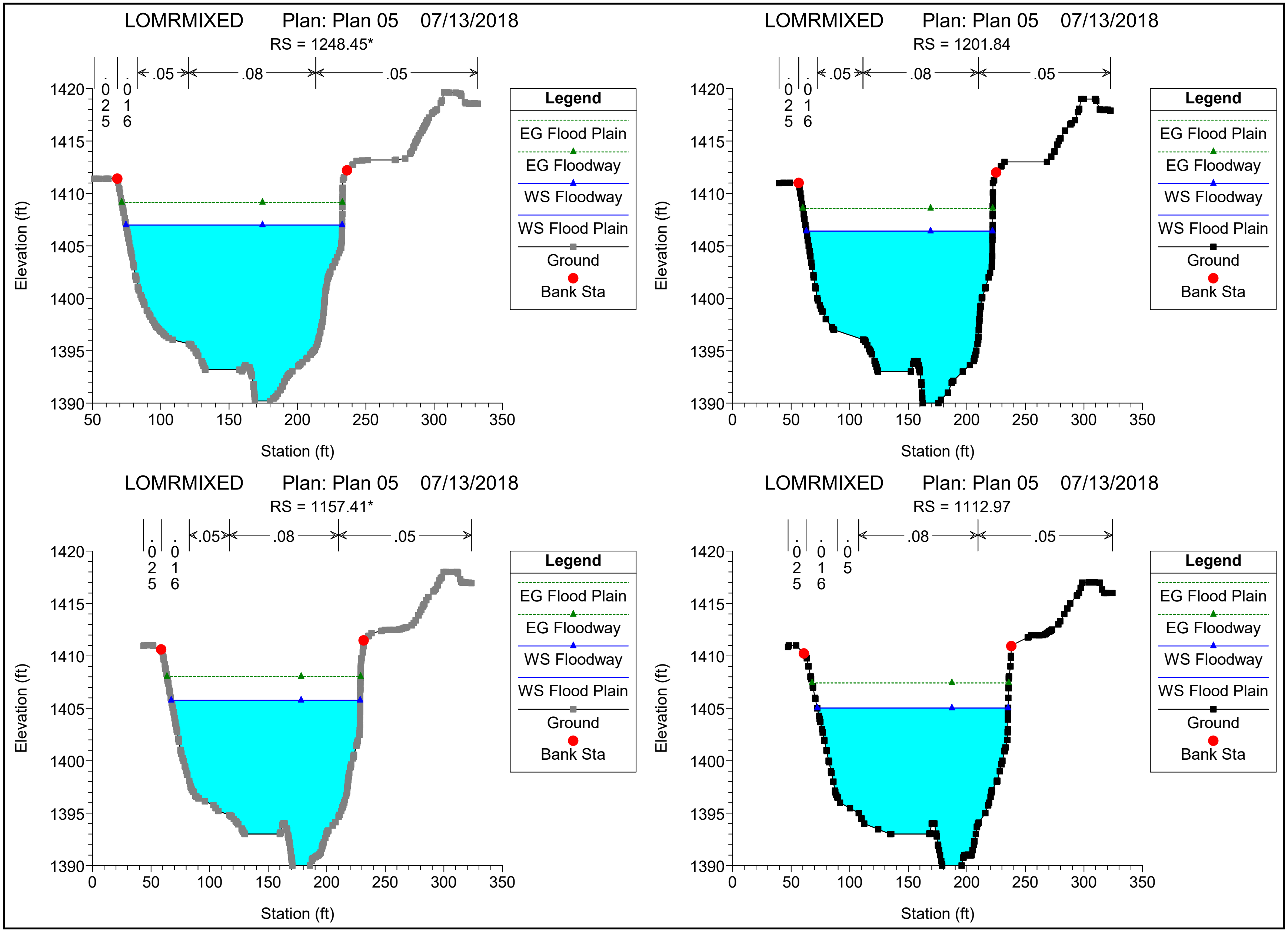
.016
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1341.68*
.025
.016
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1295.06*
.025
.016
.05
.08
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta



LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1248.45*
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Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1201.84
.025 .016 .05 .08 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1157.41*
.025 .016 .05 .08 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1112.97
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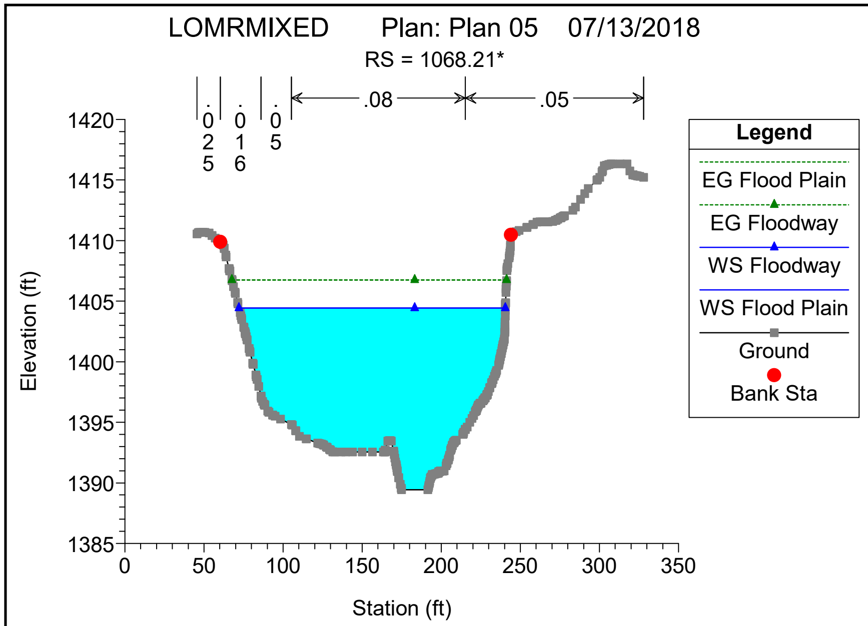
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1068.21*
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.08
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Elevation (ft)
Station (ft)
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1405
1400
1395
1390
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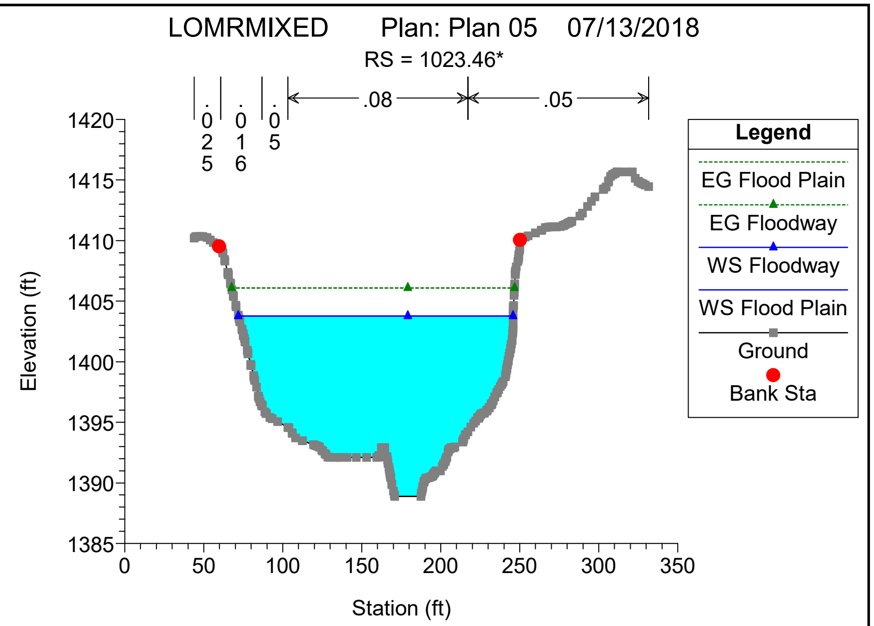
150
200
250
300
350
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 1023.46*
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Elevation (ft)
Station (ft)
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1405
1400
1395
1390
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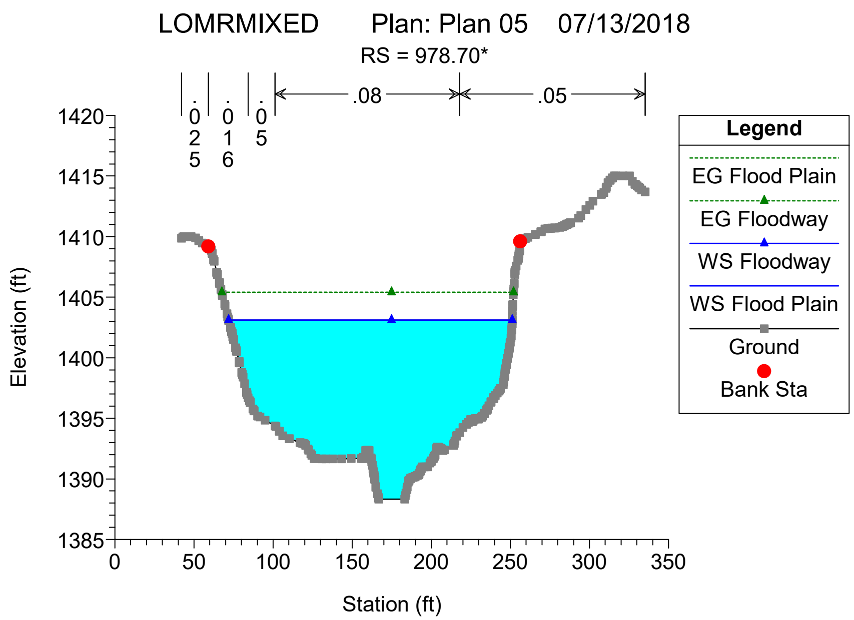
150
200
250
300
350
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 978.70*
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.05
.08
.05
Elevation (ft)
Station (ft)
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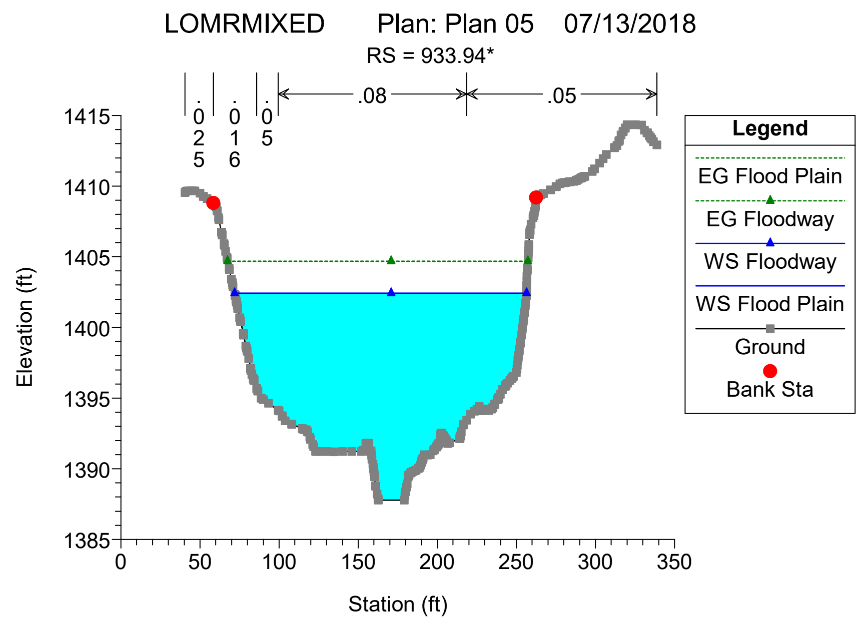
1415
1410
1405
1400
1395
1390
1385
0
50
100
150
200
250
300
350
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 933.94*
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.08
.05
Elevation (ft)
Station (ft)
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1405
1400
1395
1390
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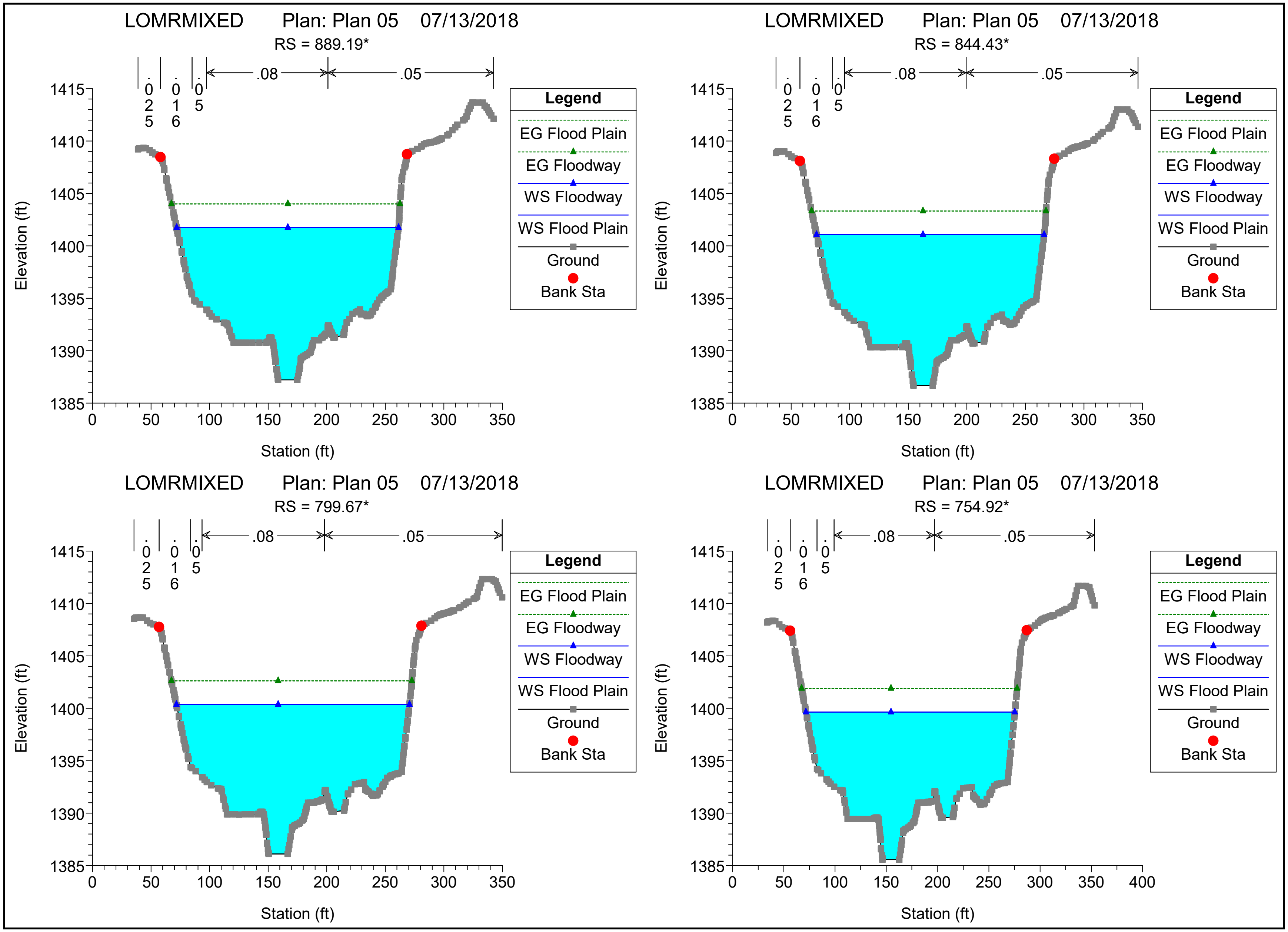
150
200
250
300
350
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 889.19*
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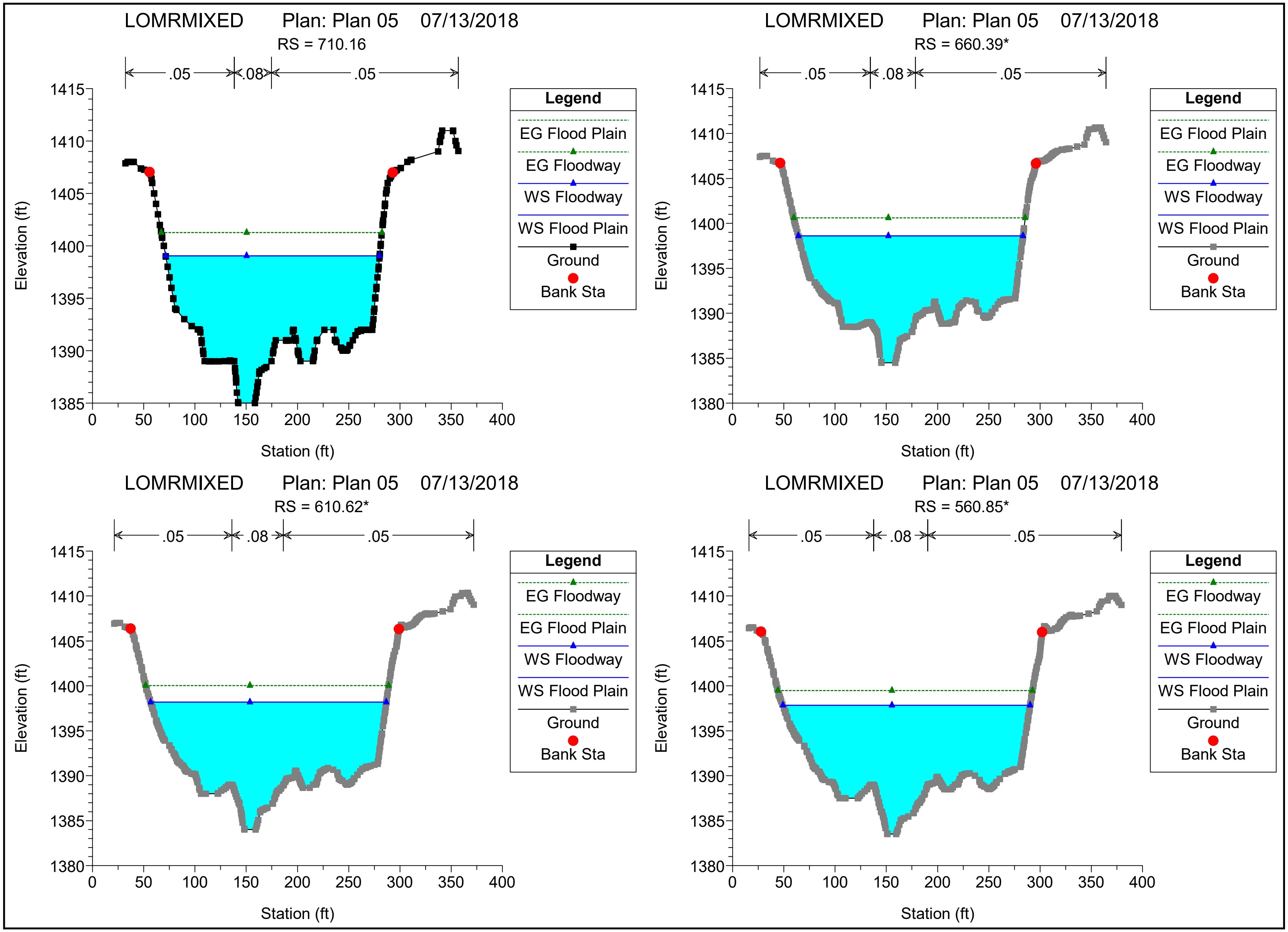
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 844.43*
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 799.67*
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 754.92*



LOMRMIXED Plan: Plan 05 07/13/2018
RS = 710.16
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Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 660.39*
.05
.08
.05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 610.62*
.05
.08
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 560.85*
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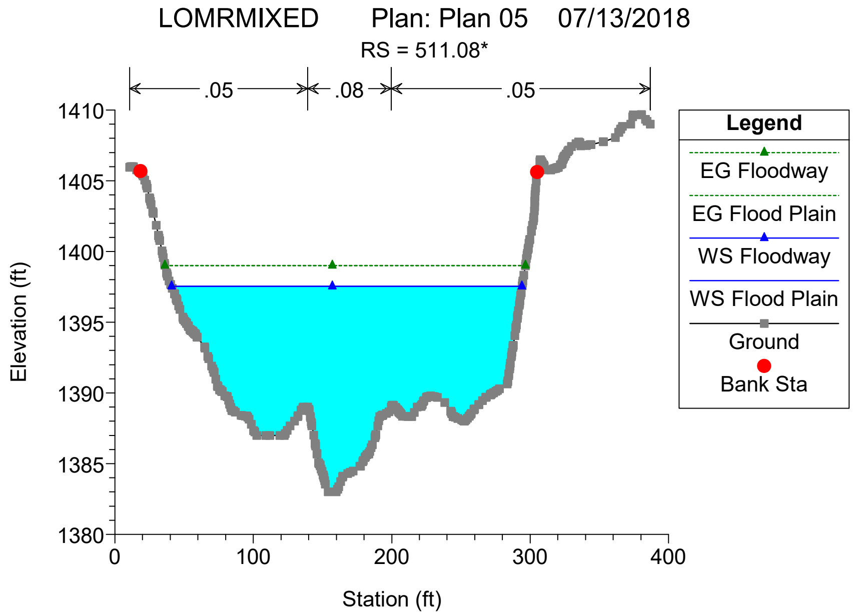
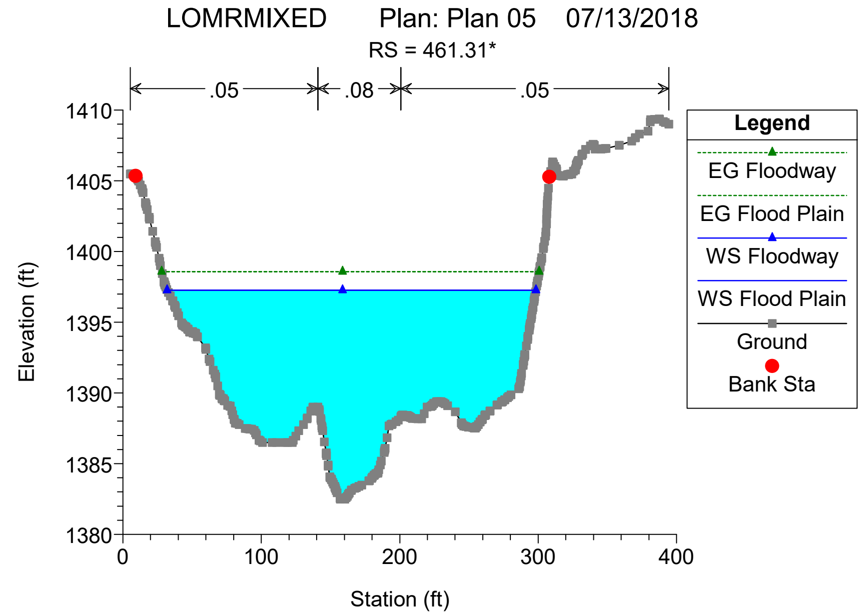
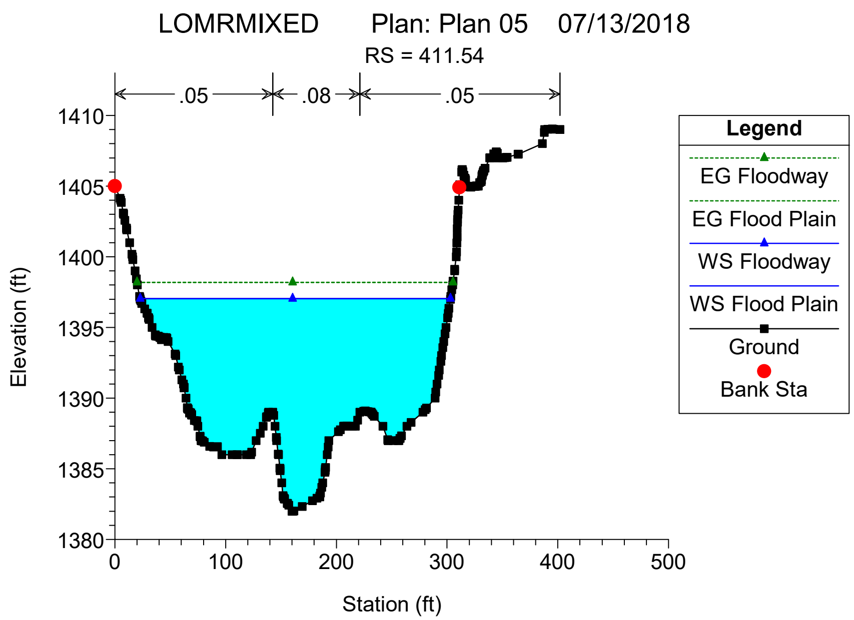
.08
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 511.08*
.05
.08
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1410
1405
1400
1395
1390
1385
1380
0
100
200
300
400
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 461.31*
.05
.08
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1410
1405
1400
1395
1390
1385
1380
0
100
200
300
400
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 411.54
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.08
.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
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1405
1400
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1390
1385
1380
0
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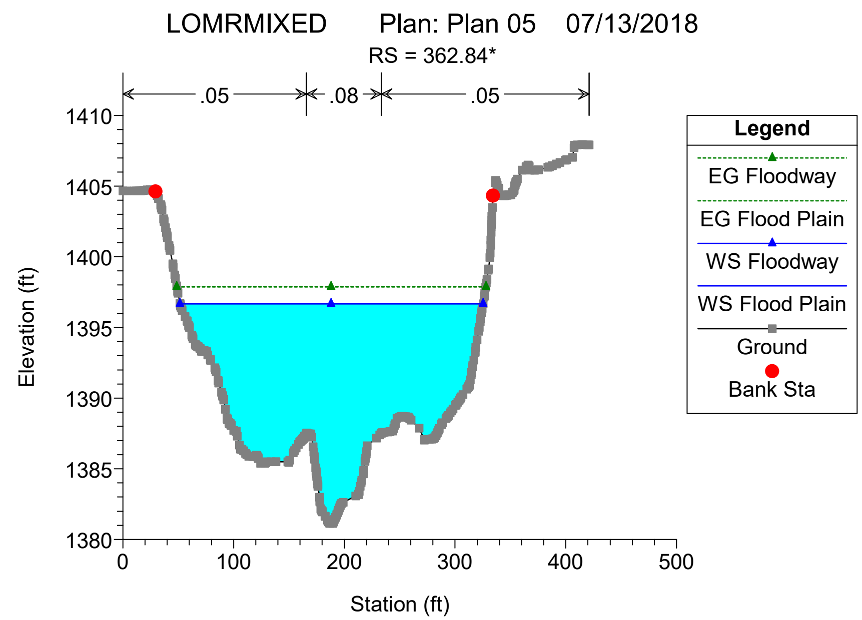
200
300
400
500
Station (ft)


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 362.84*
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.05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
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1400
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1390
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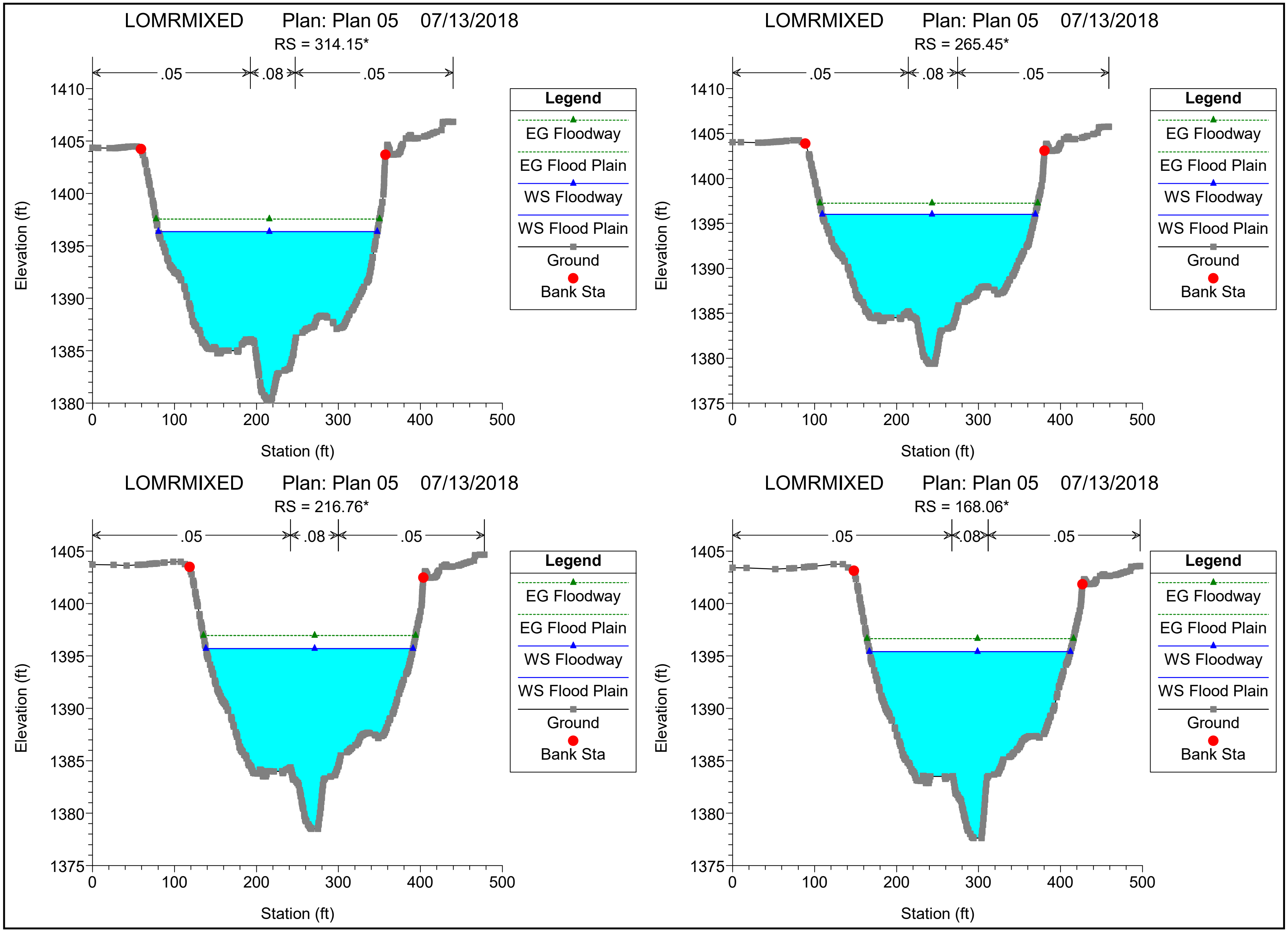
1380
0
100
200
300
400
500
Station (ft)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RS = 314.15*
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Elevation (ft)
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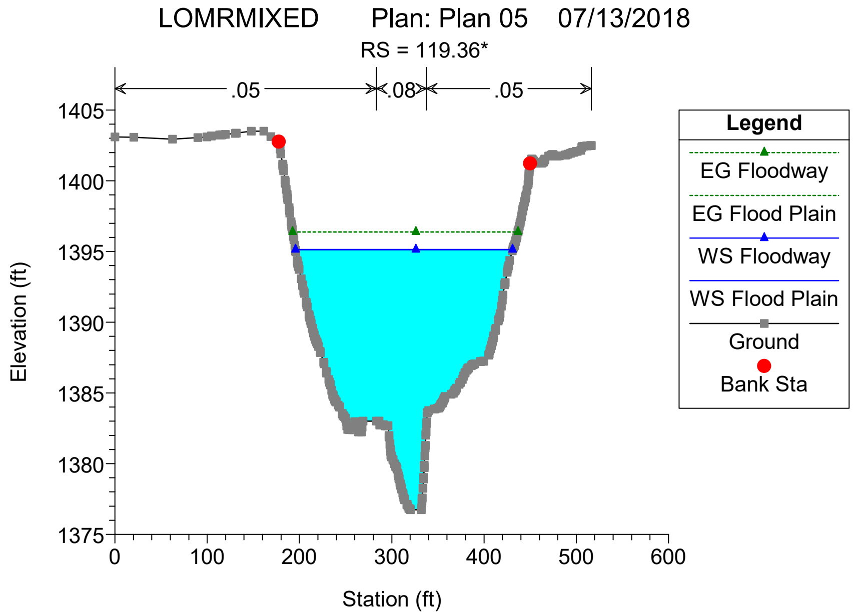
1405
1400
1395
1390
1385
1380
Station (ft)
0 100 200 300 400 500
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 265.45*
.05 .08 .05
Elevation (ft)
1410
1405
1400
1395
1390
1385
1380
1375
Station (ft)
0 100 200 300 400 500
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 216.76*
.05 .08 .05
Elevation (ft)
1405
1400
1395
1390
1385
1380
1375
Station (ft)
0 100 200 300 400 500
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
LOMRMIXED Plan: Plan 05 07/13/2018
RS = 168.06*
.05 .08 .05
Elevation (ft)
1405
1400
1395
1390
1385
1380
1375
Station (ft)
0 100 200 300 400 500
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 119.36*
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.08
.05
Elevation (ft)
Station (ft)
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1400
1395
1390
1385
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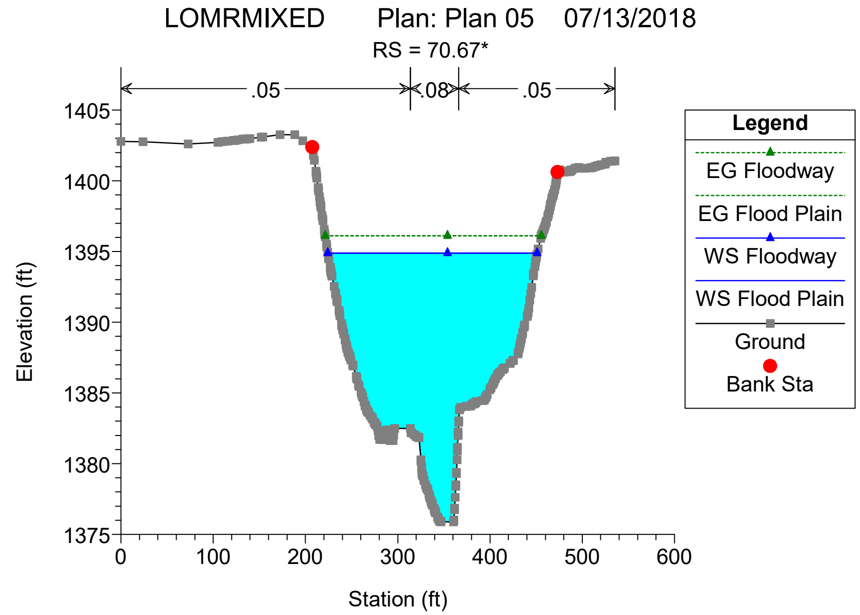
300
400
500
600
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 70.67*
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.08
.05
Elevation (ft)
Station (ft)
1405
1400
1395
1390
1385
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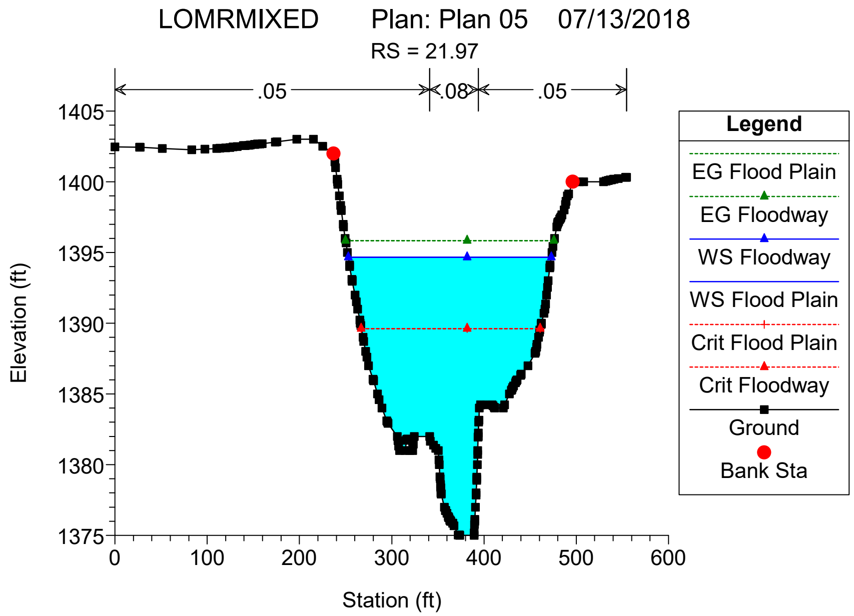
300
400
500
600
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXED Plan: Plan 05 07/13/2018
RS = 21.97
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.08
.05
Elevation (ft)
Station (ft)
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1400
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1380
1375
0
100
200
300
400
500
600
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

HEC-RAS Model: Mixed Flow Regime Critical Depth

HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2

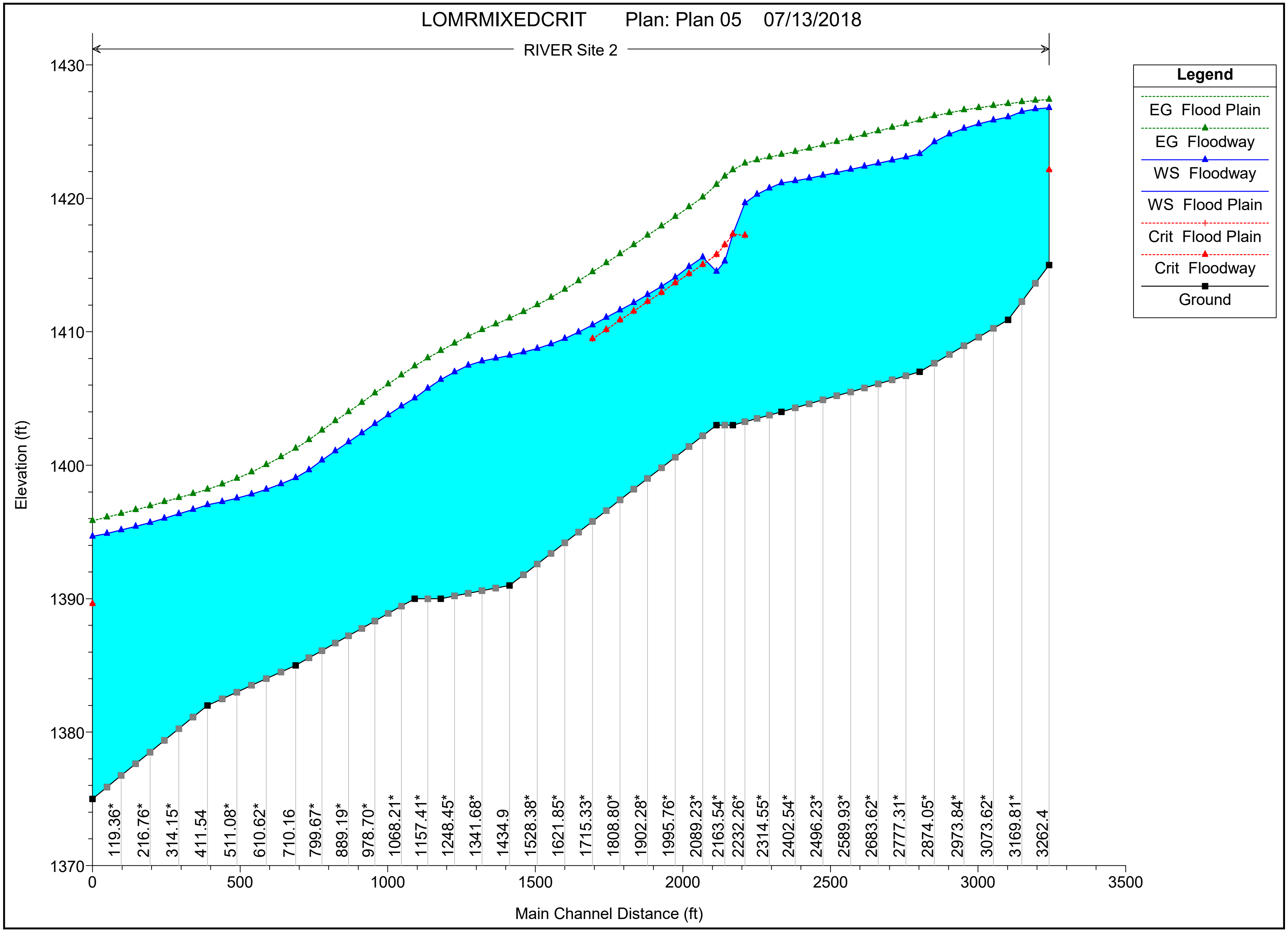
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	3262.4	Flood Plain	21400.00	1415.00	1426.78	1422.13	1427.41	0.001715	6.39	3346.60	391.20	0.39
Site 2	3262.4	Floodway	21400.00	1415.00	1426.78	1422.13	1427.41	0.001715	6.39	3346.60	391.20	0.39
Site 2	3216.10*	Flood Plain	21400.00	1413.63	1426.69		1427.33	0.002074	6.41	3336.40	367.92	0.38
Site 2	3216.10*	Floodway	21400.00	1413.63	1426.69		1427.33	0.002074	6.41	3336.40	367.92	0.38
Site 2	3169.81*	Flood Plain	21400.00	1412.27	1426.49		1427.22	0.002053	6.85	3122.00	312.15	0.38
Site 2	3169.81*	Floodway	21400.00	1412.27	1426.49		1427.22	0.002053	6.85	3122.00	312.15	0.38
Site 2	3123.51	Flood Plain	21400.00	1410.90	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43
Site 2	3123.51	Floodway	21400.00	1410.90	1426.09		1427.09	0.002526	8.01	2671.46	247.03	0.43
Site 2	3073.62*	Flood Plain	21400.00	1410.25	1425.85		1426.95	0.002741	8.39	2550.19	231.79	0.45
Site 2	3073.62*	Floodway	21400.00	1410.25	1425.85		1426.95	0.002741	8.39	2550.19	231.79	0.45
Site 2	3023.73*	Flood Plain	21400.00	1409.60	1425.57		1426.79	0.002965	8.86	2415.55	216.27	0.47
Site 2	3023.73*	Floodway	21400.00	1409.60	1425.57		1426.79	0.002965	8.86	2415.55	216.27	0.47
Site 2	2973.84*	Flood Plain	21400.00	1408.95	1425.23		1426.62	0.003334	9.44	2266.58	200.39	0.49
Site 2	2973.84*	Floodway	21400.00	1408.95	1425.23		1426.62	0.003334	9.44	2266.58	200.39	0.49
Site 2	2923.94*	Flood Plain	21400.00	1408.30	1424.80		1426.42	0.003815	10.19	2100.33	184.52	0.53
Site 2	2923.94*	Floodway	21400.00	1408.30	1424.80		1426.42	0.003815	10.19	2100.33	184.52	0.53
Site 2	2874.05*	Flood Plain	21400.00	1407.65	1424.22		1426.17	0.004647	11.20	1910.09	168.45	0.59
Site 2	2874.05*	Floodway	21400.00	1407.65	1424.22		1426.17	0.004647	11.20	1910.09	168.45	0.59
Site 2	2824.16	Flood Plain	21400.00	1407.00	1423.33		1425.86	0.005803	12.75	1679.07	151.80	0.68
Site 2	2824.16	Floodway	21400.00	1407.00	1423.33		1425.86	0.005803	12.75	1679.07	151.80	0.68
Site 2	2777.31*	Flood Plain	21400.00	1406.70	1423.09		1425.58	0.005638	12.65	1691.78	153.45	0.67
Site 2	2777.31*	Floodway	21400.00	1406.70	1423.09		1425.58	0.005638	12.65	1691.78	153.45	0.67
Site 2	2730.47*	Flood Plain	21400.00	1406.40	1422.86		1425.30	0.005567	12.55	1705.06	155.10	0.67
Site 2	2730.47*	Floodway	21400.00	1406.40	1422.86		1425.30	0.005567	12.55	1705.06	155.10	0.67
Site 2	2683.62*	Flood Plain	21400.00	1406.10	1422.62		1425.03	0.005515	12.46	1717.99	156.70	0.66
Site 2	2683.62*	Floodway	21400.00	1406.10	1422.62		1425.03	0.005515	12.46	1717.99	156.70	0.66
Site 2	2636.77*	Flood Plain	21400.00	1405.80	1422.39		1424.77	0.005435	12.36	1731.08	158.28	0.66
Site 2	2636.77*	Floodway	21400.00	1405.80	1422.39		1424.77	0.005435	12.36	1731.08	158.28	0.66
Site 2	2589.93*	Flood Plain	21400.00	1405.50	1422.16		1424.50	0.005376	12.27	1744.17	159.80	0.65
Site 2	2589.93*	Floodway	21400.00	1405.50	1422.16		1424.50	0.005376	12.27	1744.17	159.80	0.65
Site 2	2543.08*	Flood Plain	21400.00	1405.20	1421.94		1424.24	0.005275	12.18	1757.64	160.61	0.65
Site 2	2543.08*	Floodway	21400.00	1405.20	1421.94		1424.24	0.005275	12.18	1757.64	160.61	0.65
Site 2	2496.23*	Flood Plain	21400.00	1404.90	1421.72		1423.99	0.005150	12.08	1772.01	161.31	0.64
Site 2	2496.23*	Floodway	21400.00	1404.90	1421.72		1423.99	0.005150	12.08	1772.01	161.31	0.64
Site 2	2449.38*	Flood Plain	21400.00	1404.60	1421.51		1423.74	0.005012	11.97	1787.50	162.13	0.64
Site 2	2449.38*	Floodway	21400.00	1404.60	1421.51		1423.74	0.005012	11.97	1787.50	162.13	0.64
Site 2	2402.54*	Flood Plain	21400.00	1404.30	1421.31		1423.49	0.004896	11.86	1804.01	162.78	0.63
Site 2	2402.54*	Floodway	21400.00	1404.30	1421.31		1423.49	0.004896	11.86	1803.99	162.78	0.63
Site 2	2355.69	Flood Plain	21400.00	1404.00	1421.14		1423.27	0.003839	11.71	1827.04	163.57	0.62
Site 2	2355.69	Floodway	21400.00	1404.00	1421.14		1423.27	0.003839	11.71	1827.06	163.57	0.62
Site 2	2314.55*	Flood Plain	21400.00	1403.75	1420.77		1423.09	0.004284	12.22	1750.71	157.63	0.65
Site 2	2314.55*	Floodway	21400.00	1403.75	1420.77		1423.09	0.004283	12.22	1750.75	157.63	0.65
Site 2	2273.40*	Flood Plain	21400.00	1403.50	1420.29		1422.87	0.004843	12.89	1660.63	150.87	0.68
Site 2	2273.40*	Floodway	21400.00	1403.50	1420.29		1422.87	0.004842	12.89	1660.64	150.87	0.68
Site 2	2232.26*	Flood Plain	21400.00	1403.25	1419.65	1417.23	1422.62	0.005424	13.82	1548.21	143.28	0.74
Site 2	2232.26*	Floodway	21400.00	1403.25	1419.65	1417.23	1422.62	0.005423	13.82	1548.25	143.28	0.74
Site 2	2191.11	Flood Plain	21400.00	1403.00	1417.32	1417.32	1422.13	0.010390	17.60	1215.68	126.08	1.00
Site 2	2191.11	Floodway	21400.00	1403.00	1417.32	1417.32	1422.13	0.010392	17.61	1215.55	126.07	1.00
Site 2	2163.54*	Flood Plain	21400.00	1403.00	1415.29	1416.51	1421.64	0.015300	20.21	1058.72	117.87	1.19
Site 2	2163.54*	Floodway	21400.00	1403.00	1415.29	1416.51	1421.64	0.015300	20.21	1058.72	117.87	1.19
Site 2	2135.97	Flood Plain	21400.00	1403.00	1414.52	1415.78	1421.02	0.032885	20.47	1045.67	115.90	1.20
Site 2	2135.97	Floodway	21400.00	1403.00	1414.52	1415.78	1421.02	0.032885	20.47	1045.67	115.90	1.20
Site 2	2089.23*	Flood Plain	21400.00	1402.20	1415.59	1415.03	1420.08	0.015107	17.00	1259.04	122.57	0.93

HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2 (Continued)

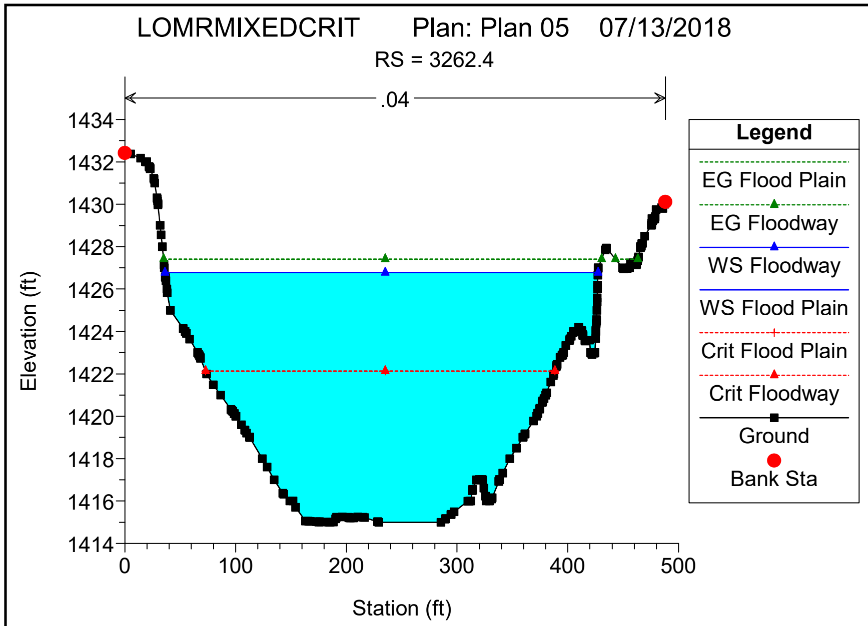
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	2089.23*	Floodway	21400.00	1402.20	1415.59	1415.03	1420.08	0.015107	17.00	1259.04	122.57	0.93
Site 2	2042.49*	Flood Plain	21400.00	1401.40	1414.87	1414.34	1419.36	0.015327	17.00	1259.07	123.04	0.94
Site 2	2042.49*	Floodway	21400.00	1401.40	1414.87	1414.34	1419.36	0.015327	17.00	1259.07	123.04	0.94
Site 2	1995.76*	Flood Plain	21400.00	1400.60	1414.08	1413.66	1418.63	0.015116	17.11	1250.87	123.18	0.95
Site 2	1995.76*	Floodway	21400.00	1400.60	1414.08	1413.66	1418.63	0.015116	17.11	1250.87	123.18	0.95
Site 2	1949.02*	Flood Plain	21400.00	1399.80	1413.41	1412.93	1417.92	0.014696	17.04	1255.81	123.73	0.94
Site 2	1949.02*	Floodway	21400.00	1399.80	1413.41	1412.94	1417.92	0.014696	17.04	1255.81	123.73	0.94
Site 2	1902.28*	Flood Plain	21400.00	1399.00	1412.77	1412.26	1417.22	0.014605	16.91	1265.25	124.40	0.93
Site 2	1902.28*	Floodway	21400.00	1399.00	1412.77	1412.26	1417.22	0.014605	16.91	1265.25	124.40	0.93
Site 2	1855.54*	Flood Plain	21400.00	1398.20	1412.17	1411.54	1416.52	0.013993	16.73	1279.49	125.19	0.92
Site 2	1855.54*	Floodway	21400.00	1398.20	1412.17	1411.54	1416.52	0.013993	16.73	1279.49	125.19	0.92
Site 2	1808.80*	Flood Plain	21400.00	1397.40	1411.63	1410.87	1415.84	0.013512	16.46	1300.18	126.13	0.90
Site 2	1808.80*	Floodway	21400.00	1397.40	1411.63	1410.87	1415.84	0.013512	16.46	1300.18	126.13	0.90
Site 2	1762.07*	Flood Plain	21400.00	1396.59	1411.07	1410.14	1415.16	0.013879	16.21	1320.37	127.03	0.89
Site 2	1762.07*	Floodway	21400.00	1396.59	1411.07	1410.14	1415.16	0.013879	16.21	1320.37	127.03	0.89
Site 2	1715.33*	Flood Plain	21400.00	1395.79	1410.51	1409.48	1414.48	0.013667	15.99	1338.30	127.89	0.87
Site 2	1715.33*	Floodway	21400.00	1395.79	1410.51	1409.48	1414.48	0.013667	15.99	1338.30	127.89	0.87
Site 2	1668.59*	Flood Plain	21400.00	1394.99	1409.97		1413.82	0.013127	15.73	1360.40	128.81	0.85
Site 2	1668.59*	Floodway	21400.00	1394.99	1409.97		1413.82	0.013127	15.73	1360.40	128.81	0.85
Site 2	1621.85*	Flood Plain	21400.00	1394.19	1409.49		1413.18	0.012272	15.40	1389.41	129.91	0.83
Site 2	1621.85*	Floodway	21400.00	1394.19	1409.49		1413.18	0.012272	15.40	1389.41	129.91	0.83
Site 2	1575.11*	Flood Plain	21400.00	1393.39	1409.08		1412.57	0.011131	14.98	1428.38	131.21	0.80
Site 2	1575.11*	Floodway	21400.00	1393.39	1409.08		1412.57	0.011131	14.98	1428.38	131.21	0.80
Site 2	1528.38*	Flood Plain	21400.00	1392.59	1408.75		1412.01	0.010087	14.49	1477.05	132.71	0.77
Site 2	1528.38*	Floodway	21400.00	1392.59	1408.75		1412.01	0.010087	14.49	1477.05	132.71	0.77
Site 2	1481.64*	Flood Plain	21400.00	1391.79	1408.47		1411.50	0.008803	13.94	1534.67	134.39	0.73
Site 2	1481.64*	Floodway	21400.00	1391.79	1408.47		1411.50	0.008803	13.94	1534.67	134.39	0.73
Site 2	1434.9	Flood Plain	21400.00	1390.99	1408.23		1411.02	0.008447	13.40	1597.58	136.18	0.69
Site 2	1434.9	Floodway	21400.00	1390.99	1408.23		1411.02	0.008447	13.40	1597.58	136.18	0.69
Site 2	1388.29*	Flood Plain	21400.00	1390.79	1408.02		1410.57	0.007947	12.82	1669.87	141.46	0.66
Site 2	1388.29*	Floodway	21400.00	1390.79	1408.02		1410.57	0.007947	12.82	1669.87	141.46	0.66
Site 2	1341.68*	Flood Plain	21400.00	1390.59	1407.80		1410.15	0.007640	12.29	1741.43	151.82	0.64
Site 2	1341.68*	Floodway	21400.00	1390.59	1407.80		1410.15	0.007640	12.29	1741.43	151.82	0.64
Site 2	1295.06*	Flood Plain	21400.00	1390.40	1407.48		1409.68	0.011086	11.90	1798.73	157.20	0.62
Site 2	1295.06*	Floodway	21400.00	1390.40	1407.48		1409.68	0.011086	11.90	1798.73	157.20	0.62
Site 2	1248.45*	Flood Plain	21400.00	1390.20	1406.98		1409.14	0.011510	11.77	1817.68	158.17	0.61
Site 2	1248.45*	Floodway	21400.00	1390.20	1406.98		1409.14	0.011510	11.77	1817.68	158.17	0.61
Site 2	1201.84	Flood Plain	21400.00	1390.00	1406.41		1408.58	0.012173	11.81	1811.80	158.94	0.62
Site 2	1201.84	Floodway	21400.00	1390.00	1406.41		1408.58	0.012173	11.81	1811.80	158.94	0.62
Site 2	1157.41*	Flood Plain	21400.00	1390.00	1405.76		1408.03	0.012372	12.07	1772.94	161.29	0.64
Site 2	1157.41*	Floodway	21400.00	1390.00	1405.76		1408.03	0.012372	12.07	1772.94	161.29	0.64
Site 2	1112.97	Flood Plain	21400.00	1390.00	1405.03		1407.43	0.014200	12.42	1723.67	162.87	0.67
Site 2	1112.97	Floodway	21400.00	1390.00	1405.03		1407.43	0.014200	12.42	1723.67	162.87	0.67
Site 2	1068.21*	Flood Plain	21400.00	1389.44	1404.42		1406.76	0.014791	12.28	1742.84	168.38	0.67
Site 2	1068.21*	Floodway	21400.00	1389.44	1404.42		1406.76	0.014791	12.28	1742.84	168.38	0.67
Site 2	1023.46*	Flood Plain	21400.00	1388.89	1403.78		1406.08	0.014994	12.18	1756.44	173.86	0.68
Site 2	1023.46*	Floodway	21400.00	1388.89	1403.78		1406.08	0.014994	12.18	1756.44	173.86	0.68
Site 2	978.70*	Flood Plain	21400.00	1388.33	1403.11		1405.40	0.015452	12.12	1765.45	179.29	0.68
Site 2	978.70*	Floodway	21400.00	1388.33	1403.11		1405.40	0.015452	12.12	1765.45	179.29	0.68
Site 2	933.94*	Flood Plain	21400.00	1387.78	1402.42		1404.69	0.015862	12.10	1768.13	184.50	0.69
Site 2	933.94*	Floodway	21400.00	1387.78	1402.42		1404.69	0.015862	12.10	1768.13	184.50	0.69
Site 2	889.19*	Flood Plain	21400.00	1387.22	1401.73		1404.00	0.015039	12.08	1772.18	189.46	0.70
Site 2	889.19*	Floodway	21400.00	1387.22	1401.73		1404.00	0.015039	12.08	1772.18	189.46	0.70

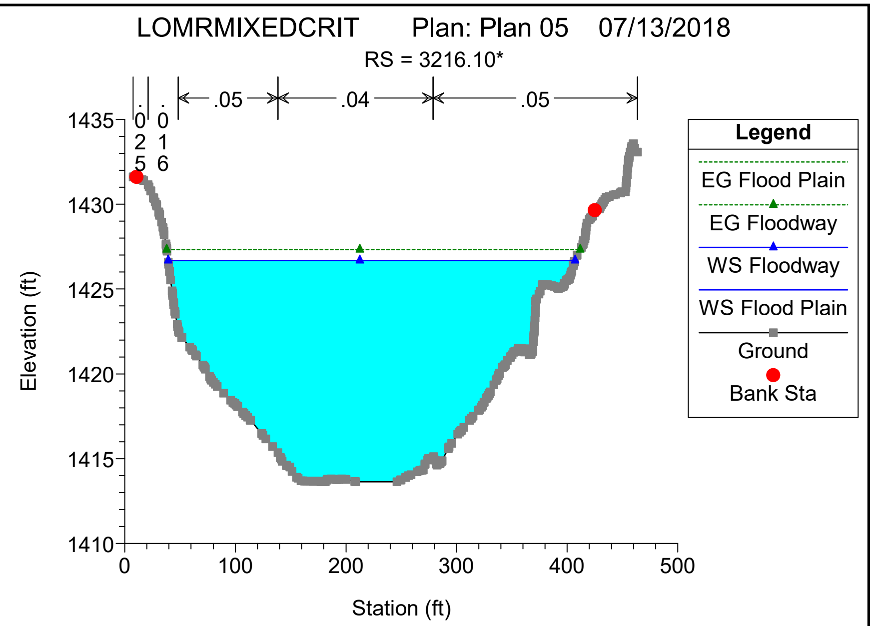
HEC-RAS Plan: Plan 04 River: RIVER Reach: Site 2 (Continued)

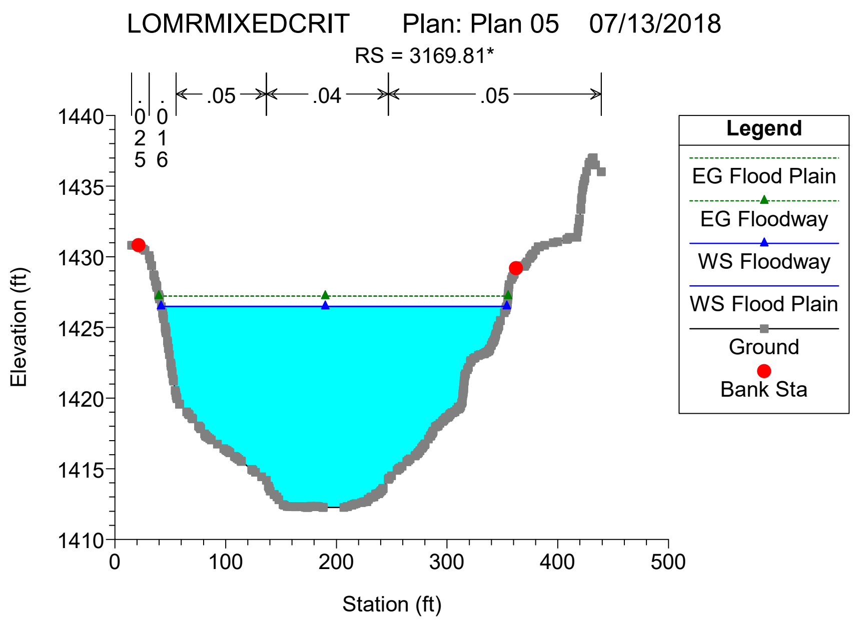
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Site 2	844.43*	Flood Plain	21400.00	1386.67	1401.06		1403.32	0.015253	12.04	1778.12	194.29	0.70
Site 2	844.43*	Floodway	21400.00	1386.67	1401.06		1403.32	0.015253	12.04	1778.12	194.29	0.70
Site 2	799.67*	Flood Plain	21400.00	1386.11	1400.37		1402.62	0.015774	12.03	1778.54	199.06	0.71
Site 2	799.67*	Floodway	21400.00	1386.11	1400.37		1402.62	0.015774	12.03	1778.54	199.06	0.71
Site 2	754.92*	Flood Plain	21400.00	1385.56	1399.64		1401.91	0.016002	12.08	1771.25	203.76	0.72
Site 2	754.92*	Floodway	21400.00	1385.56	1399.64		1401.91	0.016002	12.08	1771.25	203.76	0.72
Site 2	710.16	Flood Plain	21400.00	1385.00	1399.06		1401.27	0.012213	11.93	1794.10	208.93	0.72
Site 2	710.16	Floodway	21400.00	1385.00	1399.06		1401.27	0.012213	11.93	1794.10	208.93	0.72
Site 2	660.39*	Flood Plain	21400.00	1384.50	1398.60		1400.63	0.011441	11.42	1873.20	219.30	0.69
Site 2	660.39*	Floodway	21400.00	1384.50	1398.60		1400.63	0.011440	11.42	1873.23	219.30	0.69
Site 2	610.62*	Flood Plain	21400.00	1384.00	1398.19		1400.03	0.010319	10.90	1963.96	230.02	0.66
Site 2	610.62*	Floodway	21400.00	1384.00	1398.19		1400.03	0.010318	10.90	1964.02	230.02	0.66
Site 2	560.85*	Flood Plain	21400.00	1383.50	1397.83		1399.49	0.009185	10.33	2070.75	241.27	0.62
Site 2	560.85*	Floodway	21400.00	1383.50	1397.83		1399.49	0.009184	10.33	2070.81	241.27	0.62
Site 2	511.08*	Flood Plain	21400.00	1383.00	1397.52		1399.01	0.008245	9.76	2192.62	253.25	0.58
Site 2	511.08*	Floodway	21400.00	1383.00	1397.53		1399.01	0.008244	9.76	2192.71	253.25	0.58
Site 2	461.31*	Flood Plain	21400.00	1382.50	1397.26		1398.57	0.007098	9.18	2332.26	266.44	0.55
Site 2	461.31*	Floodway	21400.00	1382.50	1397.27		1398.57	0.007097	9.18	2332.36	266.45	0.55
Site 2	411.54	Flood Plain	21400.00	1382.00	1397.04		1398.19	0.006482	8.60	2487.92	280.38	0.51
Site 2	411.54	Floodway	21400.00	1382.00	1397.04		1398.19	0.006480	8.60	2488.06	280.38	0.51
Site 2	362.84*	Flood Plain	21400.00	1381.12	1396.69		1397.87	0.006383	8.73	2450.72	273.74	0.51
Site 2	362.84*	Floodway	21400.00	1381.12	1396.69		1397.87	0.006382	8.73	2450.86	273.74	0.51
Site 2	314.15*	Flood Plain	21400.00	1380.25	1396.35		1397.56	0.006138	8.83	2422.75	266.95	0.52
Site 2	314.15*	Floodway	21400.00	1380.25	1396.35		1397.56	0.006137	8.83	2422.88	266.95	0.52
Site 2	265.45*	Flood Plain	21400.00	1379.38	1396.02		1397.26	0.006273	8.91	2402.04	260.04	0.52
Site 2	265.45*	Floodway	21400.00	1379.38	1396.02		1397.26	0.006272	8.91	2402.23	260.04	0.52
Site 2	216.76*	Flood Plain	21400.00	1378.50	1395.70		1396.95	0.006169	8.96	2387.59	252.79	0.51
Site 2	216.76*	Floodway	21400.00	1378.50	1395.70		1396.95	0.006168	8.96	2387.74	252.79	0.51
Site 2	168.06*	Flood Plain	21400.00	1377.62	1395.41		1396.66	0.005679	8.97	2385.70	245.07	0.51
Site 2	168.06*	Floodway	21400.00	1377.62	1395.41		1396.66	0.005678	8.97	2385.85	245.07	0.51
Site 2	119.36*	Flood Plain	21400.00	1376.75	1395.14		1396.38	0.005673	8.93	2395.09	235.49	0.49
Site 2	119.36*	Floodway	21400.00	1376.75	1395.14		1396.38	0.005672	8.93	2395.26	235.49	0.49
Site 2	70.67*	Flood Plain	21400.00	1375.88	1394.89		1396.11	0.005316	8.86	2416.42	226.90	0.48
Site 2	70.67*	Floodway	21400.00	1375.88	1394.89		1396.11	0.005315	8.86	2416.58	226.90	0.48
Site 2	21.97	Flood Plain	21400.00	1375.00	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46
Site 2	21.97	Floodway	21400.00	1375.00	1394.66	1389.63	1395.85	0.005003	8.74	2447.79	220.17	0.46

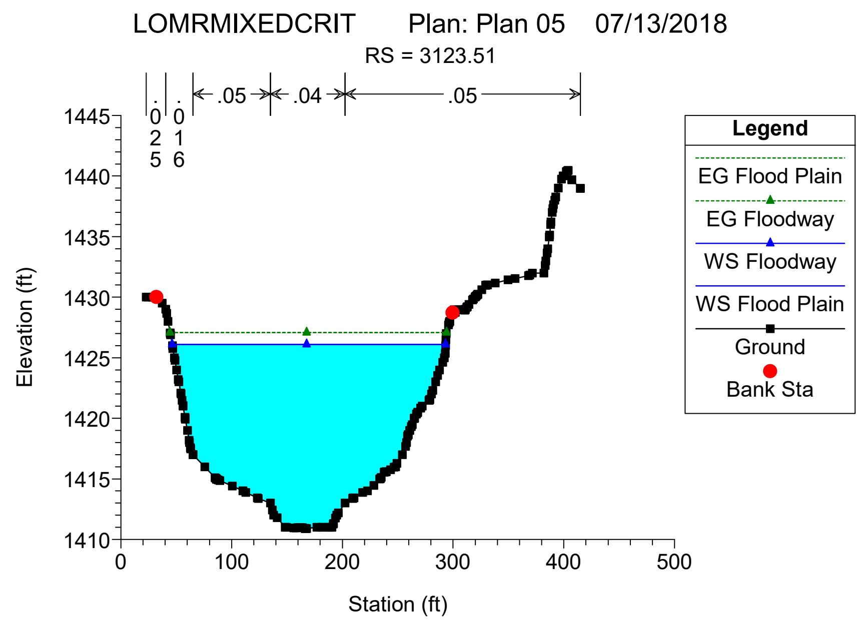


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RIVER Site 2
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Elevation (ft)
Main Channel Distance (ft)
1370
1380
1390
1400
1410
1420
1430
0
500
1000
1500
2000
2500
3000
3500
119.36*
216.76*
314.15*
411.54
511.08*
610.62*
710.16
799.67*
889.19*
978.70*
1068.21*
1157.41*
1248.45*
1341.68*
1434.9
1528.38*
1621.85*
1715.33*
1808.80*
1902.28*
1995.76*
2089.23*
2163.54*
2232.26*
2314.55*
2402.54*
2496.23*
2589.93*
2683.62*
2777.31*
2874.05*
2973.84*
3073.62*
3169.81*
3262.4


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 3262.4
.04
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

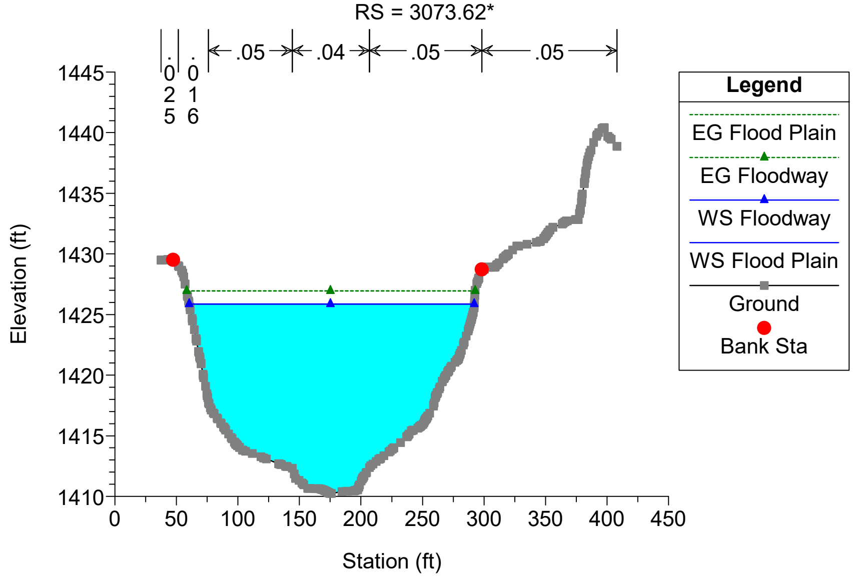

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 3216.10*
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 3169.81*
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 3123.51
.025
.016
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

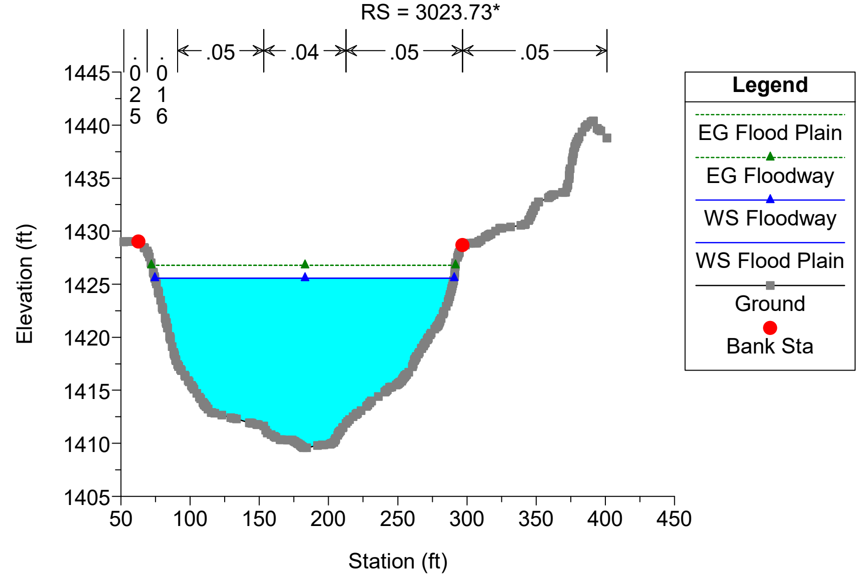
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018

RS = 3073.62*



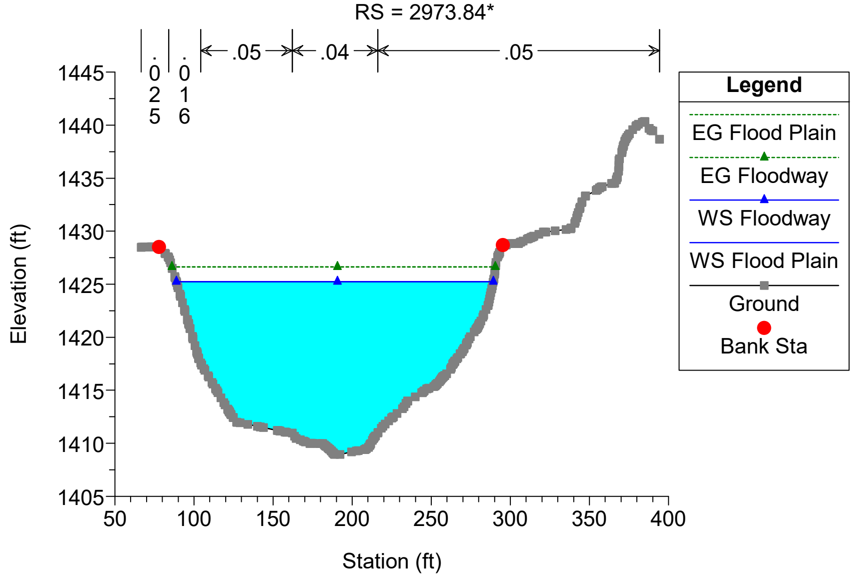
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018

RS = 3023.73*



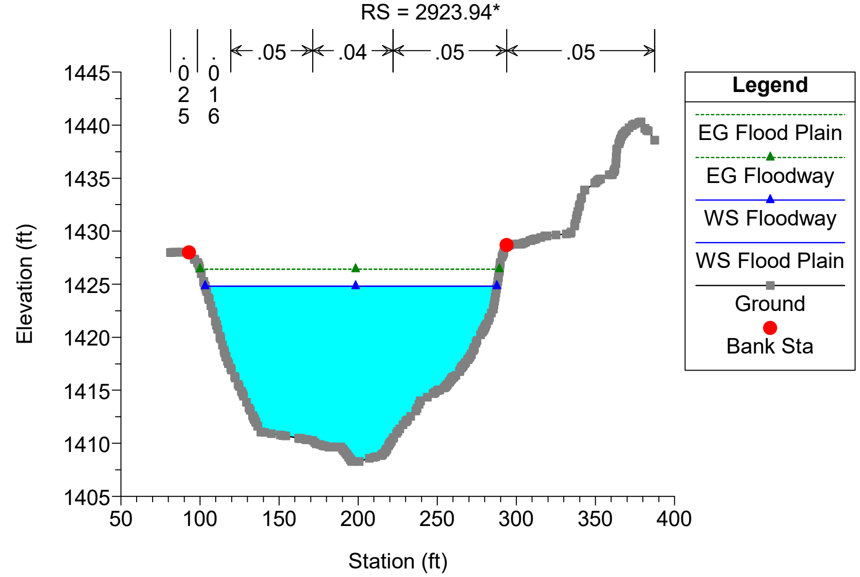
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018

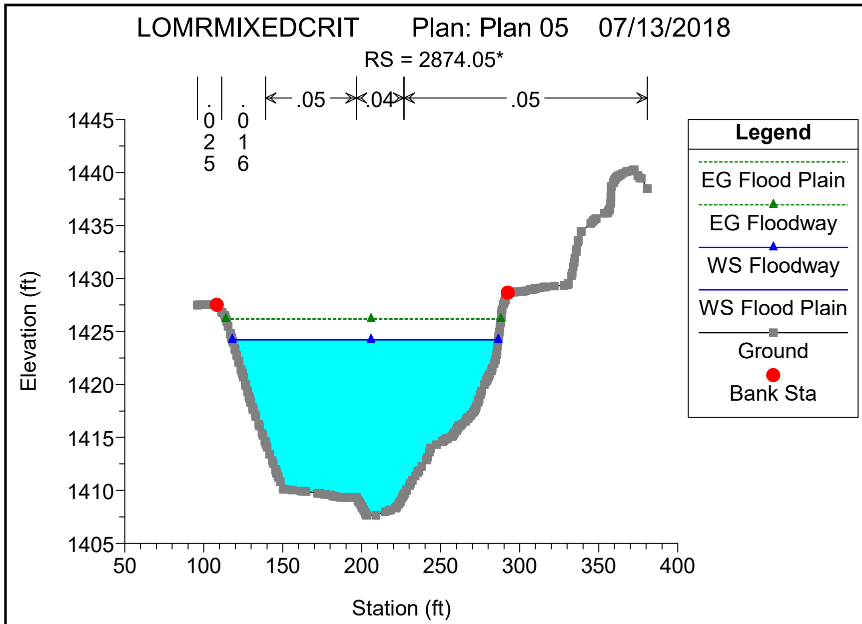
RS = 2973.84*

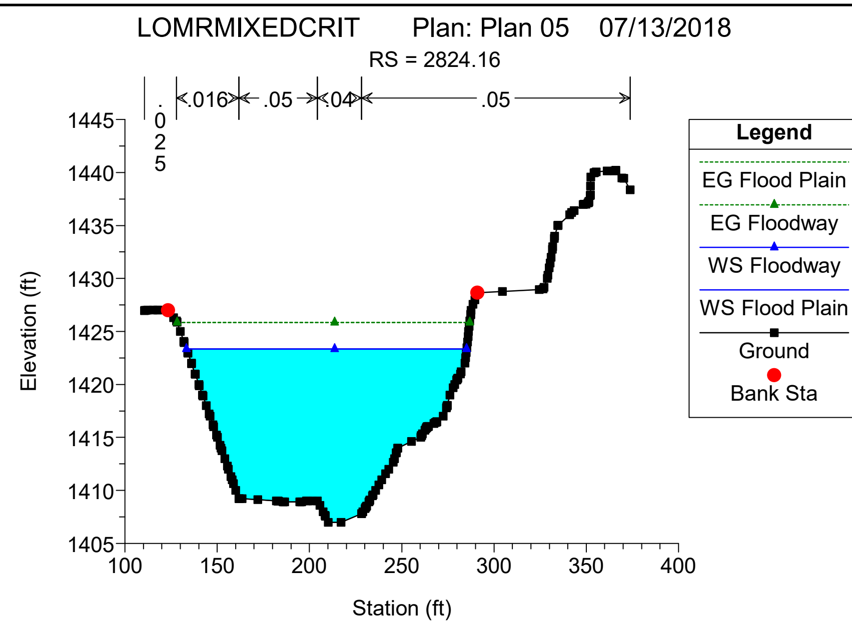


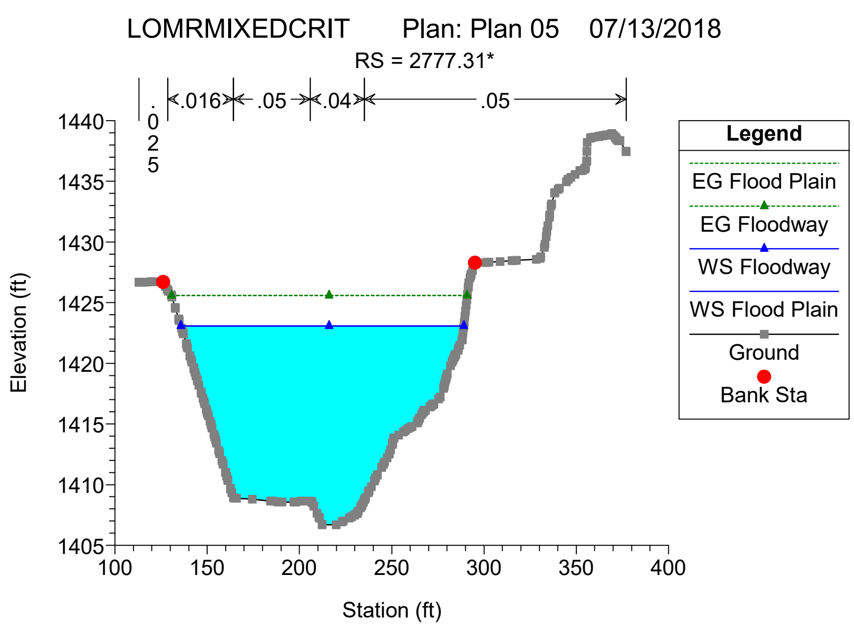
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018

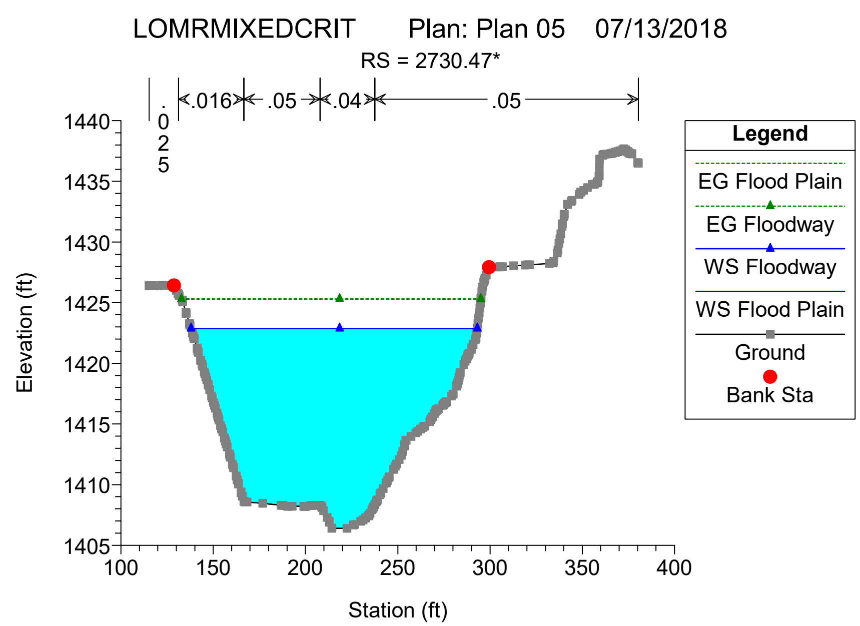
RS = 2923.94*

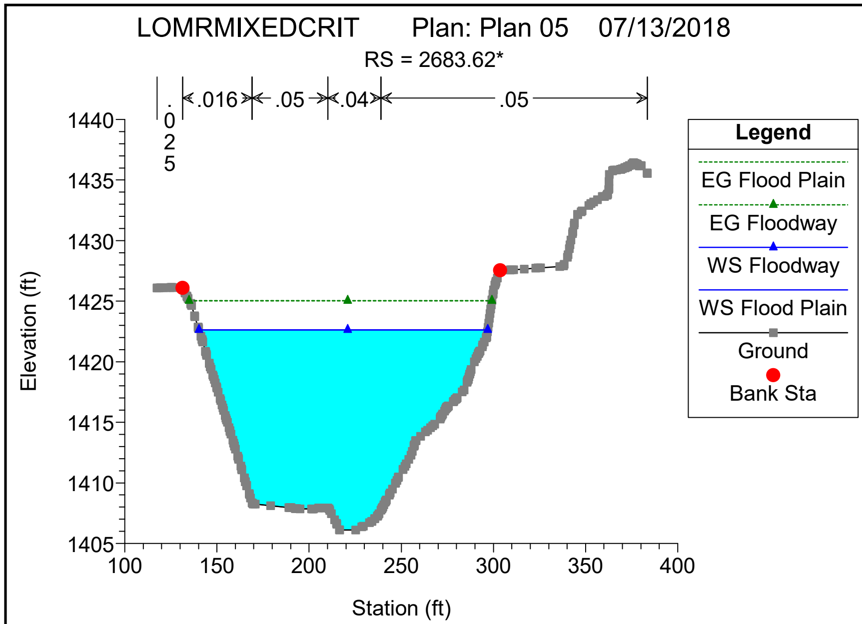


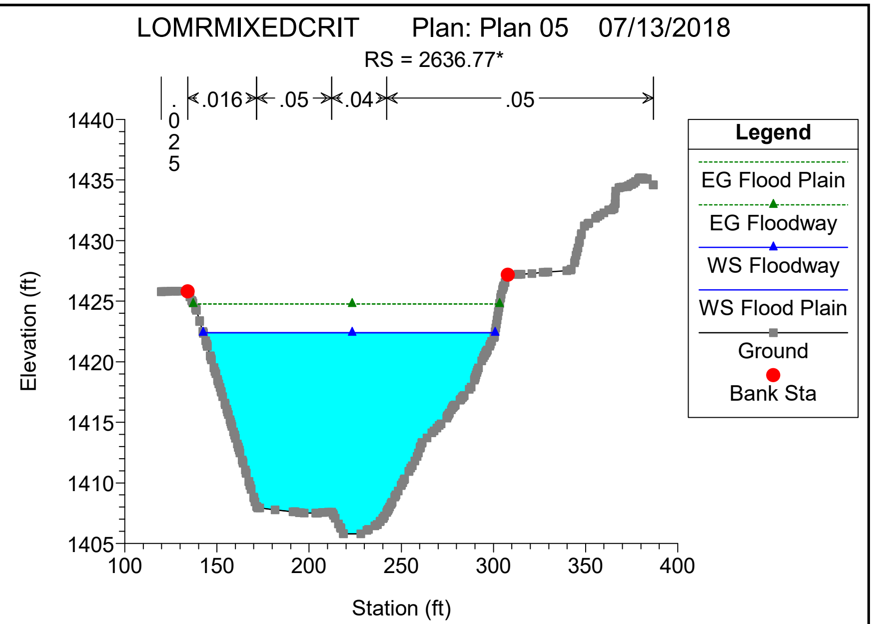

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2874.05*
.05
.04
.05
.025
.016
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1445
1440
1435
1430
1425
1420
1415
1410
1405
50
100
150
200
250
300
350
400

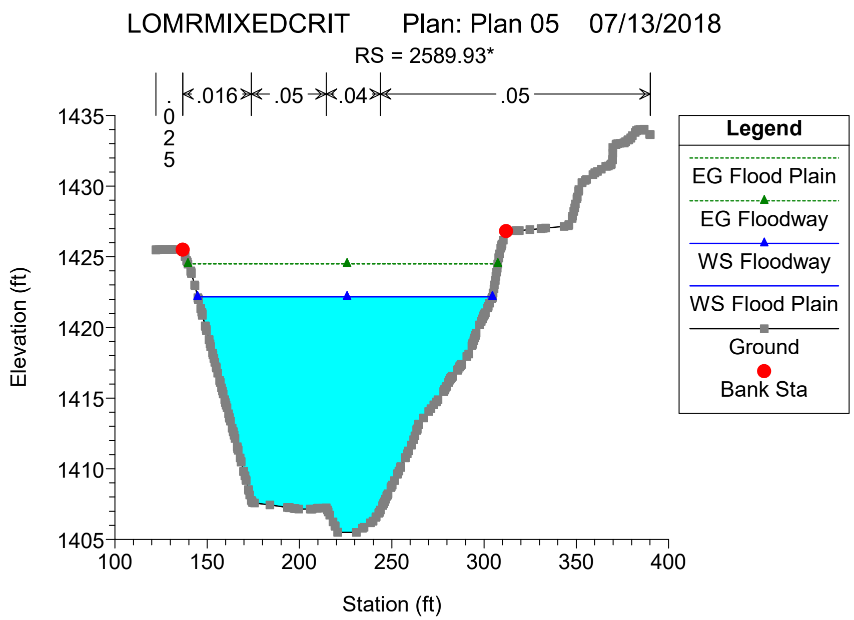

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2824.16
.016
.05
.04
.05
.025
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1445
1440
1435
1430
1425
1420
1415
1410
1405
100
150
200
250
300
350
400

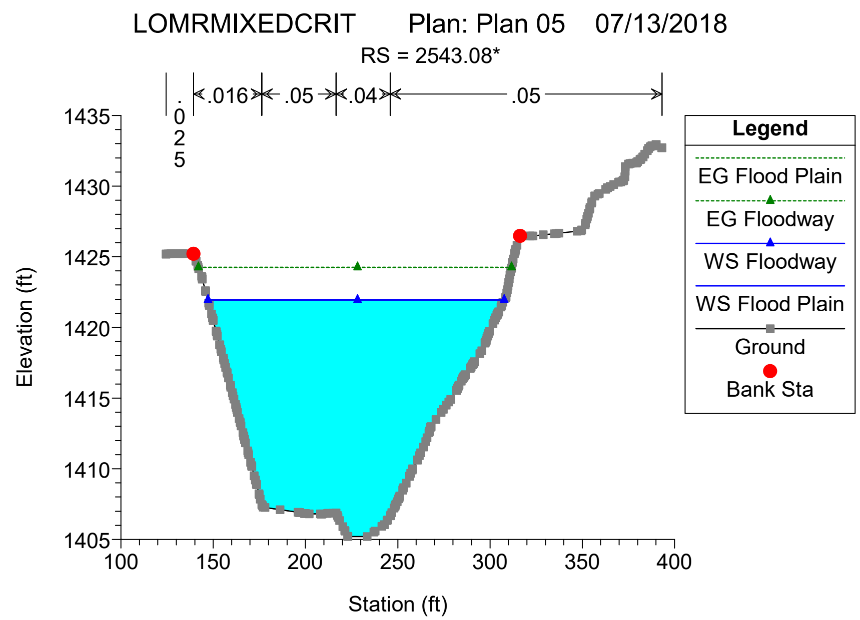

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2777.31*
.016
.05
.04
.05
.025
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1440
1435
1430
1425
1420
1415
1410
1405
100
150
200
250
300
350
400

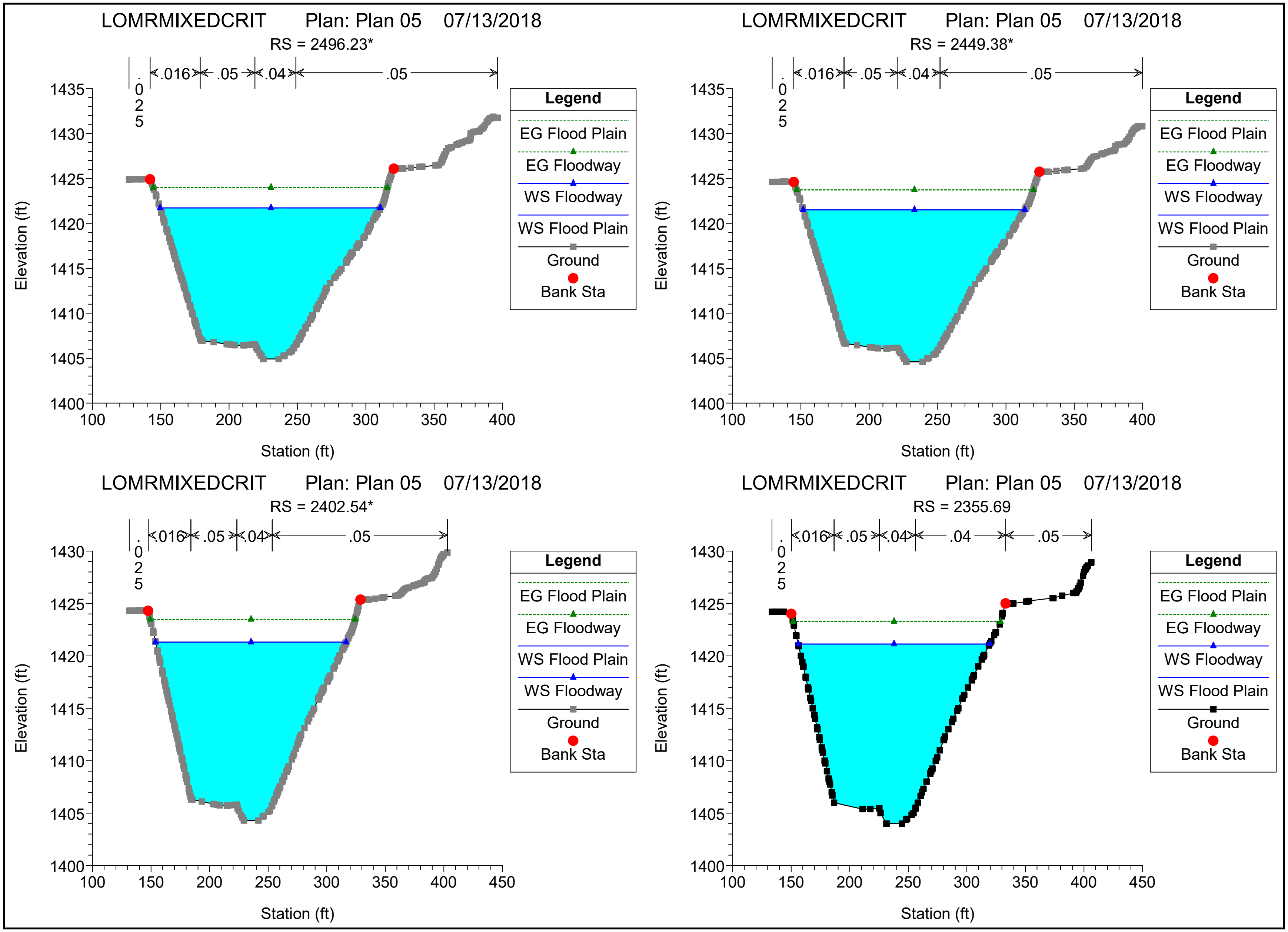

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2730.47*
.016
.05
.04
.05
.025
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
1440
1435
1430
1425
1420
1415
1410
1405
100
150
200
250
300
350
400

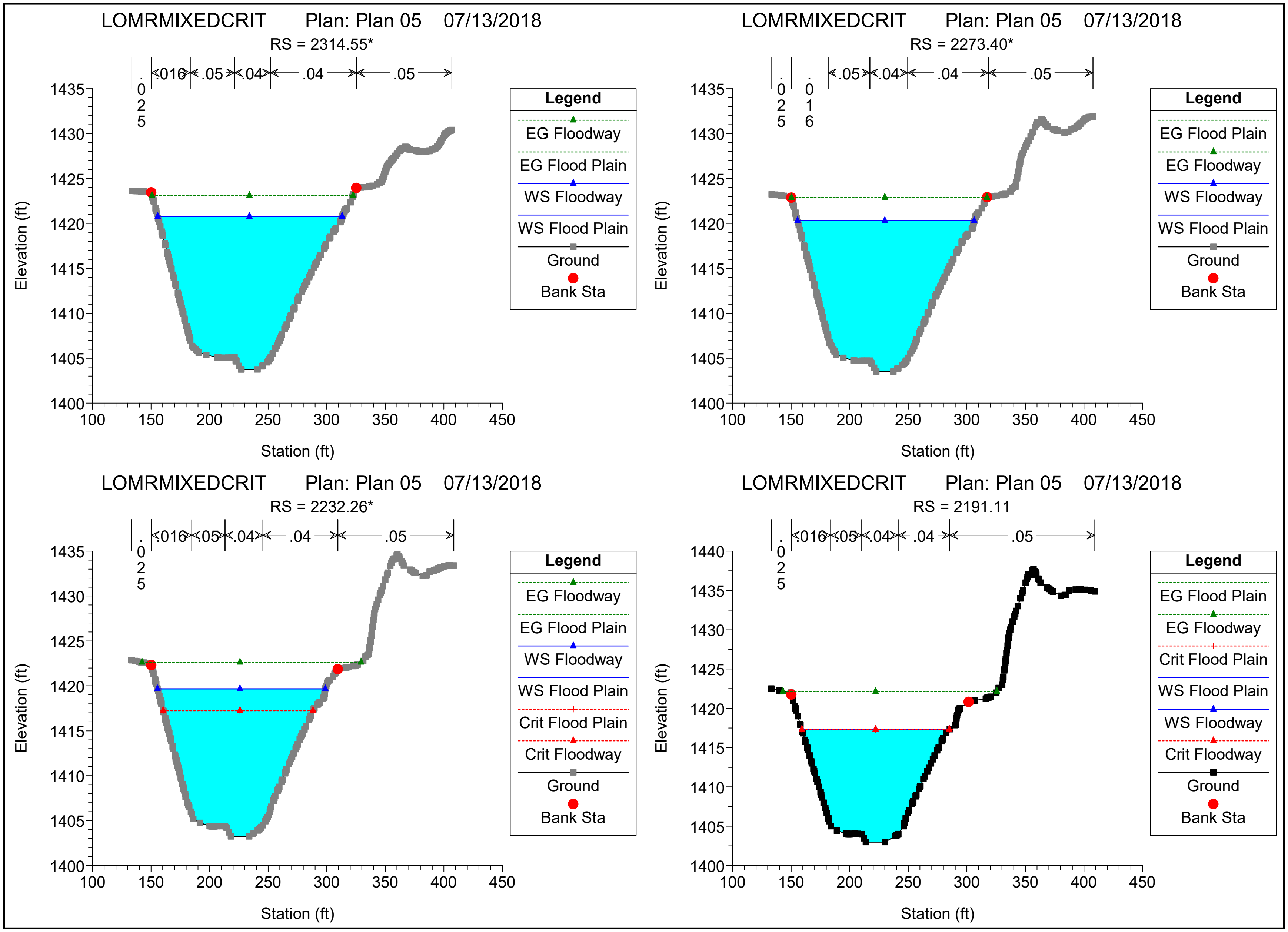

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2683.62*
.025 .016 .05 .04 .05
Elevation (ft)
1405 1410 1415 1420 1425 1430 1435 1440
Station (ft)
100 150 200 250 300 350 400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

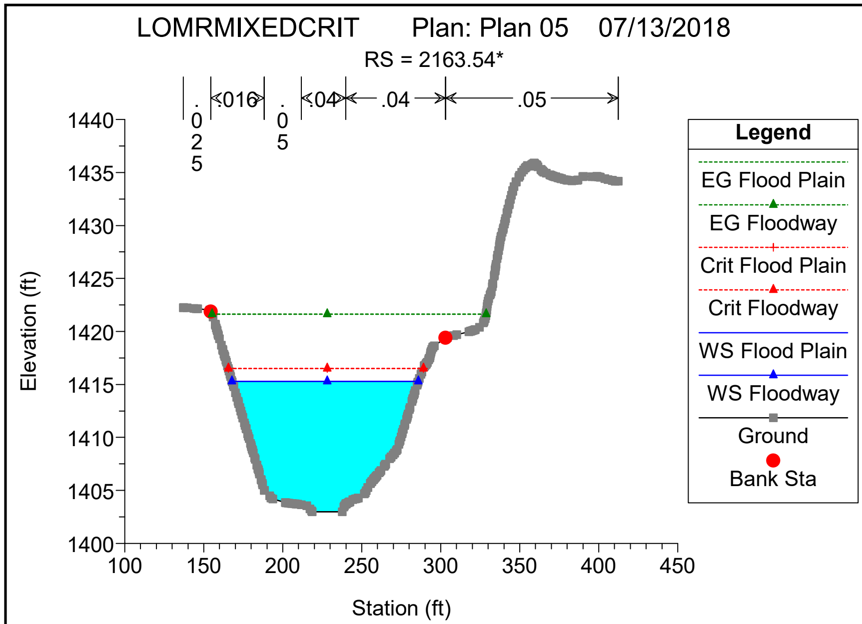

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2636.77*
.025 .016 .05 .04 .05
Elevation (ft)
1405 1410 1415 1420 1425 1430 1435 1440
Station (ft)
100 150 200 250 300 350 400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

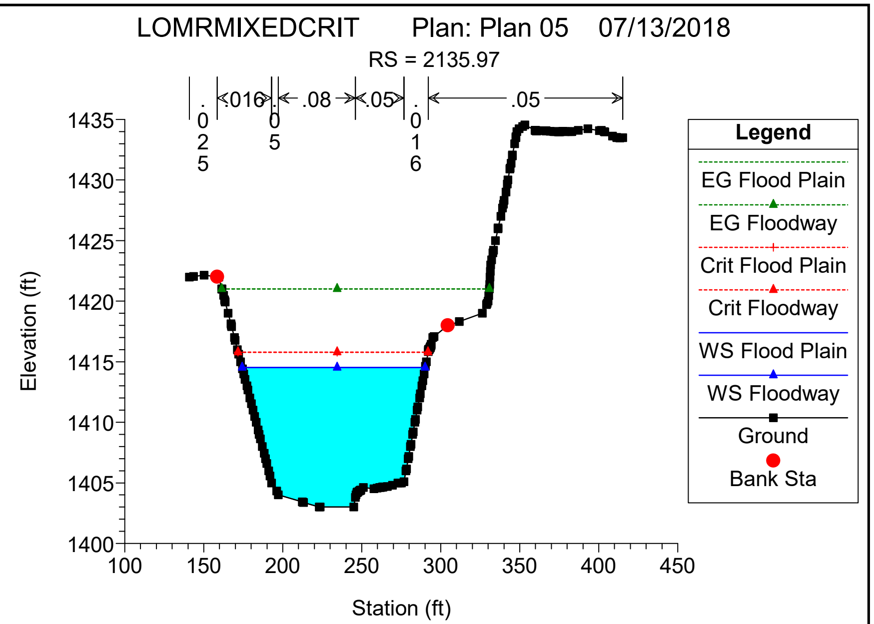

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2589.93*
.025 .016 .05 .04 .05
Elevation (ft)
1405 1410 1415 1420 1425 1430 1435
Station (ft)
100 150 200 250 300 350 400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

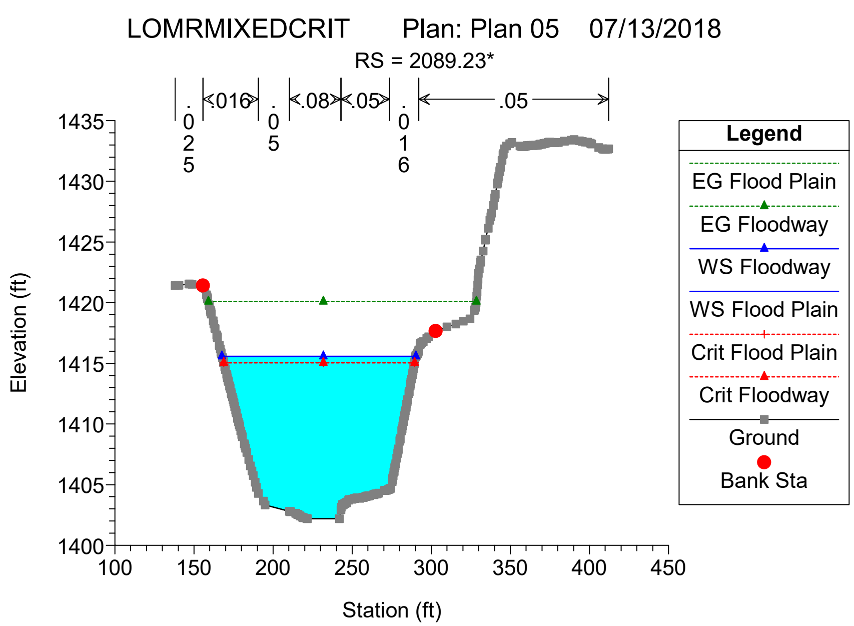

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2543.08*
.025 .016 .05 .04 .05
Elevation (ft)
1405 1410 1415 1420 1425 1430 1435
Station (ft)
100 150 200 250 300 350 400
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta

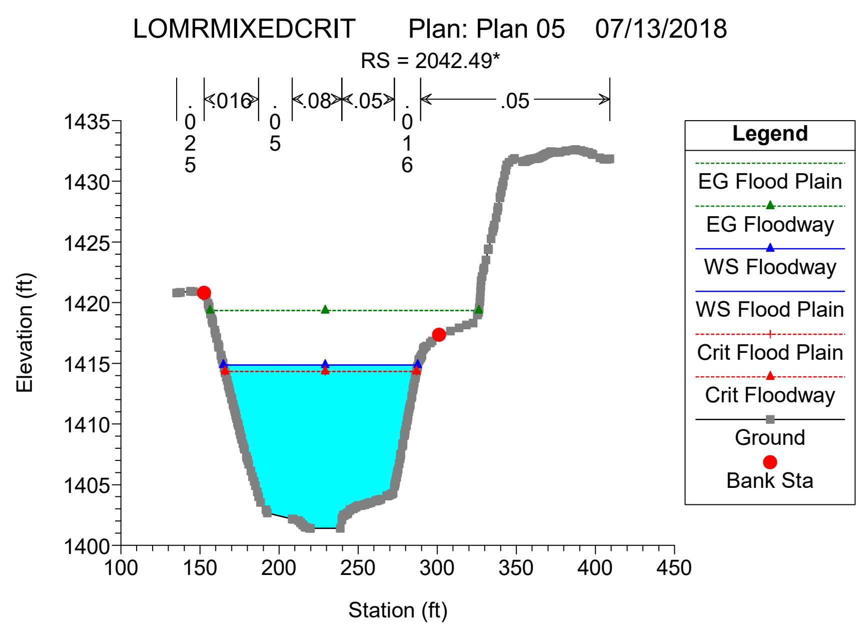

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2496.23*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2449.38*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2402.54*
.025 .016 .05 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Flood Plain
WS Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2355.69
.025 .016 .05 .04 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)

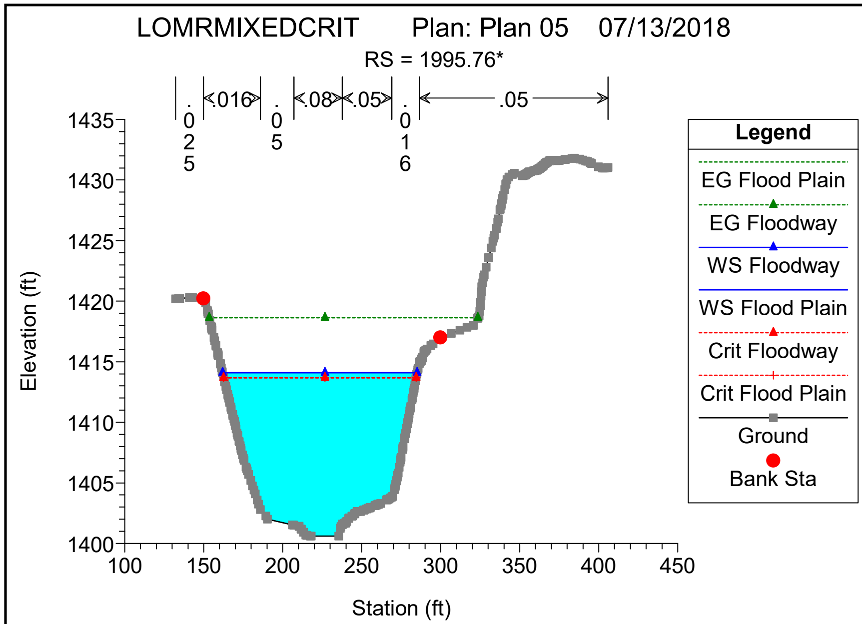

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2314.55*
.025
.016 .05 .04 .04 .05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2273.40*
.025 .016
.05 .04 .04 .05
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2232.26*
.025
.016 .05 .04 .04 .05
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)
LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2191.11
.025
.016 .05 .04 .04 .05
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
WS Flood Plain
WS Floodway
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)

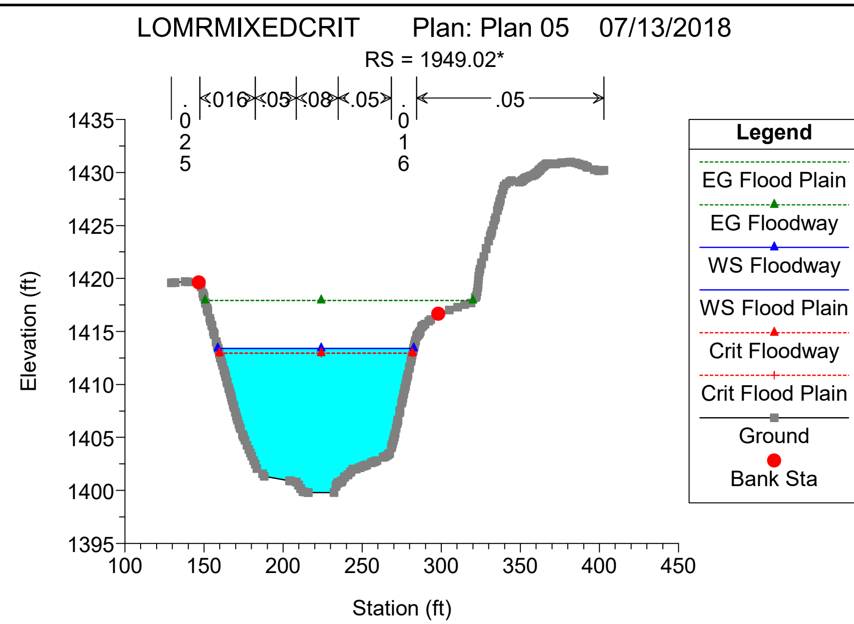

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2163.54*
.025
.016
.05
.04
.04
.05
Elevation (ft)
1400
1405
1410
1415
1420
1425
1430
1435
1440
100
150
200
250
300
350
400
450
Station (ft)
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
Crit Floodway
WS Flood Plain
WS Floodway
Ground
Bank Sta

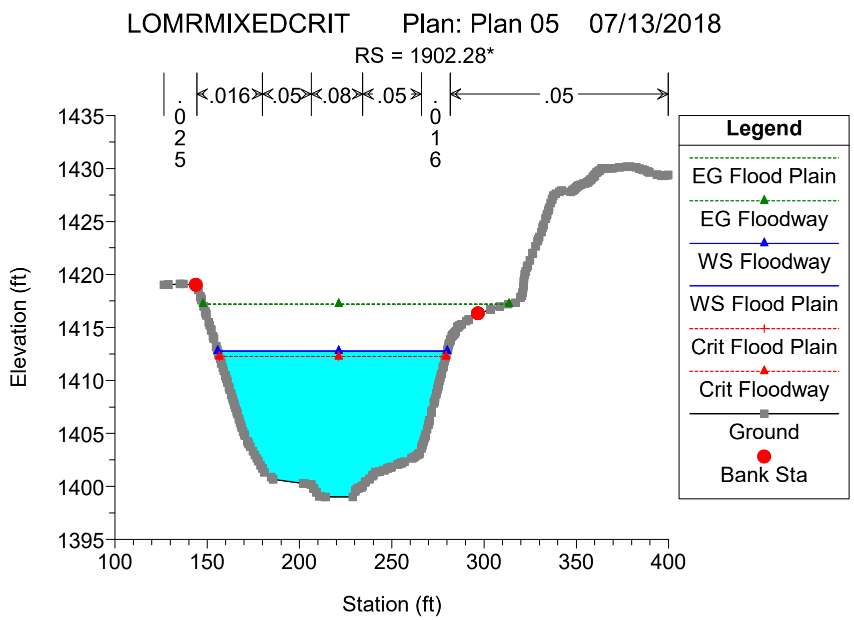

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2135.97
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
1400
1405
1410
1415
1420
1425
1430
1435
100
150
200
250
300
350
400
450
Station (ft)
Legend
EG Flood Plain
EG Floodway
Crit Flood Plain
Crit Floodway
WS Flood Plain
WS Floodway
Ground
Bank Sta

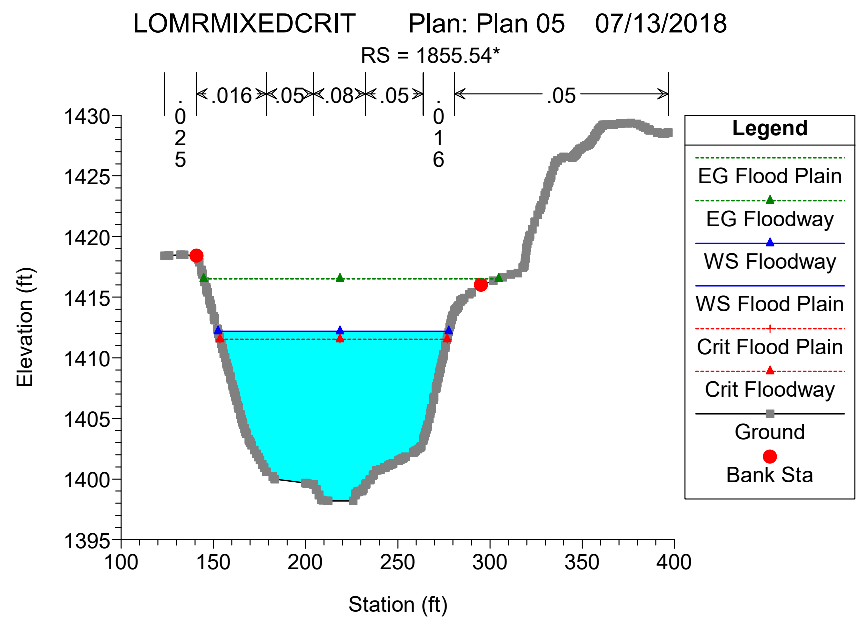

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2089.23*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
1400
1405
1410
1415
1420
1425
1430
1435
100
150
200
250
300
350
400
450
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

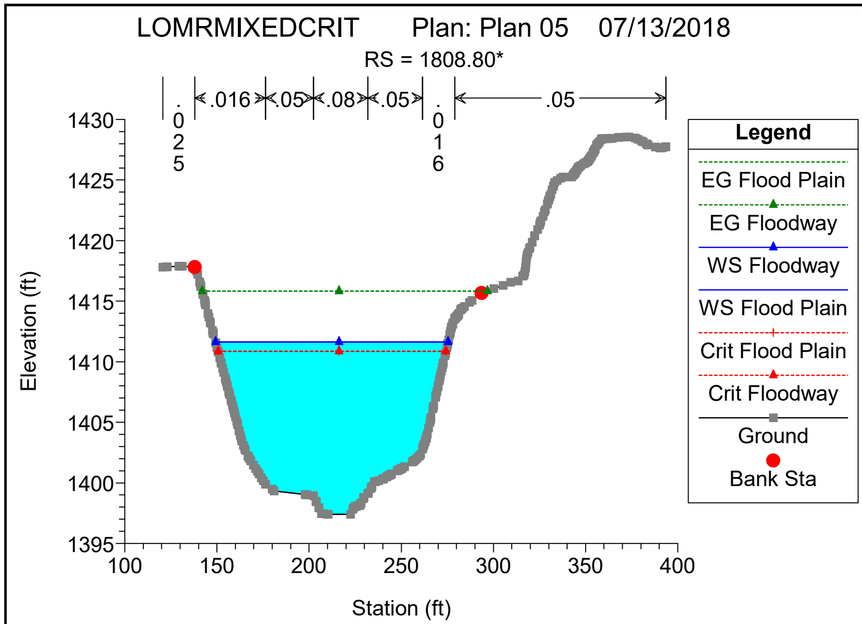

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 2042.49*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
1400
1405
1410
1415
1420
1425
1430
1435
100
150
200
250
300
350
400
450
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

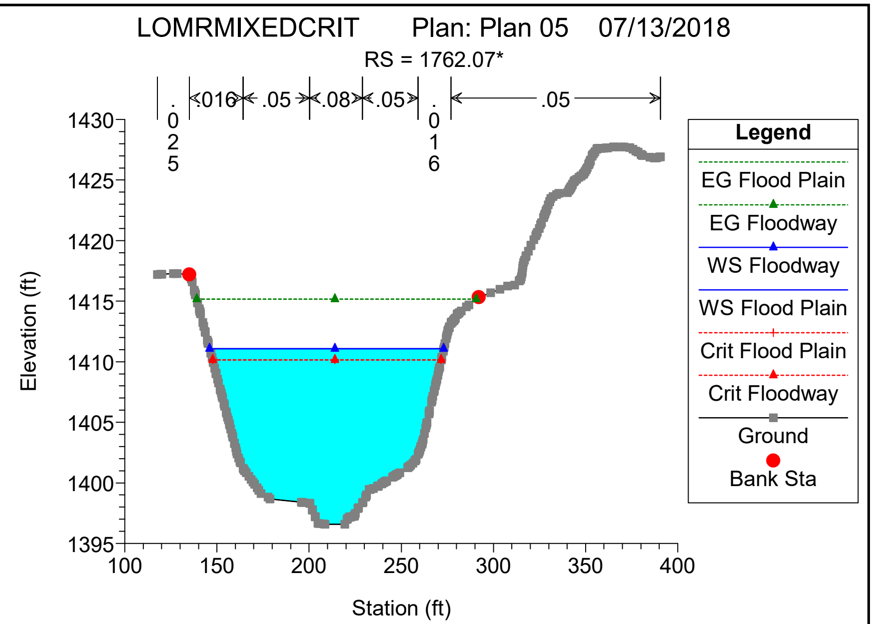

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1995.76*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Floodway
Crit Flood Plain
Ground
Bank Sta

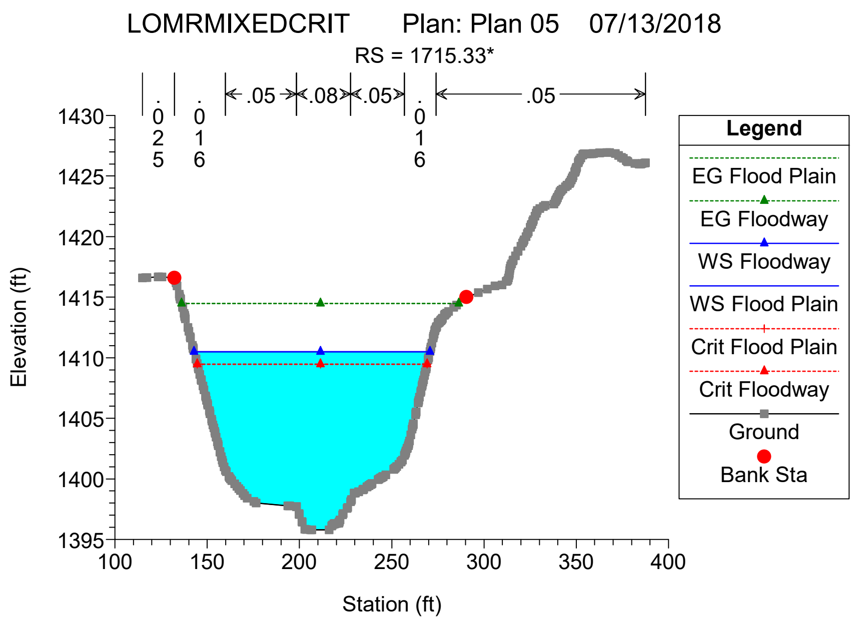

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1949.02*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Floodway
Crit Flood Plain
Ground
Bank Sta

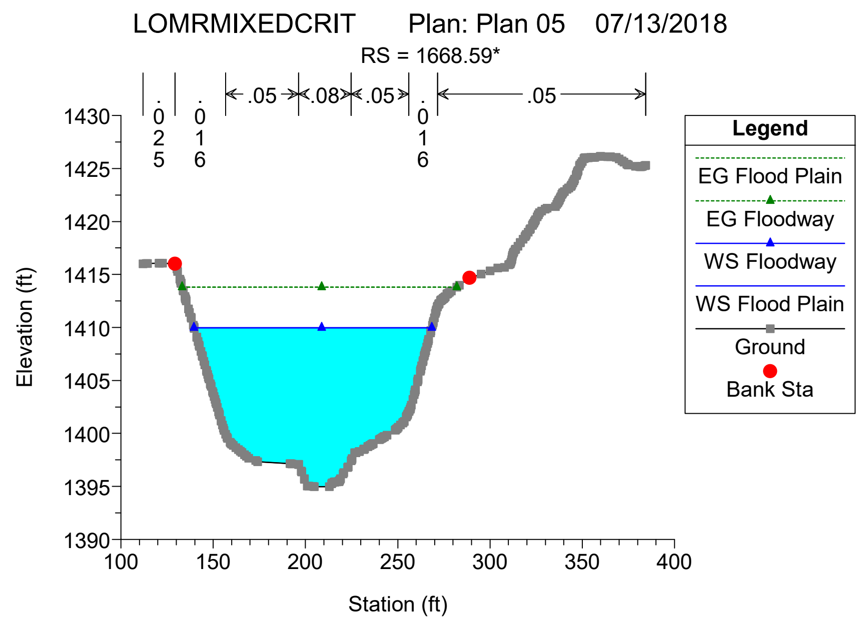

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1902.28*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

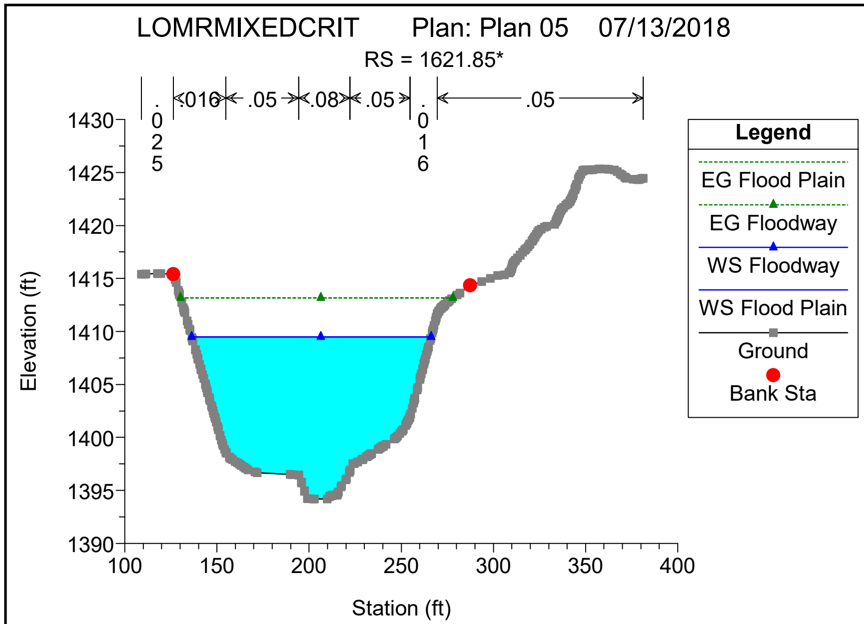

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1855.54*
.025
.016
.05
.08
.05
.016
.05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

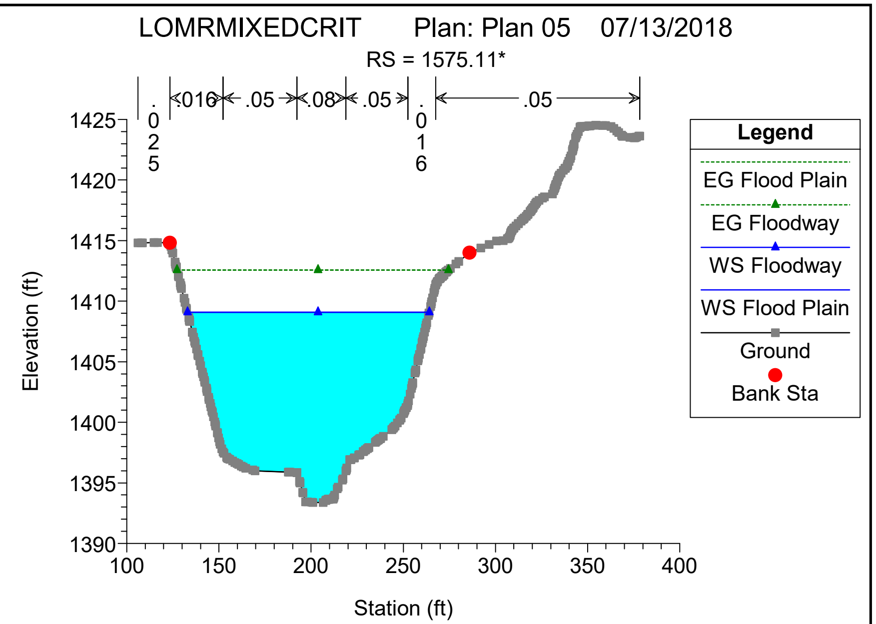

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1808.80*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

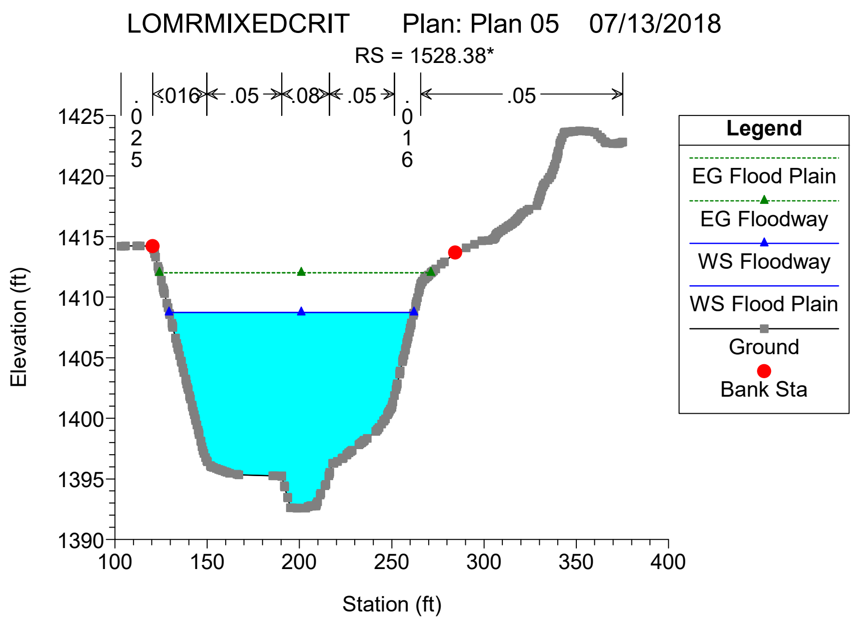

LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1762.07*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1715.33*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1668.59*
.025 .016 .05 .08 .05 .016 .05
Elevation (ft)
Station (ft)
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1621.85*
.016 .05 .08 .05 .016 .05
.025
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1430 1425 1420 1415 1410 1405 1400 1395 1390
Station (ft)
100 150 200 250 300 350 400


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1575.11*
.016 .05 .08 .05 .016 .05
.025
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
1425 1420 1415 1410 1405 1400 1395 1390
Station (ft)
100 150 200 250 300 350 400


LOMRMIXEDCRIT Plan: Plan 05 07/13/2018
RS = 1528.38*
.016 .05 .08 .05 .016 .05
.025
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Ground
Bank Sta
Elevation (ft)
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Station (ft)
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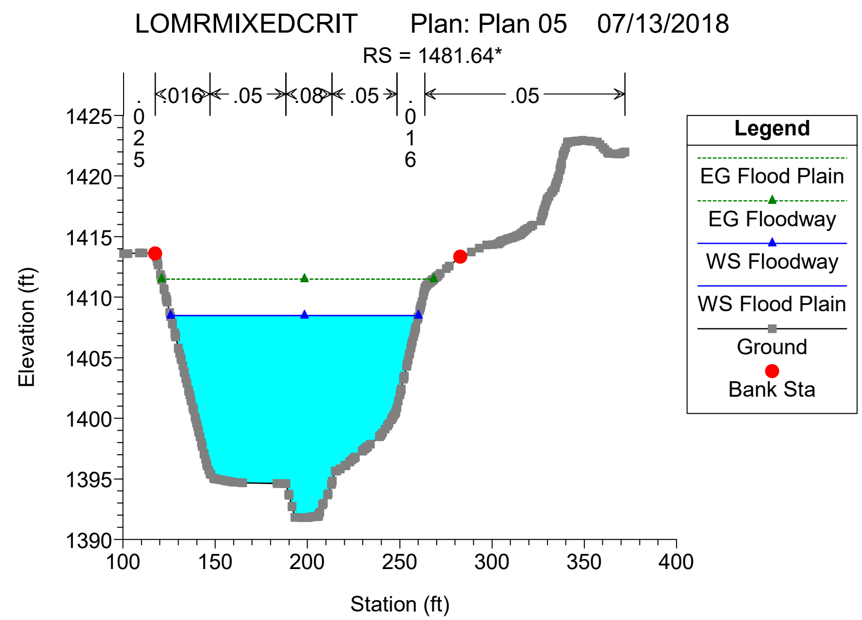
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Ground
Bank Sta
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Station (ft)
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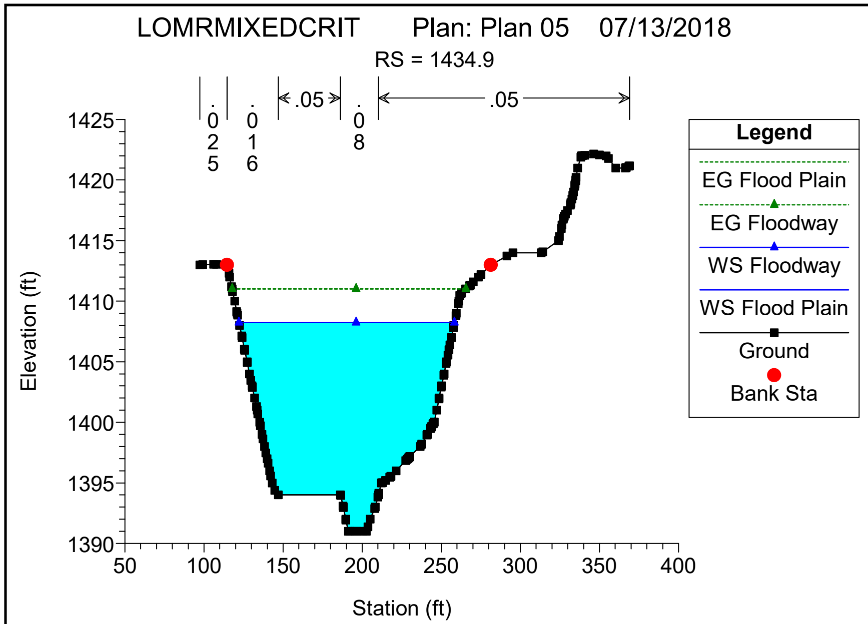
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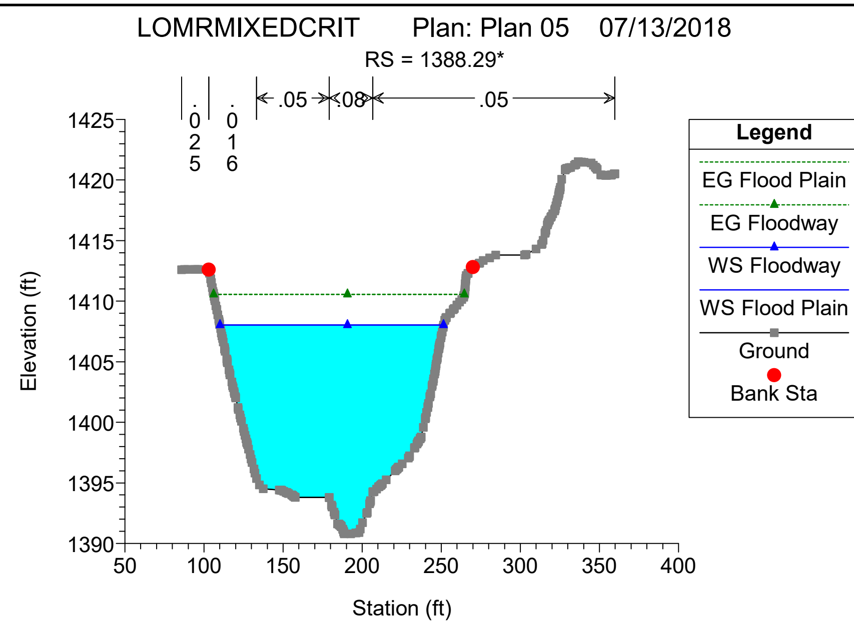
Bank Sta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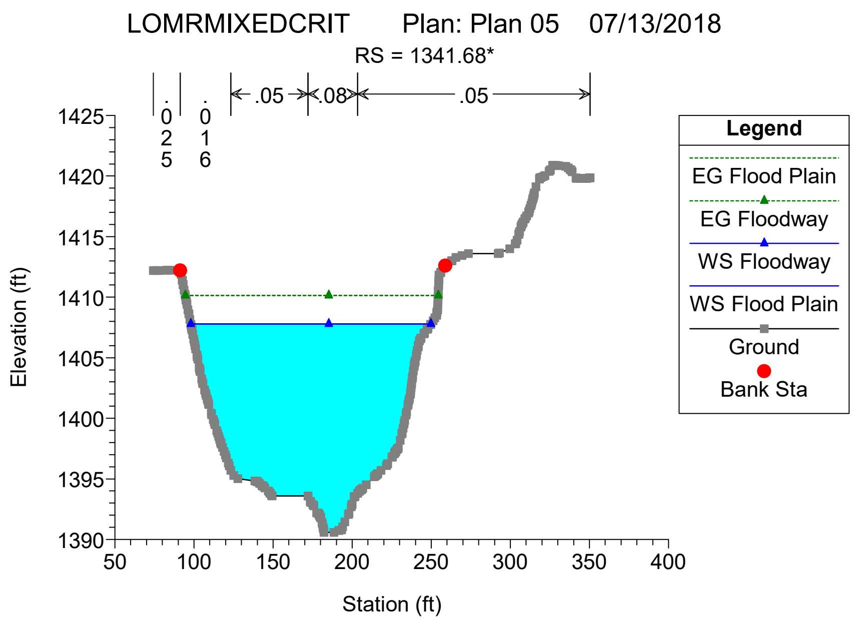
WS Flood Plain
Ground
Bank Sta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Station (ft)
Legend
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EG Floodway
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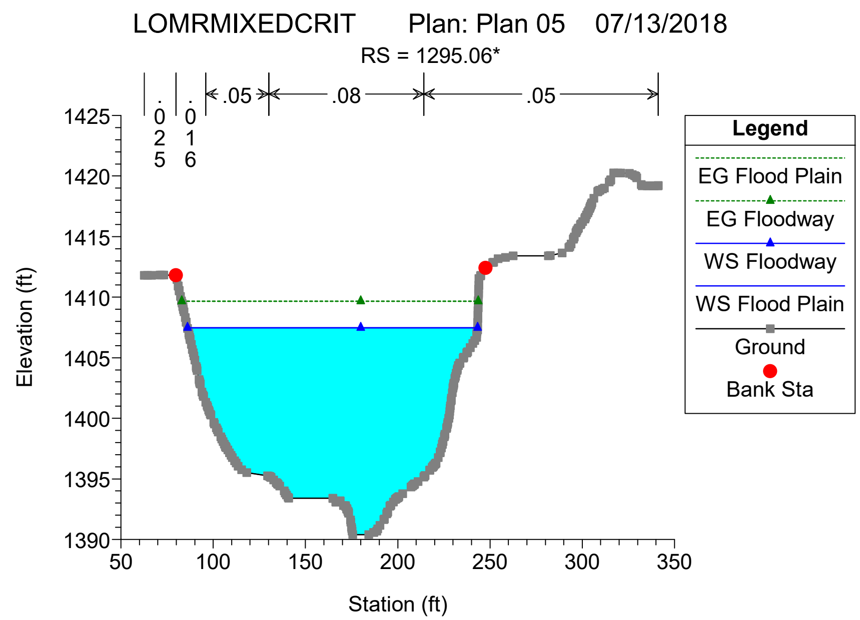
WS Flood Plain
Ground
Bank Sta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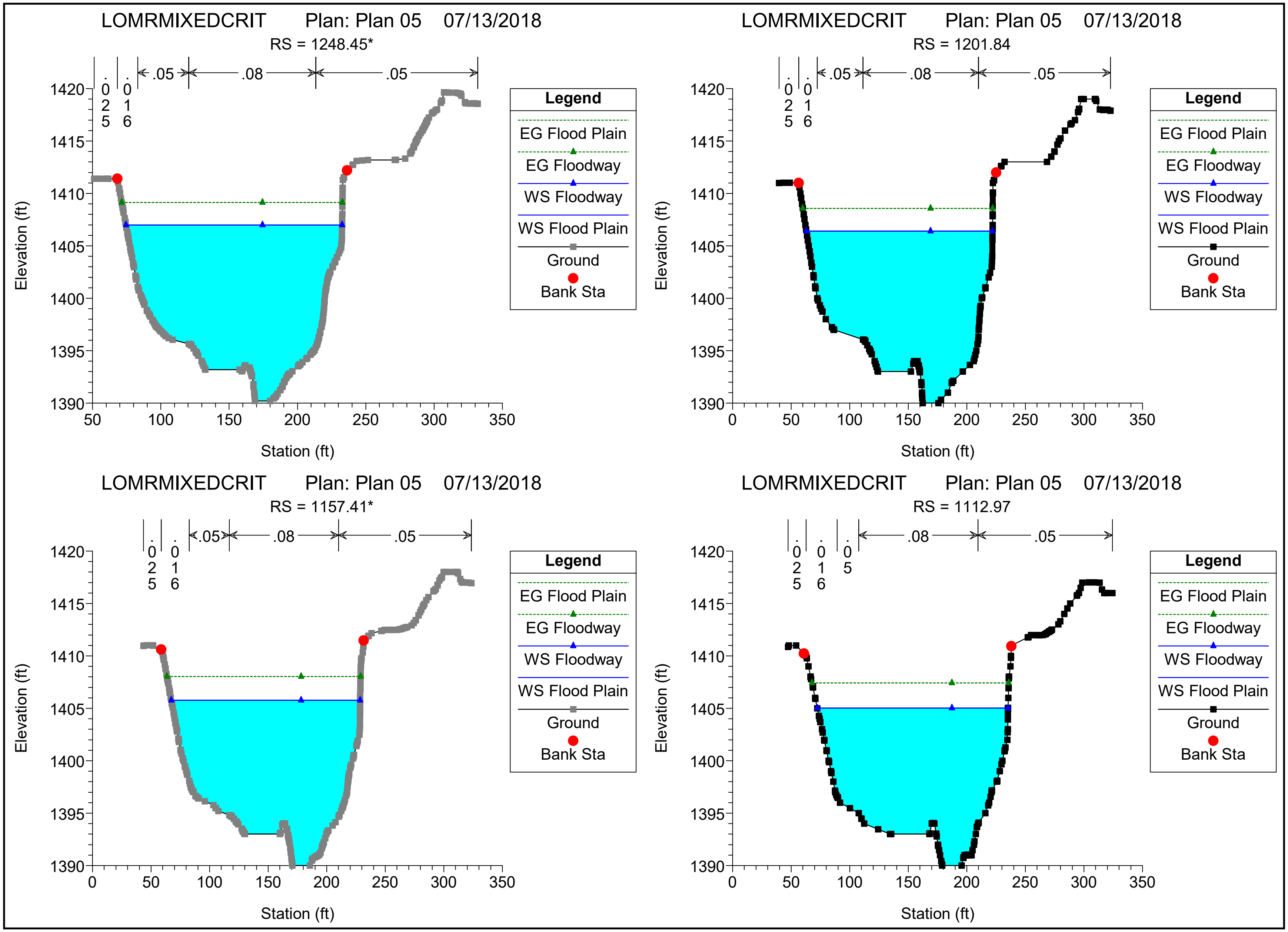
WS Flood Plain
Ground
Bank Sta



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WS Flood Plain
Ground
Bank Sta
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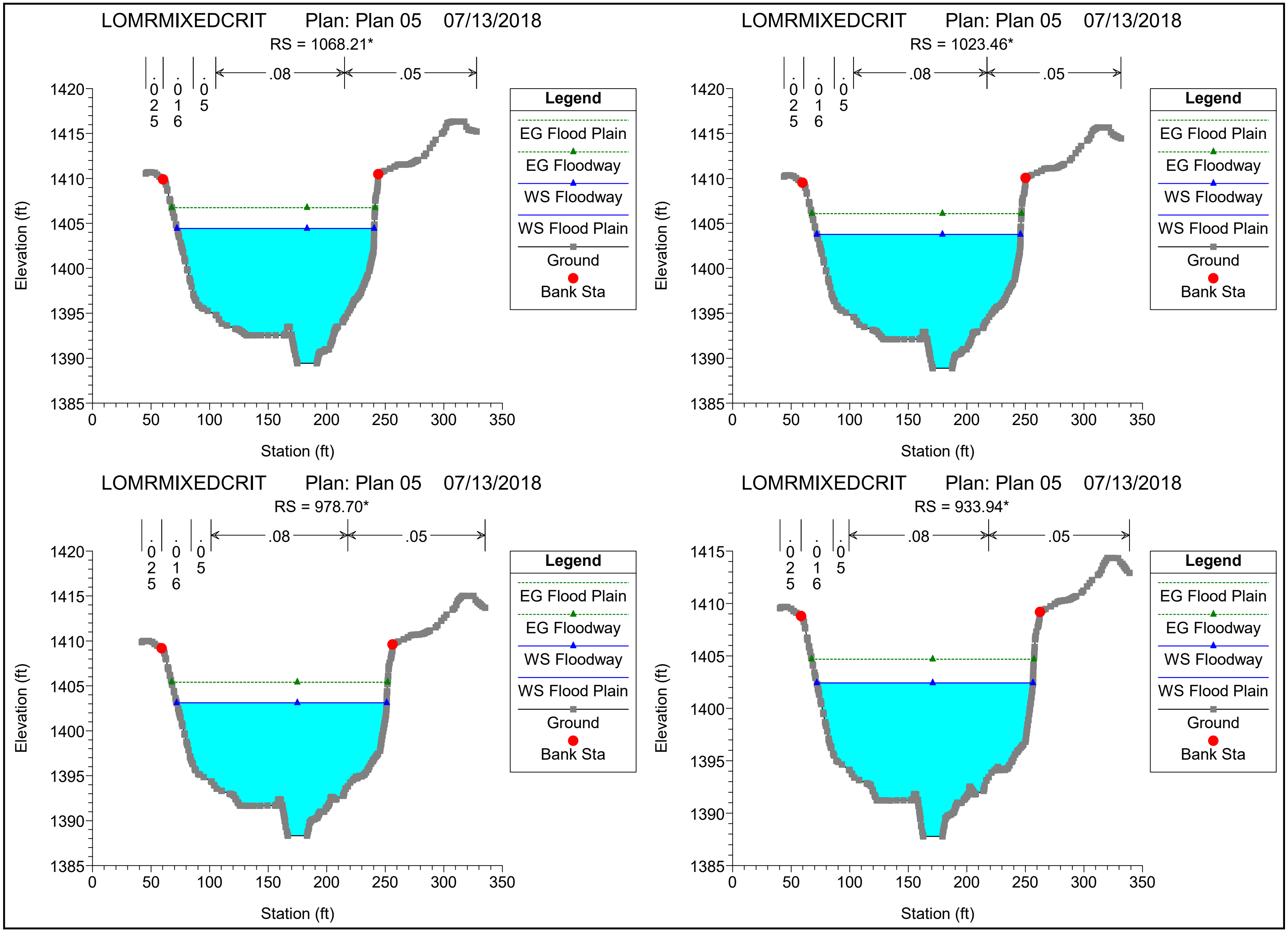
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Ground
Bank Sta
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Station (ft)
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Ground
Bank Sta
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WS Flood Plain
Ground
Bank Sta
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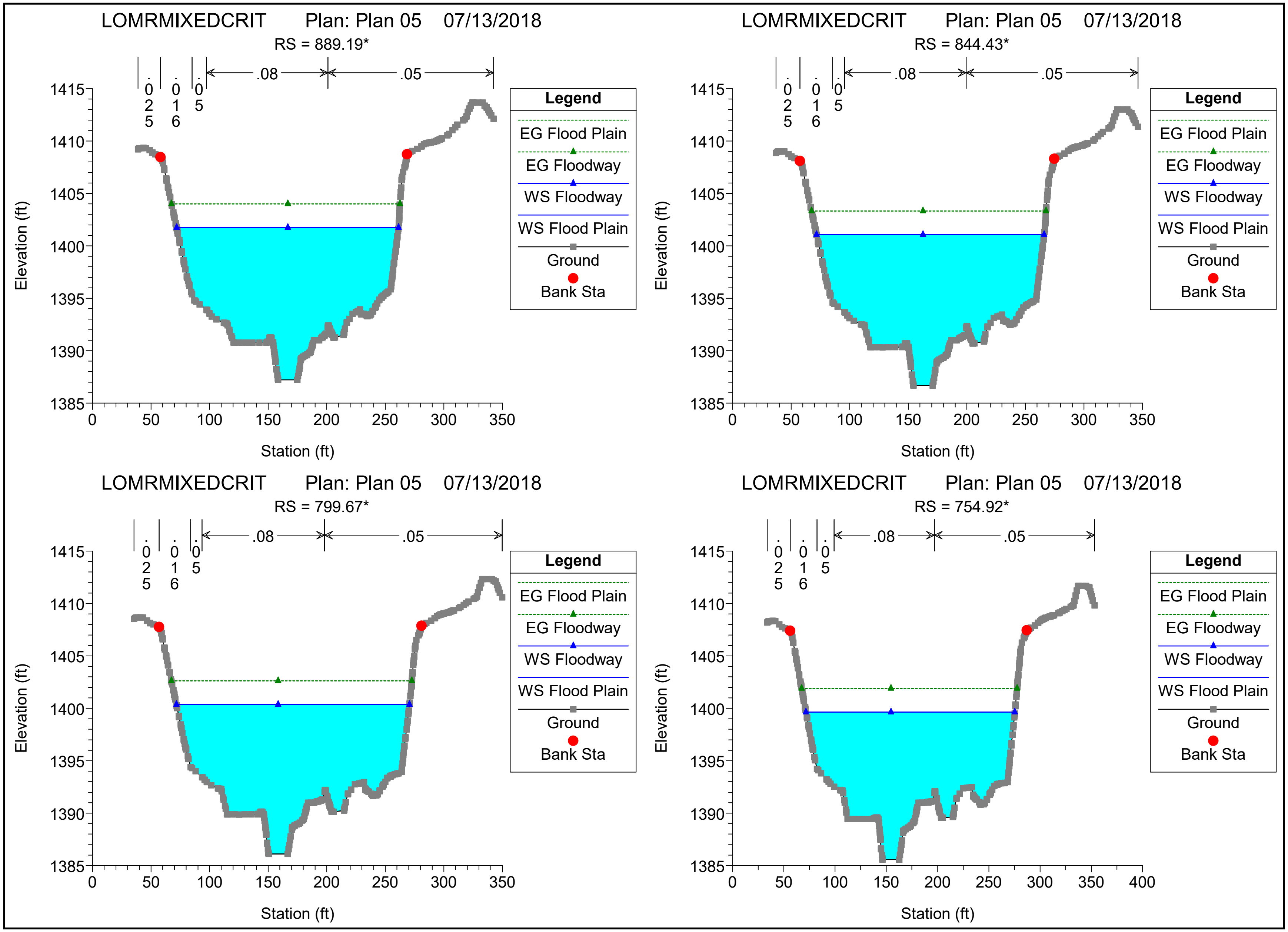
Ground
Bank Sta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Station (ft)
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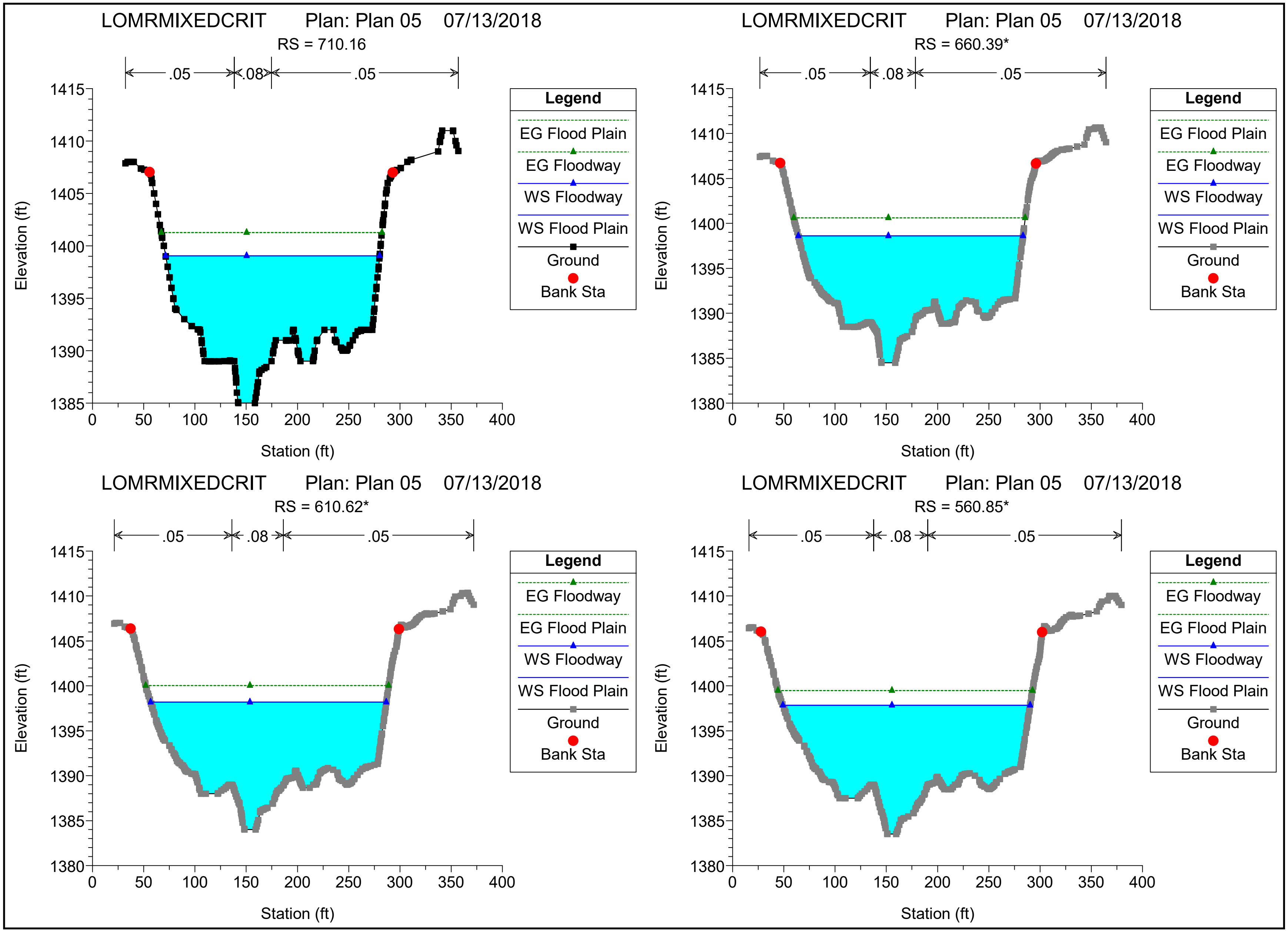
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WS Flood Plain
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Bank Sta
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Ground
Bank Sta
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WS Flood Plain
Ground
Bank Sta
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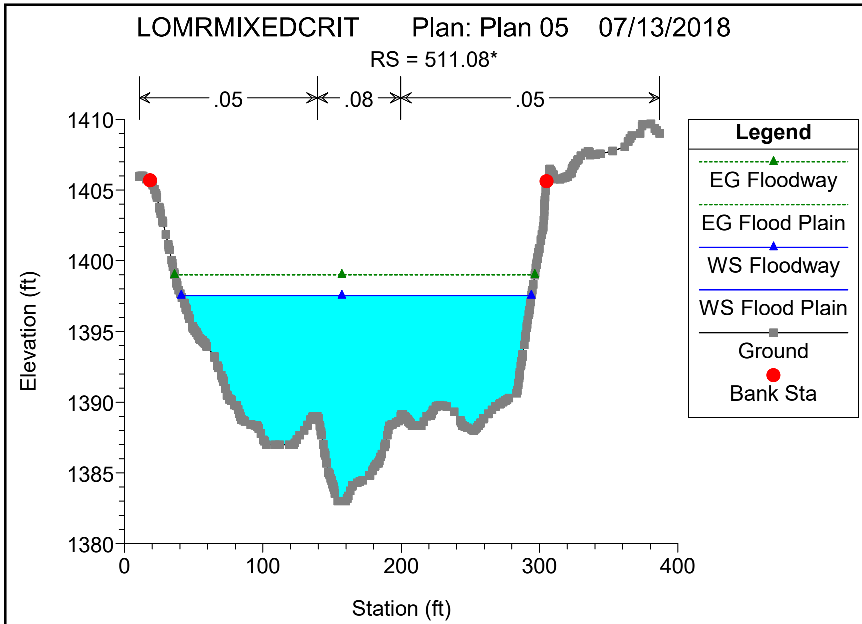
WS Flood Plain
Ground
Bank Sta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Station (ft)
Legend
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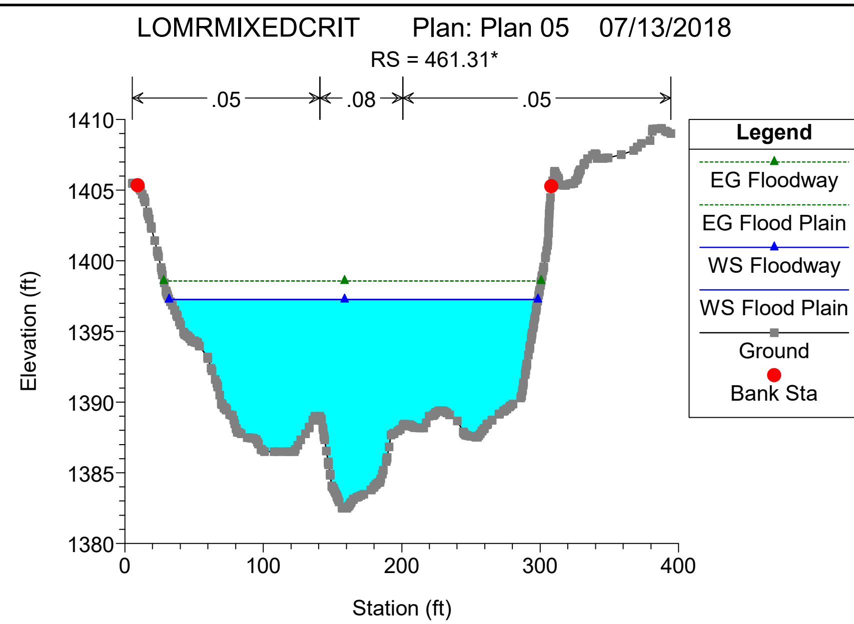
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta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Station (ft)
Legend
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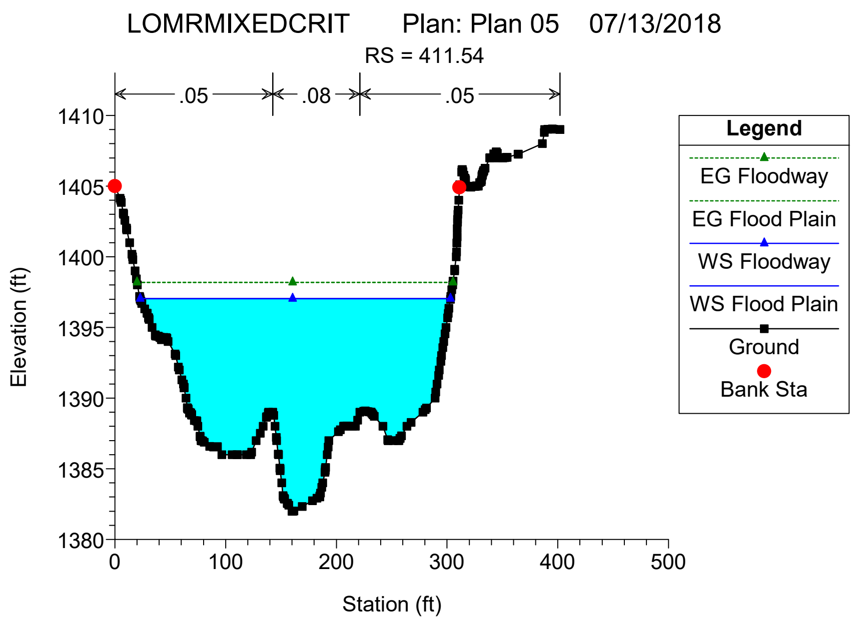
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta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1385
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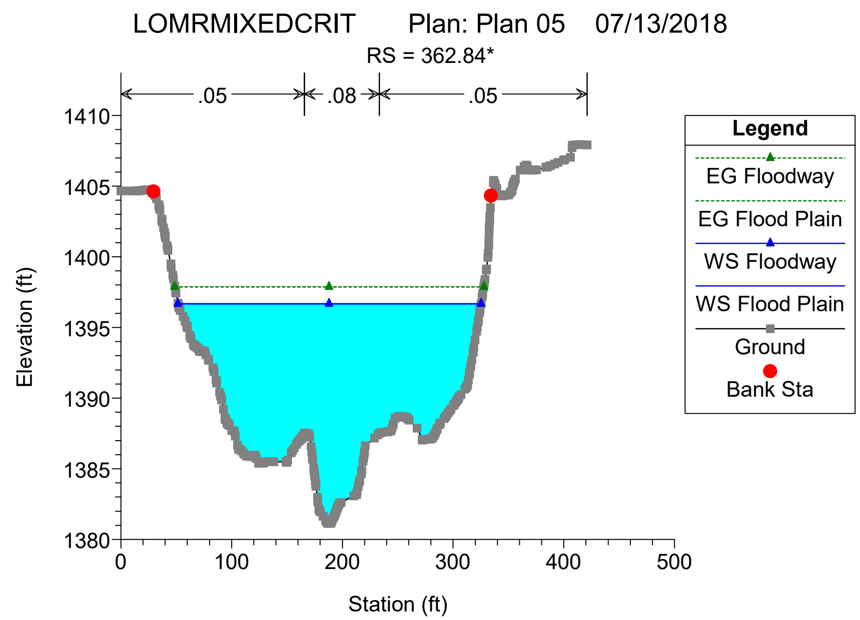
Station (ft)
Legend
EG Floodway
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta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Station (ft)
Legend
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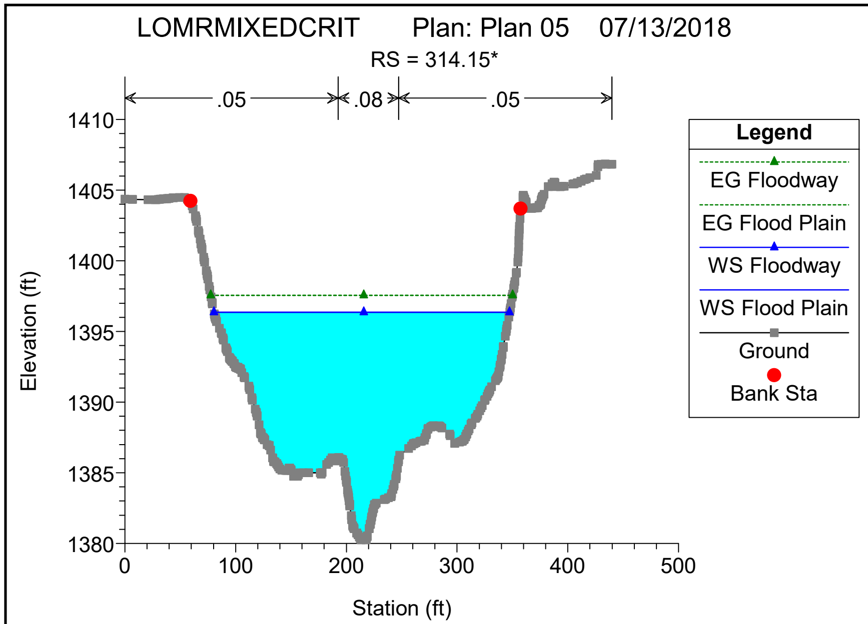
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta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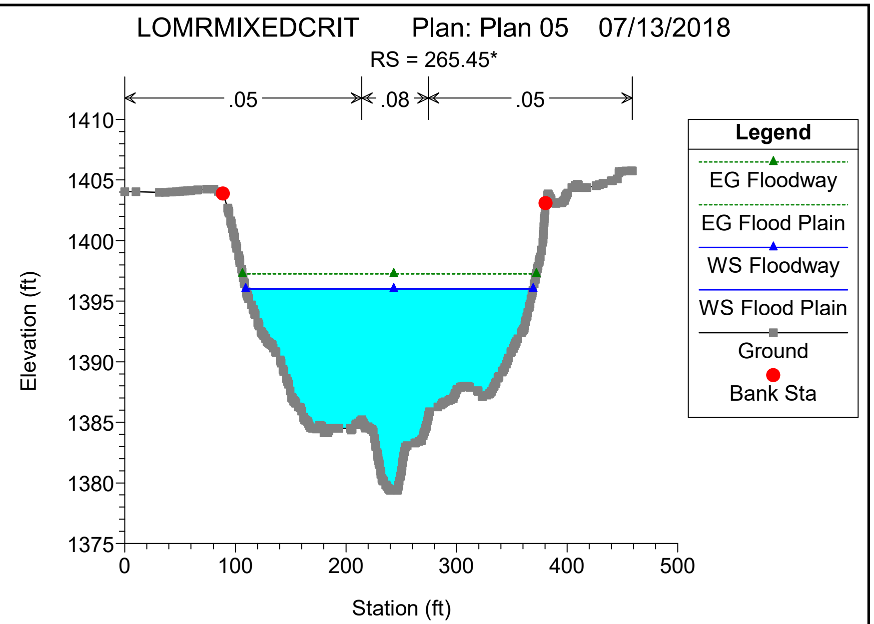
Ground
Bank Sta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Station (ft)
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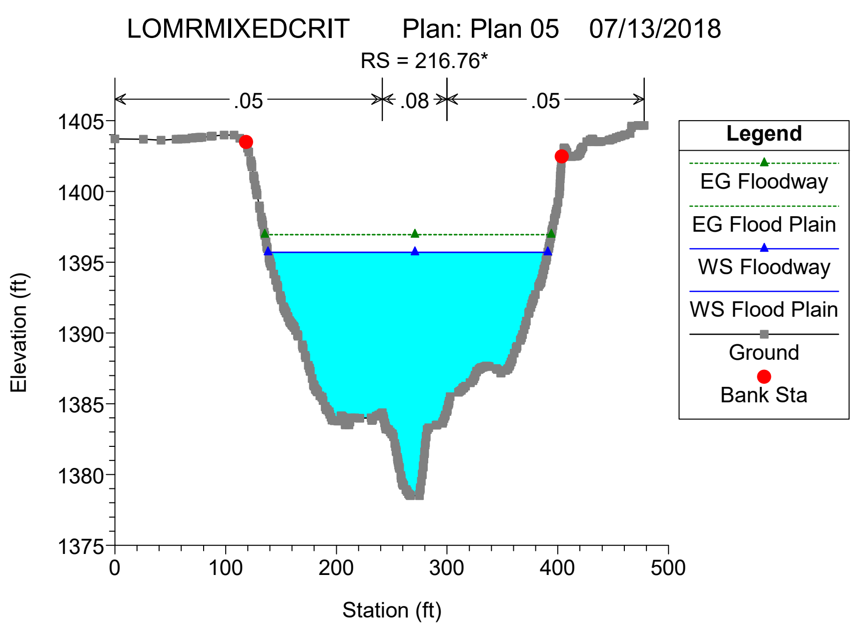
EG Flood Plain
WS Floodway
WS Flood Plain
Ground
Bank Sta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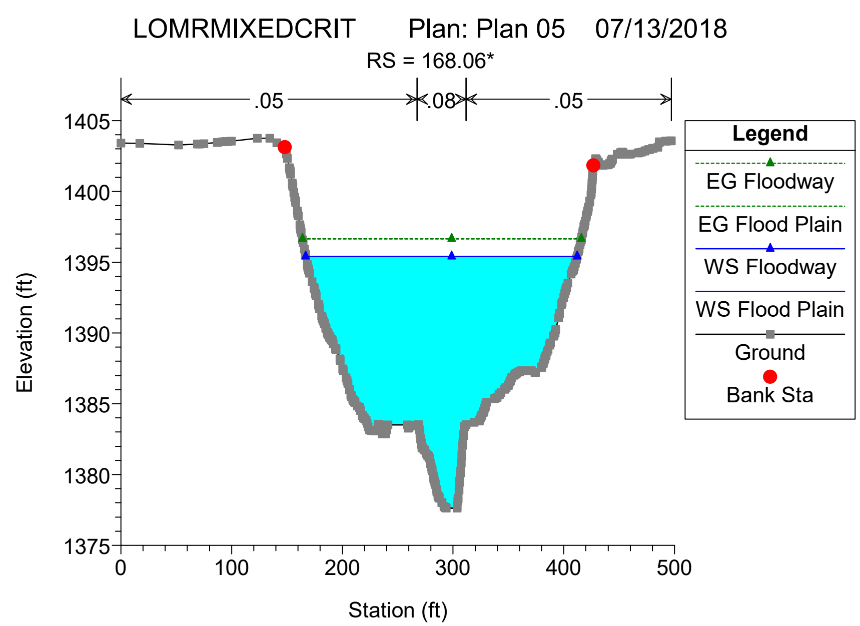
WS Flood Plain
Ground
Bank Sta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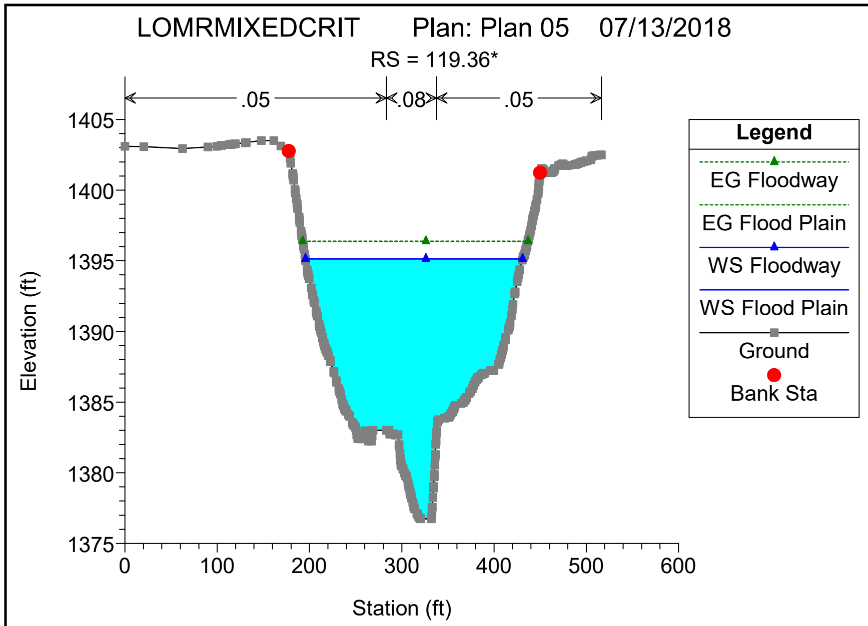
WS Flood Plain
Ground
Bank Sta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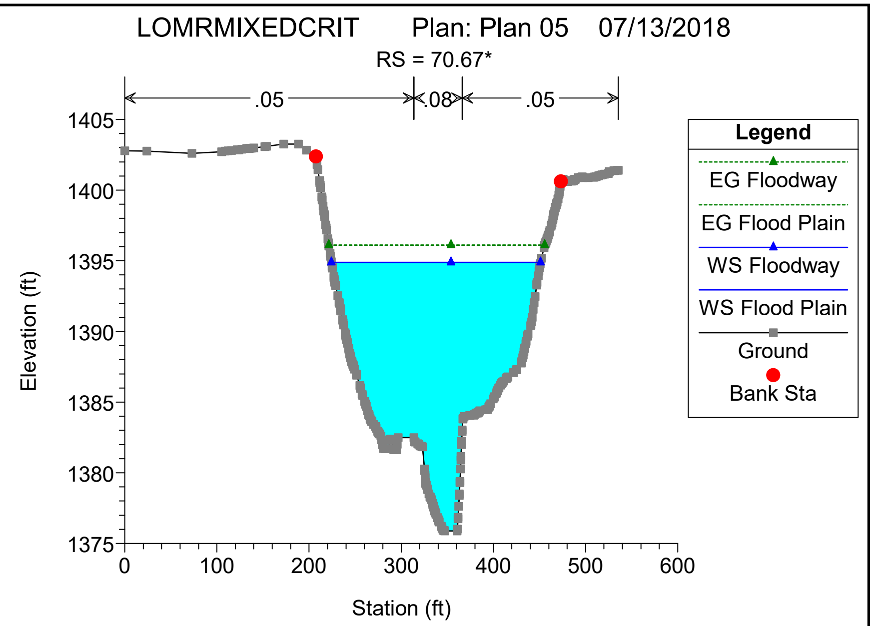
WS Flood Plain
Ground
Bank Sta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EG Flood Plain
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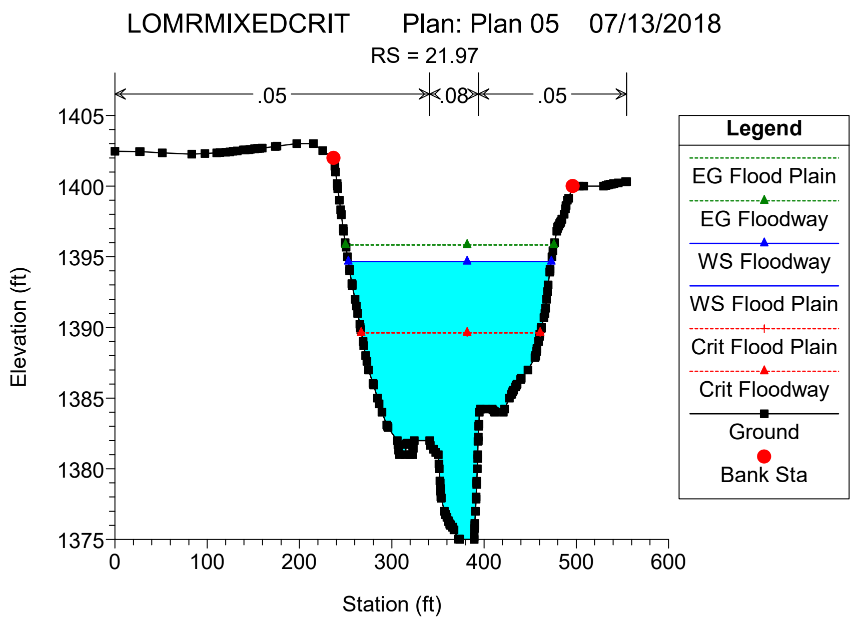
WS Flood Plain
Ground
Bank Sta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Station (ft)
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100
200
300
400
500
600
Legend
EG Flood Plain
EG Floodway
WS Floodway
WS Flood Plain
Crit Flood Plain
Crit Floodway
Ground
Bank Sta

4. SUPPORTING INFORMATION

Site Investigation Photographs
Operation and Maintenance Plan (on CD)
Topography (on CD)
Geotechnical Certification Letter
Newspaper Notification
Record Drawings
Certified Hydraulic Profile
Project Specifications (on CD)

LOGANDALE LEVEE AERIAL VIEW

On east bank facing downstream at approximately HEC-RAS Station 2824.16.

On west bank facing upstream at approximately HEC-RAS station 2191.11.

On east bank facing upstream at approximately between HEC-RAS Station 2135.97 and 1434.90.

On east bank facing upstream just upstream of approximately HEC-RAS station 1434.90.

On east bank facing upstream at approximately HEC-RAS station 1201.84.

East bank facing downstream at approximately HEC-RAS station 710.16.

February 1, 2018

Clark County Nevada – Department of Public Works
Attention: Mohamed Said Rouas, P.E.
500 S. Grand Central Pky, Box 554000
Las Vegas, Nevada 89155-4000

Subject: Muddy River Logandale Levee Certification Letter
Bid No. 604087-16, Project No. FMOA01H

Mr. Rouas:

Based on the results of our observations, field and laboratory testing, and CPT investigation, LTE certifies that, "the earth mass of the entire length of the Levee is structurally sound and that it substantially meets the design intent and the requirements set forth in the plans and specifications". Additionally, the earth mass meets the geotechnical requirements of the project design report by Kleinfelder.

The term "certification" as expressed in this letter is defined in the Nevada Revised Statutes 625.403 and constitutes an expression of professional opinion regarding the findings which are the subject of the certification.

This letter does not warranty or guarantee the levee design, hydrology, height, or subsequence maintenance.

Respectfully submitted,

LANDMARK TESTING & ENGINEERING

Russell Owens, PE
QC Responsible Engineer

PROFESSIONAL ENGINEER – STATE OF NEVADA
RUSSELL L. OWENS
Exp. 12-31-2019
CIVIL
2-1-2018
No. 12774

Steven Wells, PE
Project Manager

Newspaper Notification:

Clark County, Nevada requests a Letter of Map Revision (LOMR) due to completion of the Muddy River Logandale Levee improvements, in accordance with National Flood Insurance Program regulations 65.7(b) (1), and hereby gives notice of the County's intent to revise the Federal Emergency Management Agency (FEMA) flood hazard information in Logandale, Nevada on Flood Insurance Rate Map (FIRM) 32003C1105F. Specifically, the flood hazard shall be revised along the Muddy River just northwest of the Wells Avenue and Whitney Street intersection to approximately Cram Avenue.

The changes are limits, base flood elevations, and floodway area in a FEMA Zone 'AE'/ 'A' and the limits of the Shaded Zone 'X'. A Zone 'AE' is a Special Flood Hazard Area defined as the area of inundation subject to the 1% annual chance flood with base flood elevations determined. Zone 'A' is a Special Flood Hazard Area defined as the area of inundation subject to the 1% annual chance flood without base flood elevations determined. The floodway area within the Zone 'AE' is the channelized area of a stream plus any adjacent floodplain that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increase in flood heights. A Shaded Zone 'X' is an area of 0.2% annual chance flood, or an area of 1% annual chance flood with average depths less than 1 foot.

As a result of the revision, a floodway area within the Muddy River has been added between Wells Avenue to Waite Avenue within the limits of the completed improvements. The Zone 'A' SFHA has been revised to be contained on the west side of the completed improvements, with the 1% annual chance base flood elevations decreased by 0.1 to 3.0 feet in the Muddy River. The improvements included a levee that contains the base flood, resulting in revision of the Zone 'A' to a Shaded Zone 'X' east of the Muddy River between Wells Avenue and Cram Avenue.

Maps and detailed analysis of the revision can be reviewed at Clark County Department of Public Works Design at 500 S. Grand Central Parkway, Las Vegas, NV 89155. Interested persons may call 702.455.6050 for additional information from 8am to 5pm Monday to Friday.

5. REFERENCE MATERIALS

Flood Zone Figure from the *Flood Insurance Study,* 1995
CCRFCD Manual Table 703 – Maximum Permissible Velocities
Geotechnical Evaluation Report Muddy River Logandale Levee Excerpt
Prefinal Technical Support Data Notebook Scour Hydraulic Calculations

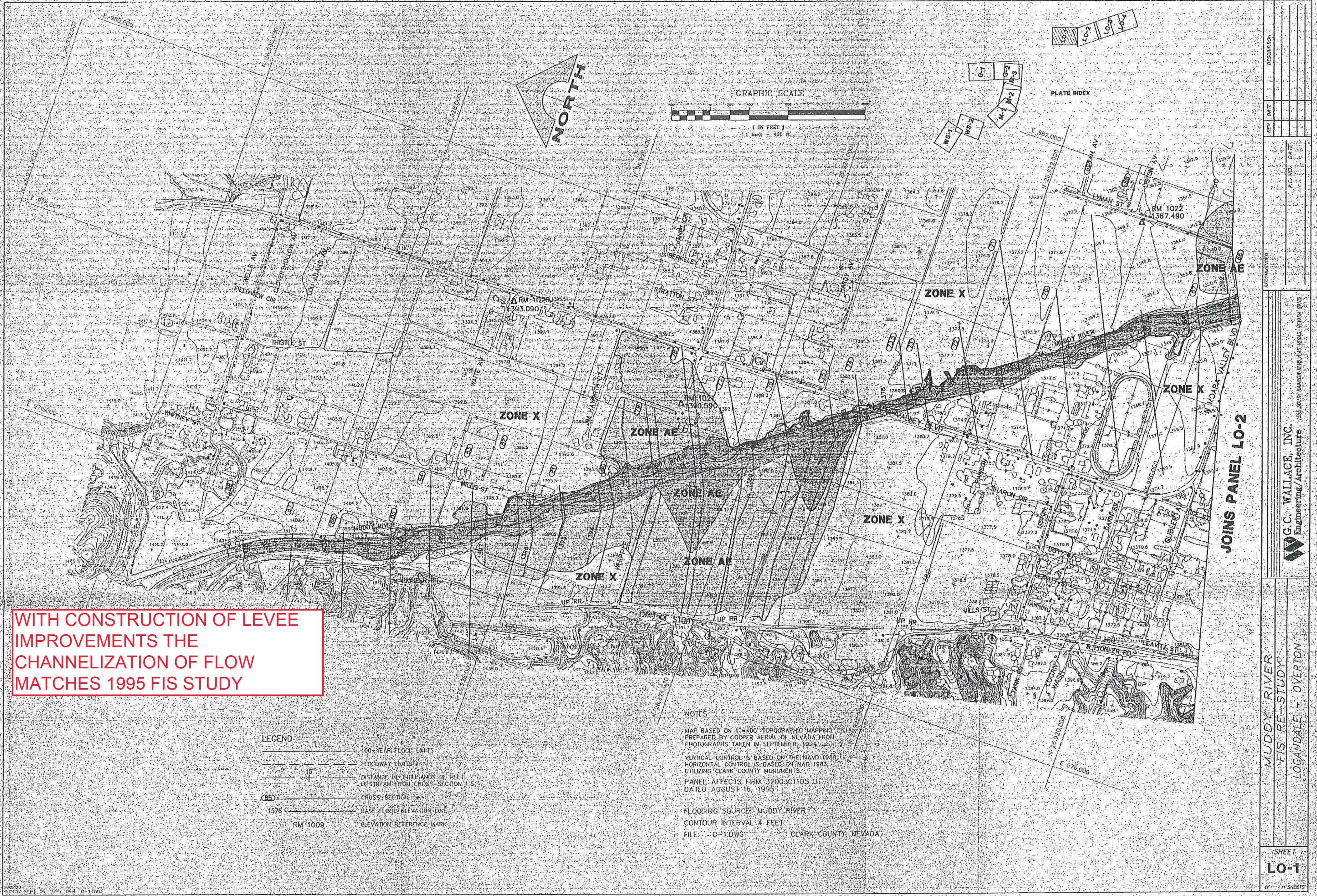
DRAFT

FLOOD INSURANCE STUDY RESTUDY

MUDDY RIVER

CLARK COUNTY, NEVADA

JULY 1995



WITH CONSTRUCTION OF LEVEE IMPROVEMENTS THE CHANNELIZATION OF FLOW MATCHES 1995 FIS STUDY

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

ADOPTED

AUGUST 12, 1999

MAXIMUM PERMISSIBLE MEAN CHANNEL VELOCITIES

Material / Lining	Maximum Permissible Mean Velocity (fps)
Natural and Improved Unlined Channels	
Fine sand,colloidal	1.50
Sandy loam,noncolloidal	1.75
Silt loam,noncolloidal	2.00
Alluvial silts,noncolloidal	2.00
Ordinary firm loam	2.50
Volcanic ash	2.50
Stiff clay,vary colloidal	3.75
Alluvial silts,colloidal	3.75
Shales and hardpans	6.00
Fine gravel	2.50
Graded loam to cobbles when noncolloidal	3.75
Graded silts to cobbles when colloidal	4.00
Coarse gravel,noncolloidal	4.00
Cobbles and shingles	5.00
Sandy silt	2.00
Silty clay	2.50
Clay	6.00
Poor sedimentary rock	10.0
Fully Lined Channels	
Unreinforced vegetation	5.0
Loose riprap	10.0
Grouted riprap	15.0
Gabions	15.0
Soil-Cement	15.0
Concrete	35.0

NOTES:
1. For composite lined channels, use the lowest of the maximum mean velocities for the materials used in the composite lining.
2. Deviations from the above values are only allowed with appropriate engineering analysis and/or suitable agreements for maintenance responsibilities.

Revision	Date

REFERENCE: Natural-Fortier and Scobey, 1926
Fully Lined-Various Sources

DRAFT

GEOTECHNICAL EVALUATION REPORT
MUDDY RIVER LOGANDALE LEVEE
MOAPA VALLEY
CLARK COUNTY, NEVADA

Prepared for:

G. C. Wallace Companies
1555 South Rainbow Boulevard
Las Vegas, Nevada 89146-2903

Prepared by:

KLEINFELDER
6380 South Polaris Avenue
Las Vegas, Nevada 89118

Kleinfelder Project No. 131026

June 21, 2013

Shear strength reduction combined with inertial forces from the ground motion may result in lateral migration (lateral spreading), extensional ground cracking of liquefied material, and slope failure. Factors known to influence liquefaction include soil type, structure, grain size, relative density, confining pressure, depth to groundwater, and the intensity and duration of ground shaking. Soils most susceptible to liquefaction are saturated, loose sandy soils and low to non-plastic silt.

A review of the soil types and consistencies as assessed by field blow count data in the soil borings for this project indicates that the majority of the subsurface soils consist of firm to hard clay soils and firm to hard silt. Clean, granular soils comprise approximately 10% of the soil encountered in our explorations. Measured levels of groundwater during drilling were 50 feet or more below the proposed levee crest elevation in the borings where groundwater was encountered. Due to the depth of groundwater, classification and consistency of the on-site soils, it is our opinion that the liquefaction potential for the site is low.

5.5 SETTLEMENT

The subsurface soils at the site are predominantly firm to hard clay and silt with interlayered granular soil layers with limestone at varying depths. The existing Logandale Levee structure has been in place for approximately 100 years. As shown on Plates 2 through 5, the height of the proposed embankment is approximately the same as the existing embankment and, with the exception of between Stations 31+00 and 34+00, the footprint of the proposed levee embankment is equal to or smaller than the existing. Between Stations 31+00 and 34+00, the existing waterside slopes are steepened to near vertical due to erosion; we assume the previously existing waterside slope prior to erosion was similar to the existing slopes in areas where erosion hasn't occurred and therefore also equal or flatter than the proposed slopes. Load-related settlement within the clay foundation soils is therefore expected to have already occurred in all areas. Rebound settlement resulting from the removal and replacement of the embankment loads is expected to be elastic and to occur during reconstruction.

PREFINAL
TECHNICAL SUPPORT DATA NOTEBOOK
FOR
MUDDY RIVER LOGANDALE LEVEE
WELLS SIDING DIVERSION STRUCTURE TO WAITE AVENUE
FLOOD CONTROL FACILITY

500.887

August 2013

Prepared for:

Clark County Public Works
500 South Grand Central Parkway
Las Vegas, Nevada 89106
Phone: (702) 455-6050
Fax: (702) 455-6113

Prepared by:

G.C. Wallace, Inc.
1555 South Rainbow Boulevard
Las Vegas, Nevada, 89146
Phone: (702) 804-2000
Fax: (702) 804-2299

Version 1.0
Last Revised: June 21, 2000

Project: Muddy River Logandale Levee XS 91.4 to XS 91
Date: 07/29/13

The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + ½Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:	Z_{lt} = long-term bed elevation changes	computed below =	4.3
	$½Z_a$ = one-half of anti-dune trough depth	computed below =	1.6
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	-0.4
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	5.5

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

	V = average channel velocity, (in fps)	15.1

Z_a Calculations:

	Z_a = anti-dune trough depth = 0.0137*V^2, (in fps)	3.1
	½*Z_a =	1.6

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)

Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)

FA = flow area immediately upstream of bend, (in ft^2)

TW = top width of flow immediately upstream of bend, (in ft)

S_e = energy slope immediately upstream of bend, (in ft/ft)

ß = angle of intersection

r_c = radius of curvature, (in ft)

T = channel top width, (in ft)

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW — ERR

r_c /T = cosß/(4*sin^2(ß/2)) — ERR

if:

rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0

0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value

rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1] — ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	13.10
d_{50} = median bed material particle size, (in ft) (B-4 LOG)	0.000295
V = mean flow velocity in approach section, (in fps)	6.9

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.1

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	13.10
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	17.10
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	378.8
W_2 = top width of the active flow area at the contracted section, (in ft)	258.5
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000369
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	16.7
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	-0.4

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	54.2
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	37.1

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = $4*Y_1(K_1/0.55)*K_2*Fr_1$^0.33 | 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = $2.27*K_1*K_2*(L^1)$^0.43*Fr^0.61+Y_a | 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = $2.0*K_1*K_2*K_3*K_4$*a^0.65*Y_1^0.35*Fr_1^0.43 | 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	8.19
V = flow velocity in upstream channel, (in fps)	6.9
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	378.8
S_o = upstream channel slope, (in ft/ft)	0.0448
L = entire upstream channel length, (in ft)	100.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$ — 0.0115

Q_s = total sediment transport rate = q_s*TW — 4.34

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0017	2869.28	7.46	282.09	17.58	10.17	4.53

↑Equilibrium slope

«Compare to Q_s Computed Above

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$ — 0.0160

Q_s = total sediment transport rate = q_s*TW — 4.53

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = $(S_e - S_o)*L$ — -4.3

if: $S_e > S_o$ then aggradation occurs

$S_e < S_o$ then degradation occurs

Version 1.0
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Project: Muddy River Logandale Levee XS 91 to XS 90.5
Date: 07/29/13

The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + \frac{1}{2}Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:			
	Z_{lt} = long-term bed elevation changes	computed below =	2.4
	$\frac{1}{2}Z_a$ = one-half of anti-dune trough depth	computed below =	2.2
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	2.5
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	7.1

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

V = average channel velocity, (in fps) 18.0

Z_a Calculations:

Z_a = anti-dune trough depth = 0.0137*V^2, (in fps) 4.4

$\frac{1}{2}*Z_a$ = 2.2

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)
Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)
FA = flow area immediately upstream of bend, (in ft^2)
TW = top width of flow immediately upstream of bend, (in ft)
S_e = energy slope immediately upstream of bend, (in ft/ft)
ß = angle of intersection
r_c = radius of curvature, (in ft)
T = channel top width, (in ft)

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW — ERR

r_c /T = cosß/(4*sin^2(ß/2)) — ERR

if:
rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1] — ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	17.10
d_{50} = median bed material particle size, (in ft) (B-4 LOG)	0.000295
V = mean flow velocity in approach section, (in fps)	8.1

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.2

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	17.10
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	18.80
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	258.5
W_2 = top width of the active flow area at the contracted section, (in ft)	183.2
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000369
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	21.3
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	2.5

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	72.8
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	54.0

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = 4*Y_1(K_1/0.55)*K_2*Fr_1^0.33 — 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = 2.27*K_1*K_2*(L^1)^0.43*Fr^0.61+Y_a — 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = 2.0*K_1*K_2*K_3*K_4*a^0.65*Y_1^0.35*Fr_1^0.43 — 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	10.24
V = flow velocity in upstream channel, (in fps)	8.1
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	258.5
S_o = upstream channel slope, (in ft/ft)	0.0155
L = entire upstream channel length, (in ft)	173.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$	0.0231
Q_s = total sediment transport rate = q_s*TW	5.98

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0017	2693.84	7.94	274.69	18.11	9.81	5.82

↑Equilibrium slope

«Compare to Q_s Computed Above

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$	0.0212
Q_s = total sediment transport rate = q_s*TW	5.82

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = $(S_e - S_o)*L$	-2.4

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

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The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + \frac{1}{2}Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:			
	Z_{lt} = long-term bed elevation changes	computed below =	0.8
	$\frac{1}{2}Z_a$ = one-half of anti-dune trough depth	computed below =	2.3
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	3.5
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	6.6

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

V = average channel velocity, (in fps) 18.4

Z_a Calculations:

Z_a = anti-dune trough depth = 0.0137*V^2, (in fps) 4.6

$\frac{1}{2}*Z_a$ = 2.3

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)

Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)

FA = flow area immediately upstream of bend, (in ft^2)

TW = top width of flow immediately upstream of bend, (in ft)

S_e = energy slope immediately upstream of bend, (in ft/ft)

ß = angle of intersection

r_c = radius of curvature, (in ft)

T = channel top width, (in ft)

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW — ERR

r_c /T = cosß/(4*sin^2(ß/2)) — ERR

if:

rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1] — ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	18.80
d_{50} = median bed material particle size, (in ft) (B-4 LOG)	0.000295
V = mean flow velocity in approach section, (in fps)	9.8

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.2

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	18.80
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	17.90
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	183.2
W_2 = top width of the active flow area at the contracted section, (in ft)	149.1
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000369
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	21.4
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	3.5

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	86.8
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	68.9

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = 4*Y_1(K_1/0.55)*K_2*Fr_1^0.33 — 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = 2.27*K_1*K_2*(L^1)^0.43*Fr^0.61+Y_a — 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = 2.0*K_1*K_2*K_3*K_4*a^0.65*Y_1^0.35*Fr_1^0.43 — 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	11.92
V = flow velocity in upstream channel, (in fps)	9.8
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	183.2
S_o = upstream channel slope, (in ft/ft)	0.0070
L = entire upstream channel length, (in ft)	167.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) — 0.0535

Q_s = total sediment transport rate = q_s*TW — 9.80

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0021	2336.07	9.16	242.25	18.7	9.64	9.69

↑Equilibrium slope

«Compare to Q_s Computed Above

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) — 0.0400

Q_s = total sediment transport rate = q_s*TW — 9.69

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = (S_e - S_o)*L — -0.8

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

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Project: Muddy River Logandale Levee XS 89 to XS 88.5
Date: 07/29/13

The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + ½Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:			
	Z_{lt} = long-term bed elevation changes	computed below =	1.0
	$½Z_a$ = one-half of anti-dune trough depth	computed below =	2.1
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	7.1
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	10.2

EXPOSED BEDROCK AT THIS LOCATION, MAXIMUM CUTOFF WALL LIMIT TO 8 FEET

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

V = average channel velocity, (in fps) 17.6

Z_a Calculations:

Z_a = anti-dune trough depth = 0.0137*V^2, (in fps) 4.2

½*Z_a = 2.1

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)	
Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)	
FA = flow area immediately upstream of bend, (in ft^2)	
TW = top width of flow immediately upstream of bend, (in ft)	
S_e = energy slope immediately upstream of bend, (in ft/ft)	
ß = angle of intersection	
r_c = radius of curvature, (in ft)	
T = channel top width, (in ft)	

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW	ERR
r_c /T = cosß/(4*sin^2(ß/2))	ERR

if:

rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1] **ERR**

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	18.70
d_{50} = median bed material particle size, (in ft)	0.000328
V = mean flow velocity in approach section, (in fps)	11.8

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.2

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	18.70
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	16.40
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	177.0
W_2 = top width of the active flow area at the contracted section, (in ft)	124.2
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000410
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	23.5
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	7.1

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	98.5
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	82.1

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = $4*Y_1(K_1/0.55)*K_2*Fr_1$^0.33 — 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = $2.27*K_1*K_2*(L^1)$^0.43*Fr^0.61+Y_a — 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = $2.0*K_1*K_2*K_3*K_4*a$^0.65*Y_1^0.35*Fr_1^0.43 — 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	10.29
V = flow velocity in upstream channel, (in fps)	11.8
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	177.0
S_o = upstream channel slope, (in ft/ft)	0.0086
L = entire upstream channel length, (in ft)	206.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.1228

Q_s = total sediment transport rate = q_s*TW 21.74

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below	
0.0037	1897.86	11.28	213.37	18.03	8.89	21.6	«Compare to Q_s Computed Above

↑Equilibrium slope

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.1012

Q_s = total sediment transport rate = q_s*TW 21.60

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = (S_e - S_o)*L -1.0

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

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Last Revised: June 21, 2000

Project: Muddy River Logandale Levee XS 88.5 to XS 88.4
Date: 07/29/13

The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + ½Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:	Z_{lt} = long-term bed elevation changes	computed below =	-0.6
	$½Z_a$ = one-half of anti-dune trough depth	computed below =	1.7
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	1.9
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	3.0

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

	V = average channel velocity, (in fps)	15.8

Z_a Calculations:

	Z_a = anti-dune trough depth = 0.0137*V^2, (in fps)	3.4
	½*Z_a =	1.7

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)	
Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)	
FA = flow area immediately upstream of bend, (in ft^2)	
TW = top width of flow immediately upstream of bend, (in ft)	
S_e = energy slope immediately upstream of bend, (in ft/ft)	
ß = angle of intersection	
r_c = radius of curvature, (in ft)	
T = channel top width, (in ft)	

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW	ERR
r_c /T = cosß/(4*sin^2(ß/2))	ERR

if:

rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1]	ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	16.40
d_{50} = median bed material particle size, (in ft) (B-7 LOG)	0.000328
V = mean flow velocity in approach section, (in fps)	17.7

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.2

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	16.40
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	15.20
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	124.2
W_2 = top width of the active flow area at the contracted section, (in ft)	115.9
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000410
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	17.1
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	1.9

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	104.5
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	89.3

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = 4*Y_1(K_1/0.55)*K_2*Fr_1^0.33 — 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = 2.27*K_1*K_2*(L^1)^0.43*Fr^0.61+Y_a — 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = 2.0*K_1*K_2*K_3*K_4*a^0.65*Y_1^0.35*Fr_1^0.43 — 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	9.76
V = flow velocity in upstream channel, (in fps)	17.7
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	124.2
S_o = upstream channel slope, (in ft/ft)	-0.0057
L = entire upstream channel length, (in ft)	47.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$ 0.7451

Q_s = total sediment transport rate = q_s*TW 92.54

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0077	1331.21	16.08	187.41	14.41	7.1	92.47

↑Equilibrium slope

«Compare to Q_s Computed Above

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$ 0.4934

Q_s = total sediment transport rate = q_s*TW 92.47

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = $(S_e - S_o)*L$ 0.6

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

Version 1.0
Last Revised: June 21, 2000

Project: Muddy River Logandale Levee XS 88.4 to XS 88
Date: 07/29/13

The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + ½Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:			
	Z_{lt} = long-term bed elevation changes	computed below =	-0.5
	$½Z_a$ = one-half of anti-dune trough depth	computed below =	2.3
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	0.8
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	2.6

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

V = average channel velocity, (in fps)	18.2

Z_a Calculations:

Z_a = anti-dune trough depth = 0.0137*V^2, (in fps)	4.5
½*Z_a =	2.3

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)

Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)

FA = flow area immediately upstream of bend, (in ft^2)

TW = top width of flow immediately upstream of bend, (in ft)

S_e = energy slope immediately upstream of bend, (in ft/ft)

ß = angle of intersection

r_c = radius of curvature, (in ft)

T = channel top width, (in ft)

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW — ERR

r_c /T = cosß/(4*sin^2(ß/2)) — ERR

if:

rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0

0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value

rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1] — ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	15.20
d_{50} = median bed material particle size, (in ft) (B-7 LOG)	0.000328
V = mean flow velocity in approach section, (in fps)	18.1

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.2

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	15.20
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	14.50
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	115.9
W_2 = top width of the active flow area at the contracted section, (in ft)	114.4
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000410
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	15.3
Z_{lbcs} = live bed contraction scour, (in ft) = $Y_2 - Y_o$	0.8

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	105.7
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	91.2

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = $4*Y_1(K_1/0.55)*K_2*Fr_1$^0.33 | 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = $2.27*K_1*K_2*(L^1)$^0.43*Fr^0.61+Y_a | 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = $2.0*K_1*K_2*K_3*K_4$*a^0.65*Y_1^0.35*Fr_1^0.43 | 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	10.19
V = flow velocity in upstream channel, (in fps)	18.1
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	115.9
S_o = upstream channel slope, (in ft/ft)	0.0029
L = entire upstream channel length, (in ft)	89.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.8253

Q_s = total sediment transport rate = q_s*TW 95.64

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below	
0.0083	1326.87	16.13	191.13	13.88	6.94	95.71	«Compare to Q_s Computed Above

↑Equilibrium slope

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.5008

Q_s = total sediment transport rate = q_s*TW 95.71

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = (S_e - S_o)*L 0.5

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

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Date: 07/29/13

The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + ½Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:			
	Z_{lt} = long-term bed elevation changes	computed below =	3.4
	$½Z_a$ = one-half of anti-dune trough depth	computed below =	1.8
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	-2.0
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	3.2

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

	V = average channel velocity, (in fps)	16.0

Z_a Calculations:

	Z_a = anti-dune trough depth = 0.0137*V^2, (in fps)	3.5
	½*Z_a =	1.8

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)	
Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)	
FA = flow area immediately upstream of bend, (in ft^2)	
TW = top width of flow immediately upstream of bend, (in ft)	
S_e = energy slope immediately upstream of bend, (in ft/ft)	
ß = angle of intersection	
r_c = radius of curvature, (in ft)	
T = channel top width, (in ft)	

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW	ERR
r_c /T = cosß/(4*sin^2(ß/2))	ERR

if:

rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1]	ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	14.60
d_{50} = median bed material particle size, (in ft) (B-10 LOG)	0.011480
V = mean flow velocity in approach section, (in fps)	17.95

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	3.9

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	14.60
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	16.00
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	118.8
W_2 = top width of the active flow area at the contracted section, (in ft)	126.4
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material ($1.25d_{50}$) in the contracted section, (in ft)	0.014350
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	14.0
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	-2.0

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	35.1
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	19.1

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = 4*Y_1(K_1/0.55)*K_2*Fr_1^0.33 — 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = 2.27*K_1*K_2*(L^1)^0.43*Fr^0.61+Y_a — 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = 2.0*K_1*K_2*K_3*K_4*a^0.65*Y_1^0.35*Fr_1^0.43 — 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	10.04
V = flow velocity in upstream channel, (in fps)	18.0
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	118.8
S_o = upstream channel slope, (in ft/ft)	0.0216
L = entire upstream channel length, (in ft)	274.7

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.7920

Q_s = total sediment transport rate = q_s*TW 94.05

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0093	1189.81	17.99	118.12	13.26	10.07	94.47

«Compare to Q_s Computed Above

↑Equilibrium slope

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.7997

Q_s = total sediment transport rate = q_s*TW 94.47

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = (S_e - S_o)*L -3.4

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

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The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + \frac{1}{2}Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:			
	Z_{lt} = long-term bed elevation changes	computed below =	-0.5
	$\frac{1}{2}Z_a$ = one-half of anti-dune trough depth	computed below =	1.4
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	1.4
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	2.3

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

V = average channel velocity, (in fps) 14.3

Z_a Calculations:

Z_a = anti-dune trough depth = 0.0137*V^2, (in fps) 2.8

$\frac{1}{2}*Z_a$ = 1.4

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)	
Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)	
FA = flow area immediately upstream of bend, (in ft^2)	
TW = top width of flow immediately upstream of bend, (in ft)	
S_e = energy slope immediately upstream of bend, (in ft/ft)	
ß = angle of intersection	
r_c = radius of curvature, (in ft)	
T = channel top width, (in ft)	

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW	ERR
r_c /T = cosß/(4*sin^2(ß/2))	ERR

if:

rc /T is >/= 10.0, or ß is <= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T <=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1]	ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c>V$ then clear water contraction is assumed. If $V_c<V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	14.70
d_{50} = median bed material particle size, (in ft) (B-10 LOG)	0.011480
V = mean flow velocity in approach section, (in fps)	13.7

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	3.9

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	14.70
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	13.50
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	134.3
W_2 = top width of the active flow area at the contracted section, (in ft)	132.2
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.014350
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	14.9
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	1.4

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	33.8
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	20.3

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = 4*Y_1(K_1/0.55)*K_2*Fr_1^0.33 | 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = 2.27*K_1*K_2*(L^1)^0.43*Fr^0.61+Y_a | 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = 2.0*K_1*K_2*K_3*K_4*a^0.65*Y_1^0.35*Fr_1^0.43 | 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	11.63
V = flow velocity in upstream channel, (in fps)	13.7
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	134.3
S_o = upstream channel slope, (in ft/ft)	0.0035
L = entire upstream channel length, (in ft)	281.0

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$ — 0.2371

Q_s = total sediment transport rate = q_s*TW — 31.85

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0054	1565.94	13.67	134.73	14.57	11.62	31.63

↑Equilibrium slope

«Compare to Q_s Computed Above

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = $C_1*(Y_h\text{^}C_2)*(V\text{^}C_3)$ — 0.2348

Q_s = total sediment transport rate = q_s*TW — 31.63

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = $(S_e - S_o)$*L — 0.5

if: $S_e > S_o$ then aggradation occurs
$S_e < S_o$ then degradation occurs

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The following equations used to compute total scour occuring at a structure or a pertinent location were taken from the CCRFCD Hydrologic Criteria and Drainage Design Manual. It is strongly recommended that this spreadsheet be used in conjunction with the Manual for explanation and determination of input parameters, and for general information regarding the methodologies and applications of the equations being used.

Determination of Total Scour, Z_t

Total scour is equal to the combination of long-term bed elevation changes, one half of anti-dune trough depth, bend scour, contraction scour, and local scour.

Total Scour, $Z_t = Z_{lt} + ½Z_a + Z_{bs} + Z_{cs} + Z_{als} + Z_{pls}$

where:	Z_{lt} = long-term bed elevation changes	computed below =	-4.0
	$½Z_a$ = one-half of anti-dune trough depth	computed below =	1.4
	Z_{bs} = bend scour	computed below =	0.0
	Z_{cs} = contraction scour (either live bed or clear water)	computed below =	0.7
	Z_{als} = abutment local scour	computed below =	0.0
	Z_{pls} = pier local scour	computed below =	0.0
		Total Scour =	-1.9

Determination of Anti-Dune Trough Depth, Z_a

Known/Input:

V = average channel velocity, (in fps) 14.3

Z_a Calculations:

Z_a = anti-dune trough depth = 0.0137*V^2, (in fps) 2.8

½*Z_a = 1.4

Determination of Bend Scour, Z_{bs}

Known/Input:

V = average velocity of flow immediately upstream of bend, (in fps)

Y_{max} = maximum depth of flow immediatley upstream of of bend, (in ft)

FA = flow area immediately upstream of bend, (in ft^2)

TW = top width of flow immediately upstream of bend, (in ft)

S_e = energy slope immediately upstream of bend, (in ft/ft)

ß = angle of intersection

r_c = radius of curvature, (in ft)

T = channel top width, (in ft)

Z_{bs} Calculations:

Y_h = hydraulic depth of flow immediately upstream of bend, (in ft) = FA/TW — ERR

r_c /T = cosß/(4*sin^2(ß/2)) — ERR

if: rc /T is >/= 10.0, or ß is </= 17.8 degrees, then Z_{bs} = 0
0.5 < r_c/T<10.0, or 17.8<ß<60 degrees, then Z_{bs} = computed value
rc /T </=0.5, or ß>60 degrees, then Z_{bs} = computed value

Z_{bs} = (0.0685*Y_{max}*V^0.8/Y_h^0.4*S_e^0.5)*[2.1[sin^2(ß/2)/cosß]^0.2-1] — ERR

Determination of Contraction Scour

There are two forms of contraction scour; live bed contraction scour and clear water contraction scour. The type of contraction scour occurring can be determined by computing the critical velocity in the approach section and comparing it to the mean velocity in the approach section. If $V_c > V$ then clear water contraction is assumed. If $V_c < V$ then live bed contraction is assumed.

Known/Input:

Y = average depth of flow in main channel or overbank area at approach section, (in ft)	15.60
d_{50} = median bed material particle size, (in ft) (B-15 LOG)	0.000492
V = mean flow velocity in approach section, (in fps)	16.82

V_c Calculations:

V_c = critical velocity above which material of d_{50} size and smaller will be transported, (in fps) = 10.95*Y^(1/6)*d_{50}^(1/3)	1.4

Live Bed Contraction Scour, Z_{lbcs} & Clear Water Contraction Scour, Z_{cwcs}:

Known/Input:

Y_1 = Average depth in the main channel or floodplain at the approach section, (in ft)	15.60
Y_o = Average depth in the main channel or floodplain at the contracted section before bridge scour, (in ft)	12.24
Q_1 = flow in the main channel or floodplain at the approach section which is transporting sediment, (in cfs)	21400.0
Q_2 = flow in the main channel or floodplain at the contracted section which is transporting sediment, (in cfs)	21400.0
W_1 = top width of the active flow area at the approach section, (in ft)	144.0
W_2 = top width of the active flow area at the contracted section, (in ft)	193.9
K_1 = exponent for mode of bed material transport	0.64
d_m = diameter of smallest non-transportable particle in the bed material (1.25d_{50}) in the contracted section, (in ft)	0.000615
C = coefficient = 120 for English units & 40 for metric units	120.0

Z_{lbcs} Calculations:

Y_2 = Average depth after scour in the contracted section (in ft) = Y_1[Q_2/Q_1]^6/7*[W_1/W_2]^K_1	12.9
Z_{lbcs} = live bed contraction scour , (in ft) = $Y_2 - Y_o$	0.7

Z_{cwcs} Calculations:

Y_2 = [Q_2^2/C*d_m^2/3*W_2^2]^3/7	59.9
Z_{cwcs} = clear water contraction scour, (in ft) = $Y_2 - Y_o$	47.6

Determination of Local Scour at Abutments, Z_{als}:

Two equations are recommended for the computation of local scour at abutments. When the wetted embankment length, L', divided by the approach flow depth, Y_1, is greater than 25, the HEC-18 report suggests using the HIRE equation. When the wetted embankment length divided by the approach depth is less than or equal to 25, the HEC-18 report suggests using an equation by Froelich.

Known/Input:

Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
K_1 = correction factor for abutment shape
K_2 = correction factor for angle of attack
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe
L^1 = length of abutment projected normal to flow, (in ft)
Y_a = average depth of flow on the floodplain at the approach section, (in ft)
Fr = Froude number of the floodplain flow at the approach section, (in ft)
V_a = average velocity of the approach flow, (in fps)
Q_a = Flow obstructed by the abutment and embankment at the approach section, (in cfs)
A_a = flow area of the approach section obstructed by the abutment and embankment, (in ft^2)

Z_{ls} Calculation by the HIRE equation:

Z_{als} = local scour at abutment = 4*Y_1(K_1/0.55)*K_2*Fr_1^0.33 | 0.0

Z_{ls} Calculation by the Froelich equation:

Z_{als} = local scour at abutment = 2.27*K_1*K_2*(L^1)^0.43*Fr^0.61+Y_a | 0.0

Determination of Local Scour at Piers, Z_{pls}:

Known/Input:

a = pier width, (in ft)
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow
K_3 = correction factor for bed condition
K_4 = correction factor for armoring of bed material
Y_1 = depth of flow at the toe of the abutment on the overbank or in the main channel taken at the cross section just upstream of the abutment, (in ft)
Fr_1 = Froude number based on velocity and depth adjacent and just upstream of the abutment toe

Z_{pls} Calculation:

Z_{pls} = local scour at pier = 2.0*K_1*K_2*K_3*K_4*a^0.65*Y_1^0.35*Fr_1^0.43 | 0.0

Determination of Long Term Bed Elevation Changes, Z_{lt}:

Long term bed elevation changes consist of either a general degradation or aggradation of the bed level over a long period of time. Determination of the long term bed elevation changes consists of determining the sediment transport rate of the upstream channel and then computing the equilibrium slope in the downstream channel that gives an equivalent sediment transport rate. The following procedure can be used to determine the depth of either degradation or aggradation that may occur within the stream channel.

Known/Input:

Y_h = hydraulic depth in upstream channel, (in ft)	8.83
V = flow velocity in upstream channel, (in fps)	16.8
C_1 = sand material constant	0.00000237
C_2 = sand material constant	-0.044
C_3 = sand material constant	4.44
TW = top width of upstream channel, (in ft)	144.0
S_o = upstream channel slope, (in ft/ft)	-0.0060
L = entire upstream channel length, (in ft)	211.6

Sediment Transport Rate, q_s in Upstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.5968

Q_s = total sediment transport rate = q_s*TW 85.95

Equilibrium Slope, S_e in Downstream Channel Calculation:

The equilibrium slope is computed using a trial and error procedure by which a given slope is chosen to compute the flow conditions in the downstream channel and from the flow conditions the sediment transport rate is calculated. When the computed rate is equal to the sediment transport rate in the upstream channel, the equilibrium slope has been found.

Flow conditions for each trial slope can be computed using normal depth. The following table can be used for data entry of flow conditions related to the equilibrium slope.

Trial Slope (ft/ft)	Area (ft^2)	Velocity (fps)	Top Width (ft)	Flow Depth (ft)	Hydraulic Depth (ft)	Q_s (cfs) from below
0.0127	1349.55	15.86	184.52	9.73	7.31	85.53

↑Equilibrium slope

«Compare to Q_s Computed Above

Sediment Transport Rate, q_s in Downstream Channel Calculation:

q_s = sediment transport rate = C_1*(Y_h^C_2)*(V^C_3) 0.4635

Q_s = total sediment transport rate = q_s*TW 85.53

Z_{lt} Calculation:

Z_{lt} = long term bed elevation changes = (S_e - S_o)*L 4.0

if: $S_e > S_o$ then aggradation occurs

$S_e < S_o$ then degradation occurs

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
XXXXXXX  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  XXXXXX   XXXX        X   X  X    X XXXXX
```

PROJECT DATA
Project Title: MRLEVEE-PROP COND-REVISED MANNNINGS N
Project File : MRLEVEEPRO-revmannings.prj
Run Date and Time: 6/25/2013 9:58:13 AM

Project in English units

PLAN DATA

Plan Title: Plan 01
Plan File : f:\Projects\500\500-887\Division\Fctl\Calcs\RAS-PostProject-revisedmannings\MRLEVEEPRO-revmannings.p01

Geometry Title: PRO-rev
Geometry File : f:\Projects\500\500-887\Division\Fctl\Calcs\RAS-PostProject-revisedmannings\MRLEVEEPRO-revmannings.g01

Flow Title : PRO
Flow File : f:\Projects\500\500-887\Division\Fctl\Calcs\RAS-PostProject-revisedmannings\MRLEVEEPRO-revmannings.f04

Plan Summary Information:

Number of:	Cross Sections =	20	Multiple Openings =	0
	Culverts =	0	Inline Structures =	0
	Bridges =	0	Lateral Structures =	0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed at all cross sections
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

Encroachment Data
Equal Conveyance = True
Left Offset = 0
Right Offset = 0

River = RIVER-1 Reach = Reach-1

RS	Profile	Method	Value1	Value2
91.5	Floodway	1	1179.78	1765.26
91	Floodway	1	46.36	317.3
90.5	Floodway	1	120.6	323.1
90	Floodway	1	115.48	281.5

89.5	Floodway	1	111.2	297.8
89	Floodway	1	114.26	305
88	Floodway	1	115.93	247.1
87.41	Floodway	1	35.4	170.7
87.4	Floodway	1	78.03	230.9
87	Floodway	1	44.73	205.2
86.4	Floodway	1	27.45	197.6
86.39	Floodway	1	27.45	197.6
86	Floodway	1	41.58	231.9
85.4	Floodway	1	68.84	305.7
85	Floodway	1	96.8	348.2
84	Floodway	1	3095.34	3461.59

FLOW DATA

Flow Title: PRO
Flow File : f:\Projects\500\500-887\Division\Fctl\Calcs\RAS-PostProject-revisedmannings\MRLEVEEPRO-revmannings.f04

Flow Data (cfs)

River	Reach	RS	Floodplain	Floodway
RIVER-1	Reach-1	91.4	21400	21400

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
RIVER-1	Reach-1	Floodplain	Critical	Known WS = 1399.5
RIVER-1	Reach-1	Floodway	Critical	Known WS = 1399.5

GEOMETRY DATA

Geometry Title: PRO-rev
Geometry File : f:\Projects\500\500-887\Division\Fctl\Calcs\RAS-PostProject-revisedmannings\MRLEVEEPRO-revmannings.g01

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 91.4

INPUT
Description:
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1428.4	3.87	1428.29	11.85	1432.28	25.85	1432	34.85	1426
131.63	1417	135.12	1416	159.91	1413.73	175.24	1413.22	194.63	1414.62
211.68	1415.07	238.43	1415.54	309.85	1416	370.52	1419.84	408.23	1425
424.13	1429	446.57	1429.68	476.6	1433	508.47	1433.09		

Manning's n Values num= 2

Sta	n Val	Sta	n Val
0	.025	34.85	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	424.13	100	100	100	.1	.3

Left Levee Station= 11.85 Elevation= 1432.28

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1427.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.74	Wt. n-Val.		0.040	
W.S. Elev (ft)	1426.26	Reach Len. (ft)	100.00	100.00	100.00
Crit W.S. (ft)	1422.04	Flow Area (sq ft)		3103.96	
E.G. Slope (ft/ft)	0.002092	Area (sq ft)		3103.96	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	378.79	Top Width (ft)		378.79	
Vel Total (ft/s)	6.89	Avg. Vel. (ft/s)		6.89	
Max Chl Dpth (ft)	13.04	Hydr. Depth (ft)		8.19	
Conv. Total (cfs)	467857.7	Conv. (cfs)		467857.7	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		380.23	
Min Ch El (ft)	1413.22	Shear (lb/sq ft)		1.07	
Alpha	1.00	Stream Power (lb/ft s)	508.47	11.85	0.00
Frctn Loss (ft)	0.21	Cum Volume (acre-ft)	1.10	140.80	1.35
C & E Loss (ft)	0.03	Cum SA (acres)	0.11	12.61	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1427.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.74	Wt. n-Val.		0.040	
W.S. Elev (ft)	1426.26	Reach Len. (ft)	100.00	100.00	100.00
Crit W.S. (ft)	1422.04	Flow Area (sq ft)		3103.96	
E.G. Slope (ft/ft)	0.002092	Area (sq ft)		3103.96	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	378.79	Top Width (ft)		378.79	
Vel Total (ft/s)	6.89	Avg. Vel. (ft/s)		6.89	
Max Chl Dpth (ft)	13.04	Hydr. Depth (ft)		8.19	
Conv. Total (cfs)	467857.7	Conv. (cfs)		467857.7	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		380.23	
Min Ch El (ft)	1413.22	Shear (lb/sq ft)		1.07	
Alpha	1.00	Stream Power (lb/ft s)	508.47	11.85	0.00
Frctn Loss (ft)	0.21	Cum Volume (acre-ft)	1.10	140.80	1.35
C & E Loss (ft)	0.03	Cum SA (acres)	0.11	12.61	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 91

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1421.33	11.5	1421.87	27.88	1430.32	42.88	1430.02	46.36	1428.68
71.47	1419	81.6	1417.47	154.4	1413.4	167.9	1410.09	174	1408.74
182.1	1409.62	186.6	1411.32	247.6	1415.03	261.1	1415.75	287.9	1415.94
294.9	1420.67	317.3	1427.15	340.6	1427.08	351.4	1431.62	397.1	1432.05
408.9	1432.11								

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	42.88	.013	71.47	.04	167.9	.04	247.6	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
42.88	317.3	195	173	137	.1	.3

Left Levee Station= 27.77 Elevation= 1430.32

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1426.77	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.01	Wt. n-Val.		0.038	

W.S. Elev (ft)	1425.75	Reach Len. (ft)	195.00	173.00	137.00
Crit W.S. (ft)	1420.99	Flow Area (sq ft)		2647.36	
E.G. Slope (ft/ft)	0.002014	Area (sq ft)		2647.36	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	258.51	Top Width (ft)		258.51	
Vel Total (ft/s)	8.08	Avg. Vel. (ft/s)		8.08	
Max Chl Dpth (ft)	17.01	Hydr. Depth (ft)		10.24	
Conv. Total (cfs)	476902.0	Conv. (cfs)		476902.0	
Length Wtd. (ft)	173.00	Wetted Per. (ft)		263.20	
Min Ch El (ft)	1408.74	Shear (lb/sq ft)		1.26	
Alpha	1.00	Stream Power (lb/ft s)	408.90	27.77	0.00
Frctn Loss (ft)	0.38	Cum Volume (acre-ft)	1.10	134.20	1.35
C & E Loss (ft)	0.05	Cum SA (acres)	0.11	11.88	0.42

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.

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1426.77	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.01	Wt. n-Val.		0.038	
W.S. Elev (ft)	1425.75	Reach Len. (ft)	195.00	173.00	137.00
Crit W.S. (ft)	1420.99	Flow Area (sq ft)		2647.36	
E.G. Slope (ft/ft)	0.002014	Area (sq ft)		2647.36	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	258.51	Top Width (ft)		258.51	
Vel Total (ft/s)	8.08	Avg. Vel. (ft/s)		8.08	
Max Chl Dpth (ft)	17.01	Hydr. Depth (ft)		10.24	
Conv. Total (cfs)	476902.0	Conv. (cfs)		476902.0	
Length Wtd. (ft)	173.00	Wetted Per. (ft)		263.20	
Min Ch El (ft)	1408.74	Shear (lb/sq ft)		1.26	
Alpha	1.00	Stream Power (lb/ft s)	408.90	27.77	0.00
Frctn Loss (ft)	0.38	Cum Volume (acre-ft)	1.10	134.20	1.35
C & E Loss (ft)	0.05	Cum SA (acres)	0.11	11.88	0.42

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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 90.5

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1416.14	59.8	1416.45	70.1	1418.53	79.5	1418.64	79.81	1418.67
107.08	1428.8	121.2	1428.5	122.16	1428.02	148.11	1415	161.52	1415
173.1	1410.48	225.8	1409.92	232.6	1406.06	244.9	1406.49	247.1	1407.71
251.3	1410.63	278.4	1411.52	323.1	1429.45	350.7	1429.72	369.8	1430.37

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	121.2	.013	148.11	.04	225.8	.04	251.3	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
121.2	323.1	183	167	165	.1	.3

Left Levee Station= 107.08 Elevation= 1428.8

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1426.34	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.49	Wt. n-Val.		0.037	
W.S. Elev (ft)	1424.85	Reach Len. (ft)	183.00	167.00	165.00
Crit W.S. (ft)	1419.83	Flow Area (sq ft)		2183.86	

E.G. Slope (ft/ft)	0.002373	Area (sq ft)		2183.86	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	183.15	Top Width (ft)		183.15	
Vel Total (ft/s)	9.80	Avg. Vel. (ft/s)		9.80	
Max Chl Dpth (ft)	18.79	Hydr. Depth (ft)		11.92	
Conv. Total (cfs)	439330.5	Conv. (cfs)		439330.5	
Length Wtd. (ft)	167.00	Wetted Per. (ft)		191.19	
Min Ch El (ft)	1406.06	Shear (lb/sq ft)		1.69	
Alpha	1.00	Stream Power (lb/ft s)	369.80	107.08	0.00
Frctn Loss (ft)	0.55	Cum Volume (acre-ft)	1.10	124.61	1.35
C & E Loss (ft)	0.14	Cum SA (acres)	0.11	11.01	0.42

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 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.
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.

CROSS SECTION OUTPUT Profile #Floodway

			Left OB	Channel	Right OB
E.G. Elev (ft)	1426.34	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.49	Wt. n-Val.		0.037	
W.S. Elev (ft)	1424.85	Reach Len. (ft)	183.00	167.00	165.00
Crit W.S. (ft)	1419.82	Flow Area (sq ft)		2183.86	
E.G. Slope (ft/ft)	0.002373	Area (sq ft)		2183.86	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	183.15	Top Width (ft)		183.15	
Vel Total (ft/s)	9.80	Avg. Vel. (ft/s)		9.80	
Max Chl Dpth (ft)	18.79	Hydr. Depth (ft)		11.92	
Conv. Total (cfs)	439330.5	Conv. (cfs)		439330.5	
Length Wtd. (ft)	167.00	Wetted Per. (ft)		191.19	
Min Ch El (ft)	1406.06	Shear (lb/sq ft)		1.69	
Alpha	1.00	Stream Power (lb/ft s)	369.80	107.08	0.00
Frctn Loss (ft)	0.55	Cum Volume (acre-ft)	1.10	124.61	1.35
C & E Loss (ft)	0.14	Cum SA (acres)	0.11	11.01	0.42

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 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.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 90

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1415.24	55.6	1415.43	63.3	1416.55	73	1417.13	73.1	1417.02
99.48	1427.2	114.48	1426.9	115.48	1426.4	151.43	1410	153.43	1409
182.22	1409	195.6	1404.89	197.7	1405.95	199.9	1407.74	212.8	1409.51
218	1408.03	228.2	1410.87	248.3	1416.37	264.5	1417.75	281.5	1428.48
306.5	1428.36	314.9	1428.52						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	114.48	.013	153.43	.04	182.22	.04	228.2	.04

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

114.48	281.5	205	213	213		.1	.3

Left Levee Station= 99.48 Elevation= 1427.2

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1425.66	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.86	Wt. n-Val.		0.035	
W.S. Elev (ft)	1422.80	Reach Len. (ft)	205.00	213.00	213.00
Crit W.S. (ft)	1420.63	Flow Area (sq ft)		1576.51	
E.G. Slope (ft/ft)	0.004776	Area (sq ft)		1576.51	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	149.12	Top Width (ft)		149.12	
Vel Total (ft/s)	13.57	Avg. Vel. (ft/s)		13.57	
Max Chl Dpth (ft)	17.91	Hydr. Depth (ft)		10.57	
Conv. Total (cfs)	309647.2	Conv. (cfs)		309647.2	
Length Wtd. (ft)	213.00	Wetted Per. (ft)		156.61	
Min Ch El (ft)	1404.89	Shear (lb/sq ft)		3.00	
Alpha	1.00	Stream Power (lb/ft s)	314.90	99.48	0.00
Frctn Loss (ft)	0.94	Cum Volume (acre-ft)	1.10	117.40	1.35
C & E Loss (ft)	0.16	Cum SA (acres)	0.11	10.37	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1425.66	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.86	Wt. n-Val.		0.035	
W.S. Elev (ft)	1422.80	Reach Len. (ft)	205.00	213.00	213.00
Crit W.S. (ft)	1420.63	Flow Area (sq ft)		1576.51	
E.G. Slope (ft/ft)	0.004776	Area (sq ft)		1576.51	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	149.12	Top Width (ft)		149.12	
Vel Total (ft/s)	13.57	Avg. Vel. (ft/s)		13.57	
Max Chl Dpth (ft)	17.91	Hydr. Depth (ft)		10.57	
Conv. Total (cfs)	309647.2	Conv. (cfs)		309647.2	
Length Wtd. (ft)	213.00	Wetted Per. (ft)		156.61	
Min Ch El (ft)	1404.89	Shear (lb/sq ft)		3.00	
Alpha	1.00	Stream Power (lb/ft s)	314.90	99.48	0.00
Frctn Loss (ft)	0.94	Cum Volume (acre-ft)	1.10	117.40	1.35
C & E Loss (ft)	0.16	Cum SA (acres)	0.11	10.37	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 89.5

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1414.27	48.7	1414.21	58.2	1415.6	68.6	1416.22	68.92	1416.34
94.98	1426.13	109.98	1425.83	111.2	1425.22	142.74	1410	174.46	1410

192.2	1404.19	194.4	1405.36	196.8	1406.92	203	1405.89	228.4	1407.8
230.7	1410.51	244.9	1411.37	273.4	1420.99	297.8	1424.48	320.2	1425.16
334.2	1425.5								

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	109.98	.013	142.74	.04	174.46	.04	228.4	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
109.98	297.8	179	188	203	.1	.3

Left Levee Station= 94.98 Elevation= 1426.13

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1424.56	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.34	Wt. n-Val.		0.036	
W.S. Elev (ft)	1422.22	Reach Len. (ft)	179.00	188.00	203.00
Crit W.S. (ft)	1419.14	Flow Area (sq ft)		1743.82	
E.G. Slope (ft/ft)	0.004116	Area (sq ft)		1743.82	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	164.58	Top Width (ft)		164.58	
Vel Total (ft/s)	12.27	Avg. Vel. (ft/s)		12.27	
Max Chl Dpth (ft)	18.03	Hydr. Depth (ft)		10.60	
Conv. Total (cfs)	333545.8	Conv. (cfs)		333545.8	
Length Wtd. (ft)	188.00	Wetted Per. (ft)		172.16	
Min Ch El (ft)	1404.19	Shear (lb/sq ft)		2.60	
Alpha	1.00	Stream Power (lb/ft s)	334.20	94.98	0.00
Frctn Loss (ft)	0.74	Cum Volume (acre-ft)	1.10	109.28	1.35
C & E Loss (ft)	0.06	Cum SA (acres)	0.11	9.60	0.42

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.

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1424.56	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.34	Wt. n-Val.		0.036	
W.S. Elev (ft)	1422.22	Reach Len. (ft)	179.00	188.00	203.00
Crit W.S. (ft)	1419.14	Flow Area (sq ft)		1743.82	
E.G. Slope (ft/ft)	0.004116	Area (sq ft)		1743.82	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	164.58	Top Width (ft)		164.58	
Vel Total (ft/s)	12.27	Avg. Vel. (ft/s)		12.27	
Max Chl Dpth (ft)	18.03	Hydr. Depth (ft)		10.60	
Conv. Total (cfs)	333545.8	Conv. (cfs)		333545.8	
Length Wtd. (ft)	188.00	Wetted Per. (ft)		172.16	
Min Ch El (ft)	1404.19	Shear (lb/sq ft)		2.60	
Alpha	1.00	Stream Power (lb/ft s)	334.20	94.98	0.00
Frctn Loss (ft)	0.74	Cum Volume (acre-ft)	1.10	109.28	1.35
C & E Loss (ft)	0.06	Cum SA (acres)	0.11	9.60	0.42

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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 89

INPUT
Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1413.3	53.4	1413.88	68.9	1414.39	97.88	1425.2	112.88	1424.9
114.26	1424.21	142.88	1410	150.9	1406	167.25	1406	170.2	1405.21
173.1	1404.72	175.5	1405.3	183.6	1407.11	186.9	1405.67	192.8	1402.86

194.1	1404.16	195.2	1405.35	203.1	1404.21	222.4	1407.04	236.8	1412.08
258.6	1417.88	285.6	1418.67	299.5	1422.44	305	1425.63	331	1426.22
348.8	1425.85	431.2	1435.95	462.5	1439.74				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	112.88	.013	150.9	.04	167.25	.04	222.4	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
97.88	305	198	206	182	.1	.3

Left Levee Station= 97.88 Elevation= 1425.2

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1423.76	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.15	Wt. n-Val.		0.036	
W.S. Elev (ft)	1421.61	Reach Len. (ft)	198.00	206.00	182.00
Crit W.S. (ft)	1418.55	Flow Area (sq ft)		1820.48	
E.G. Slope (ft/ft)	0.003807	Area (sq ft)		1820.48	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	176.95	Top Width (ft)		176.95	
Vel Total (ft/s)	11.76	Avg. Vel. (ft/s)		11.76	
Max Chl Dpth (ft)	18.75	Hydr. Depth (ft)		10.29	
Conv. Total (cfs)	346815.2	Conv. (cfs)		346815.2	
Length Wtd. (ft)	206.00	Wetted Per. (ft)		185.33	
Min Ch El (ft)	1402.86	Shear (lb/sq ft)		2.33	
Alpha	1.00	Stream Power (lb/ft s)	462.50	97.88	0.00
Frctn Loss (ft)	1.18	Cum Volume (acre-ft)	1.10	101.59	1.35
C & E Loss (ft)	0.27	Cum SA (acres)	0.11	8.87	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1423.76	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.15	Wt. n-Val.		0.036	
W.S. Elev (ft)	1421.61	Reach Len. (ft)	198.00	206.00	182.00
Crit W.S. (ft)	1418.55	Flow Area (sq ft)		1820.48	
E.G. Slope (ft/ft)	0.003807	Area (sq ft)		1820.48	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	176.95	Top Width (ft)		176.95	
Vel Total (ft/s)	11.76	Avg. Vel. (ft/s)		11.76	
Max Chl Dpth (ft)	18.75	Hydr. Depth (ft)		10.29	
Conv. Total (cfs)	346815.2	Conv. (cfs)		346815.2	
Length Wtd. (ft)	206.00	Wetted Per. (ft)		185.33	
Min Ch El (ft)	1402.86	Shear (lb/sq ft)		2.33	
Alpha	1.00	Stream Power (lb/ft s)	462.50	97.88	0.00
Frctn Loss (ft)	1.18	Cum Volume (acre-ft)	1.10	101.59	1.35
C & E Loss (ft)	0.27	Cum SA (acres)	0.11	8.87	0.42

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 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.
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.

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 88.5

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1412.01	50.79	1412.67	65.3	1413.58	93.27	1423.39	108.27	1423.09
134.44	1410	144.44	1405	158.34	1405	166.13	1403.14	170.42	1401.08
180.14	1404.88	208.2	1405	245.43	1418.07	252.09	1420.31	287.84	1423.32

Manning's n Values num= 7

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	108.27	.013	144.44	.04	158.34	.04	180.14	.04
208.2	.044	245.43	.04						

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
108.27	252.09	49	47	44	.1	.3

Left Levee Station= 93.27 Elevation= 1423.39

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1422.30	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.85	Wt. n-Val.		0.036	
W.S. Elev (ft)	1417.46	Reach Len. (ft)	49.00	47.00	44.00
Crit W.S. (ft)	1417.46	Flow Area (sq ft)		1211.24	
E.G. Slope (ft/ft)	0.009651	Area (sq ft)		1211.24	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	124.15	Top Width (ft)		124.15	
Vel Total (ft/s)	17.67	Avg. Vel. (ft/s)		17.67	
Max Chl Dpth (ft)	16.38	Hydr. Depth (ft)		9.76	
Conv. Total (cfs)	217834.9	Conv. (cfs)		217834.9	
Length Wtd. (ft)	47.00	Wetted Per. (ft)		130.62	
Min Ch El (ft)	1401.08	Shear (lb/sq ft)		5.59	
Alpha	1.00	Stream Power (lb/ft s)	287.84	93.27	0.00
Frctn Loss (ft)	0.36	Cum Volume (acre-ft)	1.10	94.42	1.35
C & E Loss (ft)	0.03	Cum SA (acres)	0.11	8.15	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION OUTPUT Profile #Floodway

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1422.30	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.85	Wt. n-Val.		0.036	
W.S. Elev (ft)	1417.46	Reach Len. (ft)	49.00	47.00	44.00
Crit W.S. (ft)	1417.46	Flow Area (sq ft)		1211.24	
E.G. Slope (ft/ft)	0.009651	Area (sq ft)		1211.24	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	124.15	Top Width (ft)		124.15	
Vel Total (ft/s)	17.67	Avg. Vel. (ft/s)		17.67	
Max Chl Dpth (ft)	16.38	Hydr. Depth (ft)		9.76	
Conv. Total (cfs)	217834.9	Conv. (cfs)		217834.9	
Length Wtd. (ft)	47.00	Wetted Per. (ft)		130.62	
Min Ch El (ft)	1401.08	Shear (lb/sq ft)		5.59	

Alpha	1.00	Stream Power (lb/ft s)	287.84	93.27	0.00
Frctn Loss (ft)	0.36	Cum Volume (acre-ft)	1.10	94.42	1.35
C & E Loss (ft)	0.03	Cum SA (acres)	0.11	8.15	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 88.4

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1411.78	52.24	1412.39	68.28	1413.6	95.6	1422.53	110.6	1422.23
135.06	1410	145.06	1405	151.49	1405	154.17	1403.22	171.83	1402.62
181.85	1401.35	194.4	1403.99	211.08	1404	239.28	1417.26	246.8	1417.92
273.6	1419.9								

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	110.6	.013	145.06	.04	151.49	.04	211.08	.013
239.28	.04								

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
110.6	239.28	100	89	94	.1	.3

Left Levee Station= 95.6 Elevation= 1422.53

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1421.67	Wt. n-Val.		0.029	
Vel Head (ft)	5.10	Reach Len. (ft)	100.00	89.00	94.00
W.S. Elev (ft)	1416.57	Flow Area (sq ft)		1180.79	
Crit W.S. (ft)	1416.57	Area (sq ft)		1180.79	
E.G. Slope (ft/ft)	0.006268	Flow (cfs)		21400.00	
Q Total (cfs)	21400.00	Top Width (ft)		115.88	
Top Width (ft)	115.88	Avg. Vel. (ft/s)		18.12	
Vel Total (ft/s)	18.12	Hydr. Depth (ft)		10.19	
Max Chl Dpth (ft)	15.22	Conv. (cfs)		270308.9	
Conv. Total (cfs)	270308.9	Wetted Per. (ft)		122.32	
Length Wtd. (ft)	89.00	Shear (lb/sq ft)		3.78	
Min Ch El (ft)	1401.35	Stream Power (lb/ft s)	273.60	95.60	0.00
Alpha	1.00	Cum Volume (acre-ft)	1.10	93.13	1.35
Frctn Loss (ft)	0.58	Cum SA (acres)	0.11	8.02	0.42
C & E Loss (ft)	0.00				

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1421.67	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.10	Wt. n-Val.		0.029	
W.S. Elev (ft)	1416.57	Reach Len. (ft)	100.00	89.00	94.00
Crit W.S. (ft)	1416.57	Flow Area (sq ft)		1180.79	
E.G. Slope (ft/ft)	0.006268	Area (sq ft)		1180.79	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	115.88	Top Width (ft)		115.88	
Vel Total (ft/s)	18.12	Avg. Vel. (ft/s)		18.12	
Max Chl Dpth (ft)	15.22	Hydr. Depth (ft)		10.19	
Conv. Total (cfs)	270308.9	Conv. (cfs)		270308.9	
Length Wtd. (ft)	89.00	Wetted Per. (ft)		122.32	
Min Ch El (ft)	1401.35	Shear (lb/sq ft)		3.78	
Alpha	1.00	Stream Power (lb/ft s)	273.60	95.60	0.00
Frctn Loss (ft)	0.58	Cum Volume (acre-ft)	1.10	93.13	1.35
C & E Loss (ft)	0.00	Cum SA (acres)	0.11	8.02	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 88

INPUT
Description:
Station Elevation Data num= 21

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1412.81	2.2	1412.49	10.4	1411.2	59.7	1412.52	74.8	1413.66
100.93	1422.05	115.93	1421.7	140.64	1409.92	150.37	1405	158.5	1405
160.2	1403.83	187.9	1402.93	188.1	1402.36	201.8	1401.09	206.9	1401.6
222.4	1401.7	247.1	1418.17	277.4	1417.15	285.7	1417.21	304.5	1429.39
331.1	1433.92								

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	115.93	.013	150.37	.04	160.2	.04	222.4	.013
247.1	.04								

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
115.93	247.1	46	46	46	.1	.3

Left Levee Station= 100.93 Elevation= 1422.05

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1420.68	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.12	Wt. n-Val.		0.031	
W.S. Elev (ft)	1415.56	Reach Len. (ft)	46.00	46.00	46.00
Crit W.S. (ft)	1415.56	Flow Area (sq ft)		1178.19	
E.G. Slope (ft/ft)	0.006841	Area (sq ft)		1178.19	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	114.36	Top Width (ft)		114.36	
Vel Total (ft/s)	18.16	Avg. Vel. (ft/s)		18.16	
Max Chl Dpth (ft)	14.47	Hydr. Depth (ft)		10.30	
Conv. Total (cfs)	258734.0	Conv. (cfs)		258734.0	
Length Wtd. (ft)	46.00	Wetted Per. (ft)		121.87	
Min Ch El (ft)	1401.09	Shear (lb/sq ft)		4.13	

Alpha	1.00	Stream Power (lb/ft s)	331.10	100.93	0.00
Frctn Loss (ft)	0.35	Cum Volume (acre-ft)	1.10	90.72	1.35
C & E Loss (ft)	0.04	Cum SA (acres)	0.11	7.79	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
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.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION OUTPUT Profile #Floodway

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1420.68	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.12	Wt. n-Val.		0.031	
W.S. Elev (ft)	1415.56	Reach Len. (ft)	46.00	46.00	46.00
Crit W.S. (ft)	1415.56	Flow Area (sq ft)		1178.58	
E.G. Slope (ft/ft)	0.006834	Area (sq ft)		1178.58	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	114.37	Top Width (ft)		114.37	
Vel Total (ft/s)	18.16	Avg. Vel. (ft/s)		18.16	
Max Chl Dpth (ft)	14.47	Hydr. Depth (ft)		10.30	
Conv. Total (cfs)	258871.5	Conv. (cfs)		258871.5	
Length Wtd. (ft)	46.00	Wetted Per. (ft)		121.89	
Min Ch El (ft)	1401.09	Shear (lb/sq ft)		4.13	
Alpha	1.00	Stream Power (lb/ft s)	331.10	100.93	0.00
Frctn Loss (ft)	0.35	Cum Volume (acre-ft)	1.10	90.72	1.35
C & E Loss (ft)	0.03	Cum SA (acres)	0.11	7.79	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
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.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 87.9

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1411.99	34.47	1412.12	56.55	1413.58	65.68	1413.6	91.2	1422.03
106.46	1422.11	137.64	1402	143.77	1401.28	159.85	1398.8	180.05	1398.48
190.4	1400.49	231.58	1407.99	243.53	1415.99	278.2	1418	307.99	1431
324.27	1431.02								

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val

0	.025	106.46	.013	137.64	.04	190.4	.04	231.58	.013
243.53	.04								

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
106.46 243.53 294.3 274.7 248.7 .1 .3
Left Levee Station= 91.2 Elevation= 1422.03

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1418.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.00	Wt. n-Val.		0.035	
W.S. Elev (ft)	1413.09	Reach Len. (ft)	294.30	274.70	248.70
Crit W.S. (ft)	1413.09	Flow Area (sq ft)		1192.02	
E.G. Slope (ft/ft)	0.008639	Area (sq ft)		1192.02	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	118.75	Top Width (ft)		118.75	
Vel Total (ft/s)	17.95	Avg. Vel. (ft/s)		17.95	
Max Chl Dpth (ft)	14.61	Hydr. Depth (ft)		10.04	
Conv. Total (cfs)	230246.3	Conv. (cfs)		230246.3	
Length Wtd. (ft)	274.70	Wetted Per. (ft)		124.68	
Min Ch El (ft)	1398.48	Shear (lb/sq ft)		5.16	
Alpha	1.00	Stream Power (lb/ft s)	324.27	91.20	0.00
Frctn Loss (ft)	1.55	Cum Volume (acre-ft)	1.10	89.47	1.35
C & E Loss (ft)	0.59	Cum SA (acres)	0.11	7.67	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
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 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.
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.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
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.

CROSS SECTION OUTPUT Profile #Floodway

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1418.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	5.00	Wt. n-Val.		0.035	
W.S. Elev (ft)	1413.09	Reach Len. (ft)	294.30	274.70	248.70
Crit W.S. (ft)	1413.09	Flow Area (sq ft)		1192.02	
E.G. Slope (ft/ft)	0.008639	Area (sq ft)		1192.02	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	118.75	Top Width (ft)		118.75	
Vel Total (ft/s)	17.95	Avg. Vel. (ft/s)		17.95	
Max Chl Dpth (ft)	14.61	Hydr. Depth (ft)		10.04	
Conv. Total (cfs)	230246.3	Conv. (cfs)		230246.3	
Length Wtd. (ft)	274.70	Wetted Per. (ft)		124.68	
Min Ch El (ft)	1398.48	Shear (lb/sq ft)		5.16	
Alpha	1.00	Stream Power (lb/ft s)	324.27	91.20	0.00
Frctn Loss (ft)	1.55	Cum Volume (acre-ft)	1.10	89.47	1.35
C & E Loss (ft)	0.59	Cum SA (acres)	0.11	7.67	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
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 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.
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.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 87.4

INPUT
Description:
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1410.53	36.9	1411.52	48.93	1412.1	67.11	1418.16	82.13	1417.85
107.46	1401	118.19	1401	125.2	1395.49	131.7	1392.56	189.8	1393.03
201.65	1394.69	230.9	1414.19	254.7	1414.49	258.5	1414.57	280.8	1425.97
282.7	1426.71								

Manning's n Values num= 7

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	82.13	.013	107.46	.04	125.2	.04	189.8	.04
201.65	.013	230.9	.04						

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
82.13	230.9	82	79	80	.1	.3

Left Levee Station= 63.03 Elevation= 1418.16

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1411.63	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.05	Wt. n-Val.		0.034	
W.S. Elev (ft)	1408.58	Reach Len. (ft)	82.00	79.00	80.00
Crit W.S. (ft)	1405.83	Flow Area (sq ft)		1527.36	
E.G. Slope (ft/ft)	0.003956	Area (sq ft)		1527.36	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	126.41	Top Width (ft)		126.41	
Vel Total (ft/s)	14.01	Avg. Vel. (ft/s)		14.01	
Max Chl Dpth (ft)	16.02	Hydr. Depth (ft)		12.08	
Conv. Total (cfs)	340227.8	Conv. (cfs)		340227.8	
Length Wtd. (ft)	79.00	Wetted Per. (ft)		135.56	
Min Ch El (ft)	1392.56	Shear (lb/sq ft)		2.78	
Alpha	1.00	Stream Power (lb/ft s)	282.70	63.03	0.00
Frctn Loss (ft)	0.45	Cum Volume (acre-ft)	1.10	80.89	1.35
C & E Loss (ft)	0.16	Cum SA (acres)	0.11	6.89	0.42

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 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.
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.

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1411.63	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.05	Wt. n-Val.		0.034	

W.S. Elev (ft)	1408.58	Reach Len. (ft)	82.00	79.00	80.00
Crit W.S. (ft)	1405.83	Flow Area (sq ft)		1527.36	
E.G. Slope (ft/ft)	0.003956	Area (sq ft)		1527.36	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	126.41	Top Width (ft)		126.41	
Vel Total (ft/s)	14.01	Avg. Vel. (ft/s)		14.01	
Max Chl Dpth (ft)	16.02	Hydr. Depth (ft)		12.08	
Conv. Total (cfs)	340227.8	Conv. (cfs)		340227.8	
Length Wtd. (ft)	79.00	Wetted Per. (ft)		135.56	
Min Ch El (ft)	1392.56	Shear (lb/sq ft)		2.78	
Alpha	1.00	Stream Power (lb/ft s)	282.70	63.03	0.00
Frctn Loss (ft)	0.45	Cum Volume (acre-ft)	1.10	80.89	1.35
C & E Loss (ft)	0.16	Cum SA (acres)	0.11	6.89	0.42

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 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.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 87.3

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1410	39.09	1410	74.71	1412	92.5	1417.77	107.5	1417.47
142.7	1394	210.07	1394	228.76	1398	239.12	1402	247.44	1404.5
259.64	1412.52	262.75	1413	287.21	1414	295.07	1416.16	307.48	1423
330.33	1423	337.09	1421.59	358.24	1410.66				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	107.5	.013	142.7	.04	247.44	.013	259.64	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
107.5	259.64	178.6	145.2	104.2	.1	.3

Left Levee Station= 92.5 Elevation= 1417.77

CROSS SECTION OUTPUT Profile #Floodplain

			Left OB	Channel	Right OB
E.G. Elev (ft)	1411.02	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.64	Wt. n-Val.		0.036	
W.S. Elev (ft)	1406.39	Reach Len. (ft)	178.60	145.20	104.20
Crit W.S. (ft)	1406.20	Flow Area (sq ft)		1238.59	
E.G. Slope (ft/ft)	0.008681	Area (sq ft)		1238.59	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	126.19	Top Width (ft)		126.19	
Vel Total (ft/s)	17.28	Avg. Vel. (ft/s)		17.28	
Max Chl Dpth (ft)	12.39	Hydr. Depth (ft)		9.82	
Conv. Total (cfs)	229687.0	Conv. (cfs)		229687.0	
Length Wtd. (ft)	145.20	Wetted Per. (ft)		132.04	
Min Ch El (ft)	1394.00	Shear (lb/sq ft)		5.08	
Alpha	1.00	Stream Power (lb/ft s)	358.24	92.50	0.00
Frctn Loss (ft)	0.87	Cum Volume (acre-ft)	1.10	78.39	1.35
C & E Loss (ft)	0.52	Cum SA (acres)	0.11	6.66	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1411.02	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.64	Wt. n-Val.		0.036	
W.S. Elev (ft)	1406.39	Reach Len. (ft)	178.60	145.20	104.20
Crit W.S. (ft)	1406.20	Flow Area (sq ft)		1238.59	
E.G. Slope (ft/ft)	0.008681	Area (sq ft)		1238.59	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	126.19	Top Width (ft)		126.19	
Vel Total (ft/s)	17.28	Avg. Vel. (ft/s)		17.28	
Max Chl Dpth (ft)	12.39	Hydr. Depth (ft)		9.82	
Conv. Total (cfs)	229687.0	Conv. (cfs)		229687.0	
Length Wtd. (ft)	145.20	Wetted Per. (ft)		132.04	
Min Ch El (ft)	1394.00	Shear (lb/sq ft)		5.08	
Alpha	1.00	Stream Power (lb/ft s)	358.24	92.50	0.00
Frctn Loss (ft)	0.87	Cum Volume (acre-ft)	1.10	78.39	1.35
C & E Loss (ft)	0.52	Cum SA (acres)	0.11	6.66	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 87

INPUT
Description:
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1409.55	11.1	1410.61	29.73	1417.03	44.73	1416.73	85	1391.98
109.5	1391.98	112.5	1392.52	155.4	1392.34	160.3	1394.35	179.76	1396.33
205.2	1413.29	242.1	1414.56	262.3	1423.27	264.2	1423.87		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	44.73	.013	85	.04	179.76	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
44.73	205.2	269.82	280.95	283.22	.1	.3

Left Levee Station= 29.73 Elevation= 1417.03

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1409.63	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.91	Wt. n-Val.		0.036	
W.S. Elev (ft)	1406.72	Reach Len. (ft)	269.82	280.95	283.22
Crit W.S. (ft)	1404.08	Flow Area (sq ft)		1562.01	
E.G. Slope (ft/ft)	0.004405	Area (sq ft)		1562.01	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	134.32	Top Width (ft)		134.32	
Vel Total (ft/s)	13.70	Avg. Vel. (ft/s)		13.70	
Max Chl Dpth (ft)	14.74	Hydr. Depth (ft)		11.63	
Conv. Total (cfs)	322435.8	Conv. (cfs)		322435.8	
Length Wtd. (ft)	280.95	Wetted Per. (ft)		142.18	
Min Ch El (ft)	1391.98	Shear (lb/sq ft)		3.02	
Alpha	1.00	Stream Power (lb/ft s)	264.20	29.73	0.00
Frctn Loss (ft)	1.55	Cum Volume (acre-ft)	1.10	73.72	1.35
C & E Loss (ft)	0.06	Cum SA (acres)	0.11	6.23	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1409.63	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.91	Wt. n-Val.		0.036	
W.S. Elev (ft)	1406.72	Reach Len. (ft)	269.82	280.95	283.22
Crit W.S. (ft)	1404.07	Flow Area (sq ft)		1562.01	
E.G. Slope (ft/ft)	0.004405	Area (sq ft)		1562.01	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	134.32	Top Width (ft)		134.32	
Vel Total (ft/s)	13.70	Avg. Vel. (ft/s)		13.70	
Max Chl Dpth (ft)	14.74	Hydr. Depth (ft)		11.63	
Conv. Total (cfs)	322435.8	Conv. (cfs)		322435.8	
Length Wtd. (ft)	280.95	Wetted Per. (ft)		142.18	
Min Ch El (ft)	1391.98	Shear (lb/sq ft)		3.02	
Alpha	1.00	Stream Power (lb/ft s)	264.20	29.73	0.00
Frctn Loss (ft)	1.55	Cum Volume (acre-ft)	1.10	73.72	1.35
C & E Loss (ft)	0.06	Cum SA (acres)	0.11	6.23	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 86.5

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1409.22	9.46	1410	21.93	1414.38	37.33	1414	56.84	1401
70.82	1400.97	84.09	1391.62	91.93	1391	170.93	1391	187.14	1408.14
195.63	1411	203.16	1412	249.08	1414				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	37.33	.013	56.84	.04	70.82	.04	170.93	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
37.33	187.14	47	47	47	.1	.3

Left Levee Station= 21.93 Elevation= 1414.38

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1408.02	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.49	Wt. n-Val.		0.039	
W.S. Elev (ft)	1404.53	Reach Len. (ft)	47.00	47.00	47.00
Crit W.S. (ft)	1402.96	Flow Area (sq ft)		1427.76	
E.G. Slope (ft/ft)	0.007144	Area (sq ft)		1427.76	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	132.19	Top Width (ft)		132.19	
Vel Total (ft/s)	14.99	Avg. Vel. (ft/s)		14.99	

Max Chl Dpth (ft)	13.53	Hydr. Depth (ft)		10.80	
Conv. Total (cfs)	253193.4	Conv. (cfs)		253193.4	
Length Wtd. (ft)	47.00	Wetted Per. (ft)		142.08	
Min Ch El (ft)	1391.00	Shear (lb/sq ft)		4.48	
Alpha	1.00	Stream Power (lb/ft s)	249.08	21.93	0.00
Frctn Loss (ft)	0.23	Cum Volume (acre-ft)	1.10	64.08	1.35
C & E Loss (ft)	0.32	Cum SA (acres)	0.11	5.37	0.42

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
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.

CROSS SECTION OUTPUT Profile #Floodway

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1408.02	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.49	Wt. n-Val.		0.039	
W.S. Elev (ft)	1404.53	Reach Len. (ft)	47.00	47.00	47.00
Crit W.S. (ft)	1402.96	Flow Area (sq ft)		1427.76	
E.G. Slope (ft/ft)	0.007144	Area (sq ft)		1427.76	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	132.19	Top Width (ft)		132.19	
Vel Total (ft/s)	14.99	Avg. Vel. (ft/s)		14.99	
Max Chl Dpth (ft)	13.53	Hydr. Depth (ft)		10.80	
Conv. Total (cfs)	253193.4	Conv. (cfs)		253193.4	
Length Wtd. (ft)	47.00	Wetted Per. (ft)		142.08	
Min Ch El (ft)	1391.00	Shear (lb/sq ft)		4.48	
Alpha	1.00	Stream Power (lb/ft s)	249.08	21.93	0.00
Frctn Loss (ft)	0.23	Cum Volume (acre-ft)	1.10	64.08	1.35
C & E Loss (ft)	0.32	Cum SA (acres)	0.11	5.37	0.42

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 86.4

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1409.14	14.37	1413	33.29	1413.24	56.36	1400.44	65.58	1399.43
75.02	1394	103.3	1390	168.7	1390	173.3	1392	178.3	1394
183.3	1396	186.2	1398	187.3	1400	188.3	1402	189.4	1404
190.4	1406	192.6	1408	195.1	1410	197.6	1412	246.8	1414

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	33.29	.013	75.02	.04	173.3	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
33.29	197.6	55.4	72.4	94.8	.1	.3

Left Levee Station= 12.45 Elevation= 1413.33

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1407.48	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.44	Wt. n-Val.		0.036	
W.S. Elev (ft)	1405.04	Reach Len. (ft)	55.40	72.40	94.80
Crit W.S. (ft)	1401.65	Flow Area (sq ft)		1708.56	
E.G. Slope (ft/ft)	0.003543	Area (sq ft)		1708.56	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	

```
  Top Width (ft)            141.85   Top Width (ft)                      141.85
  Vel Total (ft/s)           12.53   Avg. Vel. (ft/s)                     12.53
  Max Chl Dpth (ft)          15.04   Hydr. Depth (ft)                     12.04
  Conv. Total (cfs)       359535.2   Conv. (cfs)                       359535.2
  Length Wtd. (ft)           72.40   Wetted Per. (ft)                    150.88
  Min Ch El (ft)           1390.00   Shear (lb/sq ft)                      2.50
  Alpha                       1.00   Stream Power (lb/ft s)    246.80     12.45      0.00
  Frctn Loss (ft)             0.29   Cum Volume (acre-ft)        1.10     62.38      1.35
  C & E Loss (ft)             0.03   Cum SA (acres)              0.11      5.22      0.42
```

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.

CROSS SECTION OUTPUT Profile #Floodway

```
  E.G. Elev (ft)           1407.48   Element                  Left OB   Channel   Right OB
  Vel Head (ft)               2.44   Wt. n-Val.                           0.036
  W.S. Elev (ft)           1405.04   Reach Len. (ft)            55.40     72.40     94.80
  Crit W.S. (ft)           1401.65   Flow Area (sq ft)                  1708.56
  E.G. Slope (ft/ft)      0.003543   Area (sq ft)                       1708.56
  Q Total (cfs)           21400.00   Flow (cfs)                        21400.00
  Top Width (ft)            141.85   Top Width (ft)                      141.85
  Vel Total (ft/s)           12.53   Avg. Vel. (ft/s)                     12.53
  Max Chl Dpth (ft)          15.04   Hydr. Depth (ft)                     12.04
  Conv. Total (cfs)       359535.2   Conv. (cfs)                       359535.2
  Length Wtd. (ft)           72.40   Wetted Per. (ft)                    150.88
  Min Ch El (ft)           1390.00   Shear (lb/sq ft)                      2.50
  Alpha                       1.00   Stream Power (lb/ft s)    246.80     12.45      0.00
  Frctn Loss (ft)             0.29   Cum Volume (acre-ft)        1.10     62.38      1.35
  C & E Loss (ft)             0.03   Cum SA (acres)              0.11      5.22      0.42
```

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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 86.3

INPUT
Description:

```
Station Elevation Data    num=      11
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0  1408.31    16.56     1410    26.68  1412.16     36.3  1413.48    43.53  1413.23
   79.97     1394    94.42     1394   112.22     1391   191.79     1391    209.3     1410
  265.13   1412.9

Manning's n Values        num=       5
     Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val
       0     .025    43.53     .013    79.97      .04    94.42      .04   191.79      .04

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
         43.53   209.3             145.4     131   112.9                .1       .3
Left Levee      Station=     36.3      Elevation= 1413.48
```

CROSS SECTION OUTPUT Profile #Floodplain

```
  E.G. Elev (ft)           1407.16   Element                  Left OB   Channel   Right OB
  Vel Head (ft)               2.71   Wt. n-Val.                           0.037
  W.S. Elev (ft)           1404.45   Reach Len. (ft)           145.40    131.00    112.90
  Crit W.S. (ft)           1401.71   Flow Area (sq ft)                  1621.12
  E.G. Slope (ft/ft)      0.004570   Area (sq ft)                       1621.12
  Q Total (cfs)           21400.00   Flow (cfs)                        21400.00
  Top Width (ft)            144.02   Top Width (ft)                      144.02
  Vel Total (ft/s)           13.20   Avg. Vel. (ft/s)                     13.20
  Max Chl Dpth (ft)          13.45   Hydr. Depth (ft)                     11.26
```

Conv. Total (cfs)	316552.7	Conv. (cfs)		316552.7	
Length Wtd. (ft)	131.00	Wetted Per. (ft)		152.76	
Min Ch El (ft)	1391.00	Shear (lb/sq ft)		3.03	
Alpha	1.00	Stream Power (lb/ft s)	265.13	36.30	0.00
Frctn Loss (ft)	0.86	Cum Volume (acre-ft)	1.10	59.62	1.35
C & E Loss (ft)	0.17	Cum SA (acres)	0.11	4.98	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

			Left OB	Channel	Right OB
E.G. Elev (ft)	1407.16	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.71	Wt. n-Val.		0.037	
W.S. Elev (ft)	1404.45	Reach Len. (ft)	145.40	131.00	112.90
Crit W.S. (ft)	1401.71	Flow Area (sq ft)		1621.12	
E.G. Slope (ft/ft)	0.004570	Area (sq ft)		1621.12	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	144.02	Top Width (ft)		144.02	
Vel Total (ft/s)	13.20	Avg. Vel. (ft/s)		13.20	
Max Chl Dpth (ft)	13.45	Hydr. Depth (ft)		11.26	
Conv. Total (cfs)	316552.7	Conv. (cfs)		316552.7	
Length Wtd. (ft)	131.00	Wetted Per. (ft)		152.76	
Min Ch El (ft)	1391.00	Shear (lb/sq ft)		3.03	
Alpha	1.00	Stream Power (lb/ft s)	265.13	36.30	0.00
Frctn Loss (ft)	0.86	Cum Volume (acre-ft)	1.10	59.62	1.35
C & E Loss (ft)	0.17	Cum SA (acres)	0.11	4.98	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 86

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1403.35	26.58	1412.14	41.58	1411.84	77.66	1394	85.1	1394
132.7	1391.7	144.1	1388.82	162.1	1386.09	231.9	1410.93	250.3	1410.46
256.9	1410.46	287.1	1411.56						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	41.58	.013	77.66	.04	85.1	.04	162.1	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
41.58	231.9	205.81	211.61	210.55	.1	.3

Left Levee Station= 26.58 Elevation= 1412.14

CROSS SECTION OUTPUT Profile #Floodplain

E.G. Elev (ft)	1406.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.39	Wt. n-Val.		0.037	
W.S. Elev (ft)	1401.73	Reach Len. (ft)	205.81	211.61	210.55
Crit W.S. (ft)	1401.73	Flow Area (sq ft)		1272.18	
E.G. Slope (ft/ft)	0.010296	Area (sq ft)		1272.18	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	144.03	Top Width (ft)		144.03	
Vel Total (ft/s)	16.82	Avg. Vel. (ft/s)		16.82	
Max Chl Dpth (ft)	15.64	Hydr. Depth (ft)		8.83	
Conv. Total (cfs)	210903.0	Conv. (cfs)		210903.0	
Length Wtd. (ft)	211.61	Wetted Per. (ft)		149.15	
Min Ch El (ft)	1386.09	Shear (lb/sq ft)		5.48	
Alpha	1.00	Stream Power (lb/ft s)	287.10	26.58	0.00
Frctn Loss (ft)	1.44	Cum Volume (acre-ft)	1.10	55.27	1.35
C & E Loss (ft)	0.68	Cum SA (acres)	0.11	4.55	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
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 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.
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.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1406.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.39	Wt. n-Val.		0.037	
W.S. Elev (ft)	1401.73	Reach Len. (ft)	205.81	211.61	210.55
Crit W.S. (ft)	1401.73	Flow Area (sq ft)		1272.18	
E.G. Slope (ft/ft)	0.010296	Area (sq ft)		1272.18	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	144.03	Top Width (ft)		144.03	
Vel Total (ft/s)	16.82	Avg. Vel. (ft/s)		16.82	
Max Chl Dpth (ft)	15.64	Hydr. Depth (ft)		8.83	
Conv. Total (cfs)	210903.0	Conv. (cfs)		210903.0	
Length Wtd. (ft)	211.61	Wetted Per. (ft)		149.15	
Min Ch El (ft)	1386.09	Shear (lb/sq ft)		5.48	
Alpha	1.00	Stream Power (lb/ft s)	287.10	26.58	0.00
Frctn Loss (ft)	1.44	Cum Volume (acre-ft)	1.10	55.27	1.35
C & E Loss (ft)	0.68	Cum SA (acres)	0.11	4.55	0.42

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
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 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.
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.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program
defaulted to critical depth.
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.

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 85.4

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1407.15	40.7	1406.24	53.84	1410.41	68.84	1410.11	103.44	1394
113.1	1387.86	138.9	1388.87	166.9	1388.33	176.7	1387.36	239.8	1390
264.9	1392	270.8	1394	278.8	1396	283.4	1398	285.8	1400
287.9	1402	296.3	1404	301.5	1406	305.7	1408	349.1	1410
365.3	1410	382.4	1408						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.025	68.84	.013	103.44	.04	113.1	.04	239.8	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
68.84	305.7	294.8	299.3	299.1	.1	.3

Left Levee Station= 53.84 Elevation= 1410.41

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1401.74	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.13	Wt. n-Val.		0.039	
W.S. Elev (ft)	1399.60	Reach Len. (ft)	294.80	299.30	299.10
Crit W.S. (ft)	1397.25	Flow Area (sq ft)		1825.30	
E.G. Slope (ft/ft)	0.004806	Area (sq ft)		1825.30	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	193.92	Top Width (ft)		193.92	
Vel Total (ft/s)	11.72	Avg. Vel. (ft/s)		11.72	
Max Chl Dpth (ft)	12.24	Hydr. Depth (ft)		9.41	
Conv. Total (cfs)	308691.8	Conv. (cfs)		308691.8	
Length Wtd. (ft)	299.30	Wetted Per. (ft)		198.73	
Min Ch El (ft)	1387.36	Shear (lb/sq ft)		2.76	
Alpha	1.00	Stream Power (lb/ft s)	382.40	53.84	0.00
Frctn Loss (ft)	0.93	Cum Volume (acre-ft)	1.10	47.74	1.35
C & E Loss (ft)	0.31	Cum SA (acres)	0.11	3.73	0.42

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

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1401.74	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.13	Wt. n-Val.		0.039	
W.S. Elev (ft)	1399.60	Reach Len. (ft)	294.80	299.30	299.10
Crit W.S. (ft)	1397.25	Flow Area (sq ft)		1825.35	
E.G. Slope (ft/ft)	0.004806	Area (sq ft)		1825.35	

Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	193.92	Top Width (ft)		193.92	
Vel Total (ft/s)	11.72	Avg. Vel. (ft/s)		11.72	
Max Chl Dpth (ft)	12.24	Hydr. Depth (ft)		9.41	
Conv. Total (cfs)	308704.7	Conv. (cfs)		308704.7	
Length Wtd. (ft)	299.30	Wetted Per. (ft)		198.73	
Min Ch El (ft)	1387.36	Shear (lb/sq ft)		2.76	
Alpha	1.00	Stream Power (lb/ft s)	382.40	53.84	0.00
Frctn Loss (ft)	0.93	Cum Volume (acre-ft)	1.10	47.74	1.35
C & E Loss (ft)	0.31	Cum SA (acres)	0.11	3.73	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 85

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-743.4	1402	0	1403.5	8.9	1402.29	17.58	1402.02	23.56	1405
40.08	1405.41	50.13	1400.54	59	1400.5	78.5	1400.52	96.8	1409.36
114.5	1399.15	125.8	1394.87	145.5	1390.98	158.8	1386.89	173.4	1381.93
180.5	1383.54	184.3	1385.66	219.4	1386.65	222.6	1386.17	292.6	1386.71
295.7	1387.98	320	1388.14	342.6	1400.19	348.2	1407.17	389.1	1407.09
411.3	1407.4	420.6	1409.99						

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
-743.4	.04	0	.04	158.8	.04	219.4	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
96.8	348.2	414.07	449.02	430.64	.1	.3

CROSS SECTION OUTPUT Profile #Floodplain

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1400.50	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.11	Wt. n-Val.		0.040	
W.S. Elev (ft)	1399.39	Reach Len. (ft)	414.07	449.02	430.64
Crit W.S. (ft)	1394.23	Flow Area (sq ft)		2531.08	
E.G. Slope (ft/ft)	0.002160	Area (sq ft)		2531.08	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	227.03	Top Width (ft)		227.03	
Vel Total (ft/s)	8.45	Avg. Vel. (ft/s)		8.45	
Max Chl Dpth (ft)	17.46	Hydr. Depth (ft)		11.15	
Conv. Total (cfs)	460480.0	Conv. (cfs)		460480.0	
Length Wtd. (ft)	448.25	Wetted Per. (ft)		233.54	
Min Ch El (ft)	1381.93	Shear (lb/sq ft)		1.46	
Alpha	1.00	Stream Power (lb/ft s)	420.60	0.00	0.00
Frctn Loss (ft)	0.38	Cum Volume (acre-ft)	1.10	32.78	1.35
C & E Loss (ft)	0.21	Cum SA (acres)	0.11	2.28	0.42

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 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.
Warning: When the Manning's n value for the channel was composited, the computed n value was larger [smaller] than the
largest [smallest] user entered n value. The n value has been set to the largest [smallest] entered value. The user may
wish to examine this cross section and enter a single n value for the entire channel.
Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION OUTPUT Profile #Floodway

			Left OB	Channel	Right OB
E.G. Elev (ft)	1400.50	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.11	Wt. n-Val.		0.040	
W.S. Elev (ft)	1399.39	Reach Len. (ft)	414.07	449.02	430.64
Crit W.S. (ft)	1394.23	Flow Area (sq ft)		2531.11	
E.G. Slope (ft/ft)	0.002160	Area (sq ft)		2531.11	
Q Total (cfs)	21400.00	Flow (cfs)		21400.00	
Top Width (ft)	227.03	Top Width (ft)		227.03	
Vel Total (ft/s)	8.45	Avg. Vel. (ft/s)		8.45	
Max Chl Dpth (ft)	17.46	Hydr. Depth (ft)		11.15	
Conv. Total (cfs)	460487.9	Conv. (cfs)		460487.9	
Length Wtd. (ft)	448.25	Wetted Per. (ft)		233.54	
Min Ch El (ft)	1381.93	Shear (lb/sq ft)		1.46	
Alpha	1.00	Stream Power (lb/ft s)	420.60	0.00	0.00
Frctn Loss (ft)	0.38	Cum Volume (acre-ft)	1.10	32.78	1.35
C & E Loss (ft)	0.21	Cum SA (acres)	0.11	2.28	0.42

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

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 84

INPUT
Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
2536.21	1402.2	2661.93	1402.15	3042.1	1400.51	3095.34	1401.09	3102.49	1400
3126.85	1380	3160.53	1377.3	3208.81	1380	3308.85	1384	3329.29	1388
3333.64	1392	3343.01	1396	3391.96	1396	3413.24	1396	3431.07	1400
3461.59	1402.4	3477.77	1402.24	3531.18	1403.16	3570.5	1404	3581.84	1404.36
3598.01	1408	3598.56	1412	3608.48	1416	3624.2	1420	3658.86	1420
3689.76	1420	3693.45	1424	3716.39	1424				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
2536.21	.04	3126.85	.04	3343.01	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
3126.85	3343.01	.1	.3

CROSS SECTION OUTPUT Profile #Floodplain

			Left OB	Channel	Right OB
E.G. Elev (ft)	1399.92	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.42	Wt. n-Val.	0.040	0.040	0.040
W.S. Elev (ft)	1399.50	Reach Len. (ft)			
Crit W.S. (ft)	1388.00	Flow Area (sq ft)	231.57	3828.36	273.11
E.G. Slope (ft/ft)	0.000447	Area (sq ft)	231.57	3828.36	273.11
Q Total (cfs)	21400.00	Flow (cfs)	698.99	20238.43	462.58
Top Width (ft)	325.74	Top Width (ft)	23.75	216.16	85.83
Vel Total (ft/s)	4.94	Avg. Vel. (ft/s)	3.02	5.29	1.69
Max Chl Dpth (ft)	22.20	Hydr. Depth (ft)	9.75	17.71	3.18
Conv. Total (cfs)	1012314.0	Conv. (cfs)	33065.3	957366.3	21882.1
Length Wtd. (ft)		Wetted Per. (ft)	30.73	219.19	86.22

Min Ch El (ft)	1377.30	Shear (lb/sq ft)	0.21	0.49	0.09
Alpha	1.10	Stream Power (lb/ft s)	3716.39	0.00	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

CROSS SECTION OUTPUT Profile #Floodway

E.G. Elev (ft)	1399.92	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.42	Wt. n-Val.	0.040	0.040	0.040
W.S. Elev (ft)	1399.50	Reach Len. (ft)			
Crit W.S. (ft)	1388.00	Flow Area (sq ft)	231.57	3828.36	273.11
E.G. Slope (ft/ft)	0.000447	Area (sq ft)	231.57	3828.36	273.11
Q Total (cfs)	21400.00	Flow (cfs)	698.99	20238.43	462.58
Top Width (ft)	325.74	Top Width (ft)	23.75	216.16	85.83
Vel Total (ft/s)	4.94	Avg. Vel. (ft/s)	3.02	5.29	1.69
Max Chl Dpth (ft)	22.20	Hydr. Depth (ft)	9.75	17.71	3.18
Conv. Total (cfs)	1012314.0	Conv. (cfs)	33065.3	957366.3	21882.1
Length Wtd. (ft)		Wetted Per. (ft)	30.73	219.19	86.22
Min Ch El (ft)	1377.30	Shear (lb/sq ft)	0.21	0.49	0.09
Alpha	1.10	Stream Power (lb/ft s)	3716.39	0.00	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

SUMMARY OF MANNING'S N VALUES

River:RIVER-1

Reach	River Sta.	n1	n2	n3	n4	n5	n6	n7
Reach-1	91.4	.025	.04					
Reach-1	91	.025	.013	.04	.04	.04		
Reach-1	90.5	.025	.013	.04	.04	.04		
Reach-1	90	.025	.013	.04	.04	.04		
Reach-1	89.5	.025	.013	.04	.04	.04		
Reach-1	89	.025	.013	.04	.04	.04		
Reach-1	88.5	.025	.013	.04	.04	.04	.044	.04
Reach-1	88.4	.025	.013	.04	.04	.013	.04	
Reach-1	88	.025	.013	.04	.04	.013	.04	
Reach-1	87.9	.025	.013	.04	.04	.013	.04	
Reach-1	87.4	.025	.013	.04	.04	.04	.013	.04
Reach-1	87.3	.025	.013	.04	.013	.04		
Reach-1	87	.025	.013	.04	.04			
Reach-1	86.5	.025	.013	.04	.04	.04		
Reach-1	86.4	.025	.013	.04	.04			
Reach-1	86.3	.025	.013	.04	.04	.04		
Reach-1	86	.025	.013	.04	.04	.04		
Reach-1	85.4	.025	.013	.04	.04	.04		
Reach-1	85	.04	.04	.04	.04			
Reach-1	84	.04	.04	.04				

SUMMARY OF REACH LENGTHS

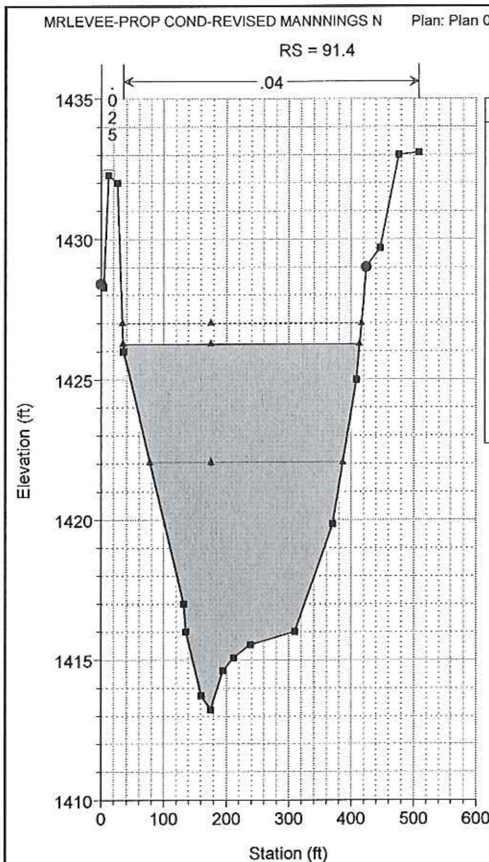
River: RIVER-1

Reach	River Sta.	Left	Channel	Right
Reach-1	91.4	100	100	100
Reach-1	91	195	173	137
Reach-1	90.5	183	167	165
Reach-1	90	205	213	213
Reach-1	89.5	179	188	203

Reach-1	89	198	206	182
Reach-1	88.5	49	47	44
Reach-1	88.4	100	89	94
Reach-1	88	46	46	46
Reach-1	87.9	294.3	274.7	248.7
Reach-1	87.4	82	79	80
Reach-1	87.3	178.6	145.2	104.2
Reach-1	87	269.82	280.95	283.22
Reach-1	86.5	47	47	47
Reach-1	86.4	55.4	72.4	94.8
Reach-1	86.3	145.4	131	112.9
Reach-1	86	205.81	211.61	210.55
Reach-1	85.4	294.8	299.3	299.1
Reach-1	85	414.07	449.02	430.64
Reach-1	84			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: RIVER-1

Reach	River Sta.	Contr.	Expan.
Reach-1	91.4	.1	.3
Reach-1	91	.1	.3
Reach-1	90.5	.1	.3
Reach-1	90	.1	.3
Reach-1	89.5	.1	.3
Reach-1	89	.1	.3
Reach-1	88.5	.1	.3
Reach-1	88.4	.1	.3
Reach-1	88	.1	.3
Reach-1	87.9	.1	.3
Reach-1	87.4	.1	.3
Reach-1	87.3	.1	.3
Reach-1	87	.1	.3
Reach-1	86.5	.1	.3
Reach-1	86.4	.1	.3
Reach-1	86.3	.1	.3
Reach-1	86	.1	.3
Reach-1	85.4	.1	.3
Reach-1	85	.1	.3
Reach-1	84	.1	.3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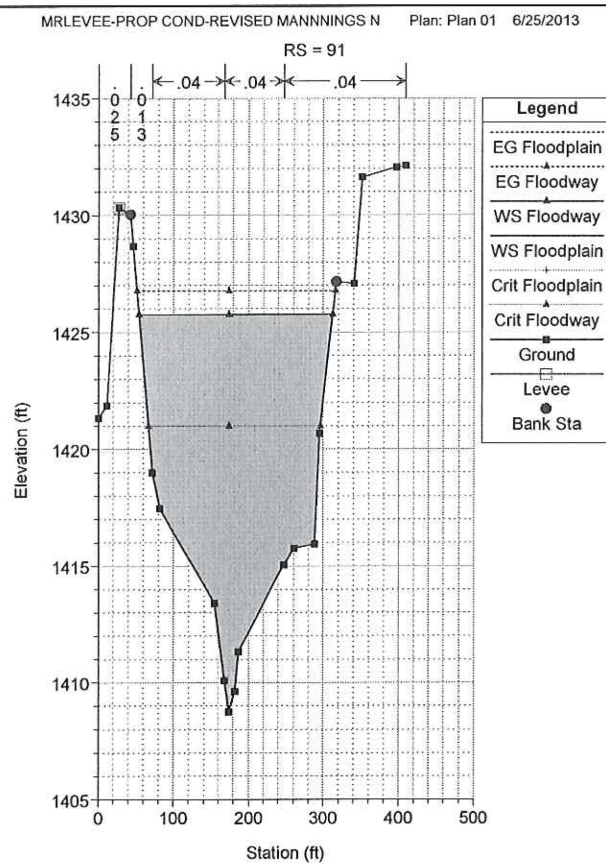
EG Floodway
WS Floodway
WS Floodplain
Crit Floodplain
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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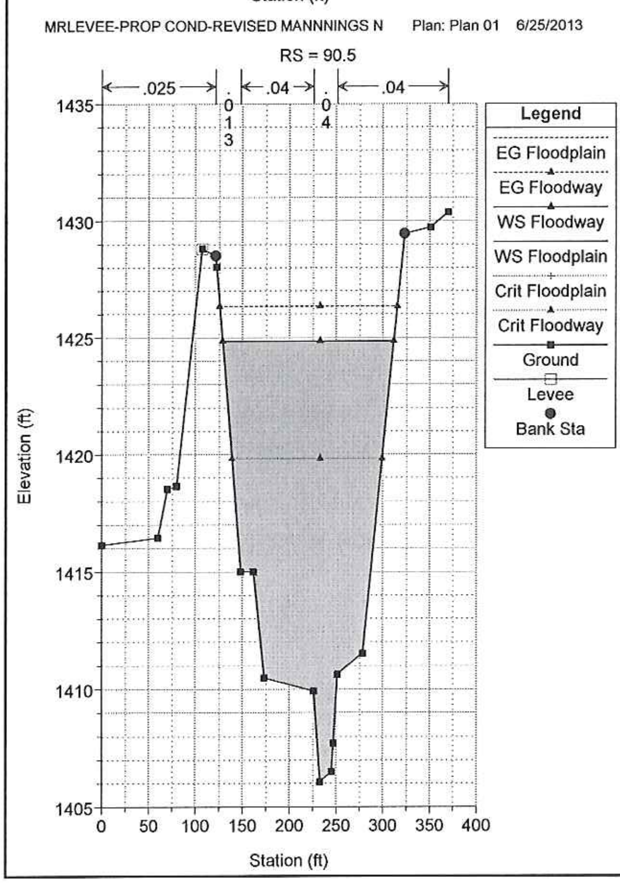
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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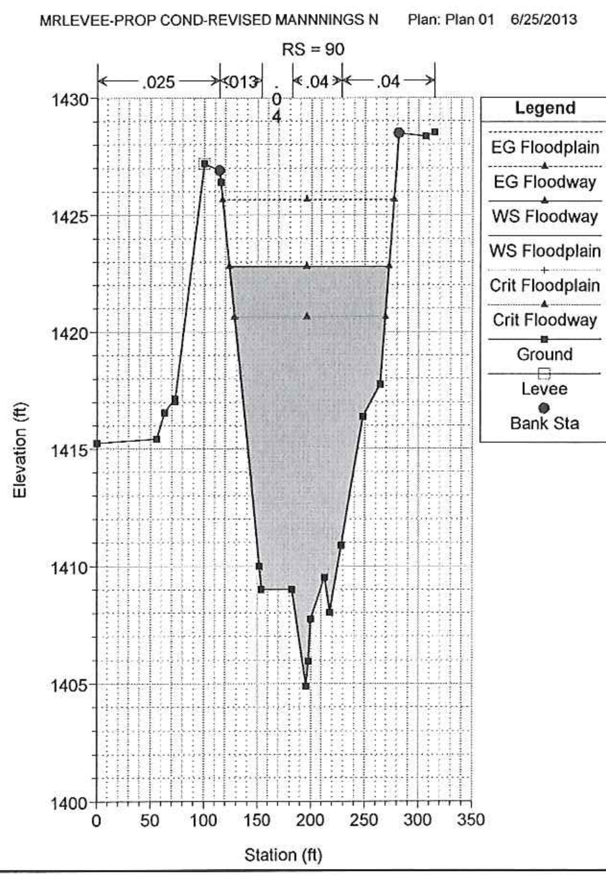
WS Floodplain
Crit Floodplain
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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WS Floodway
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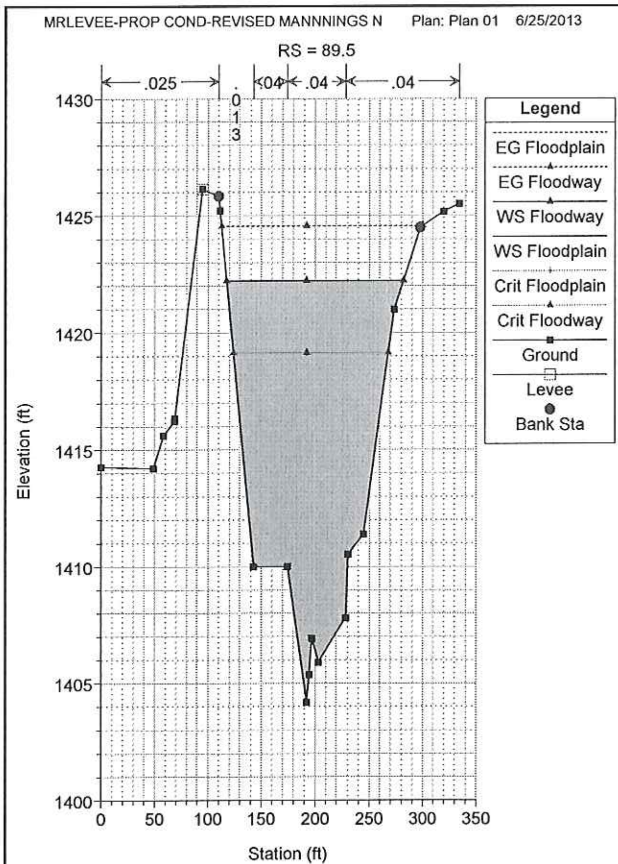
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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WS Floodway
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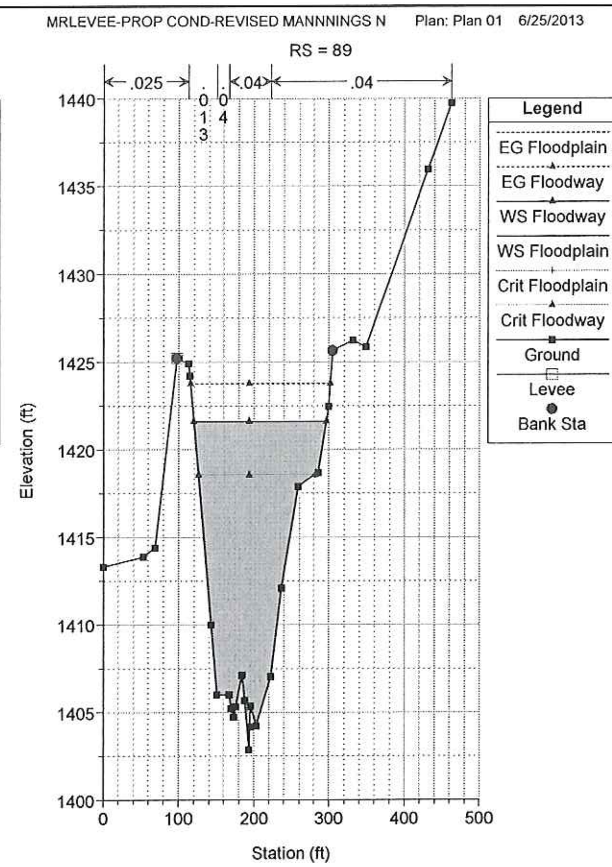
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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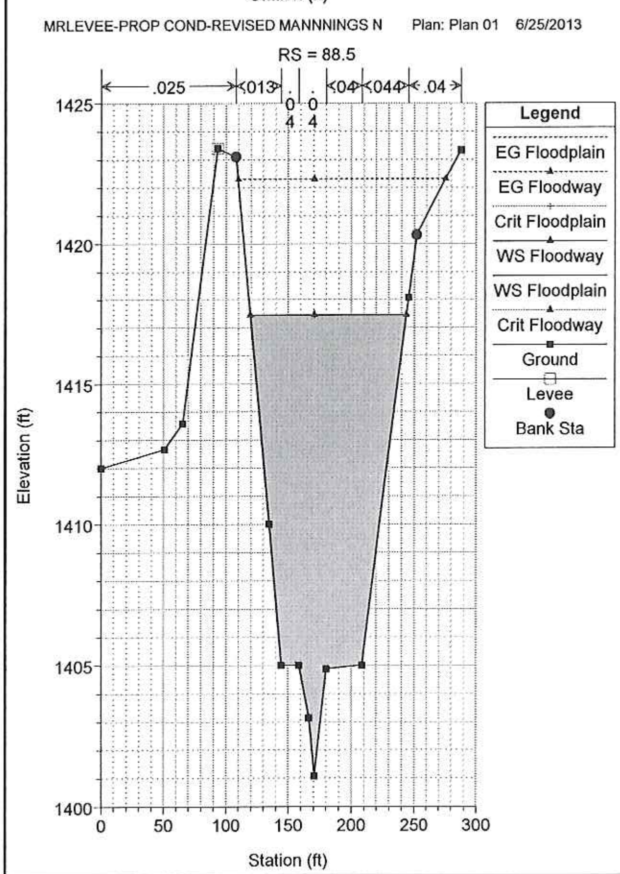
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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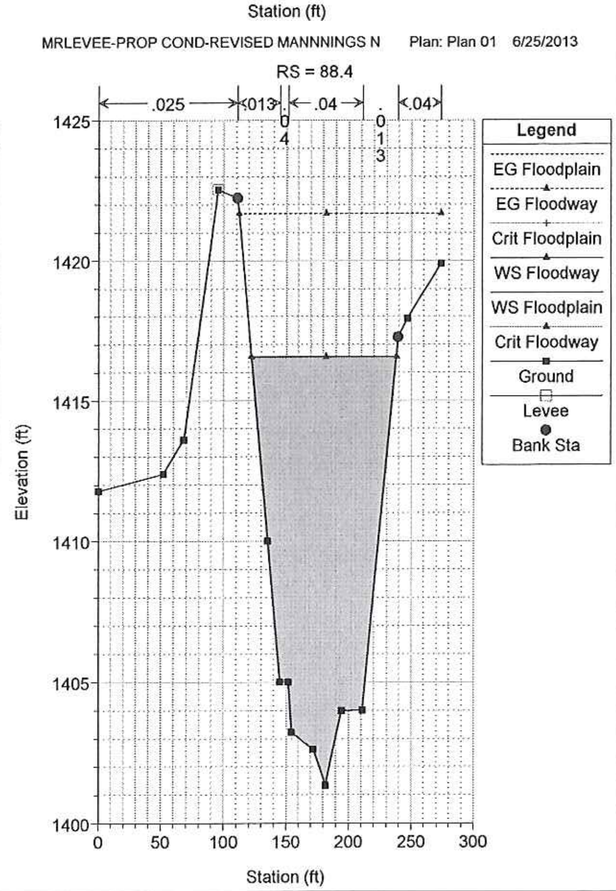
WS Floodplain
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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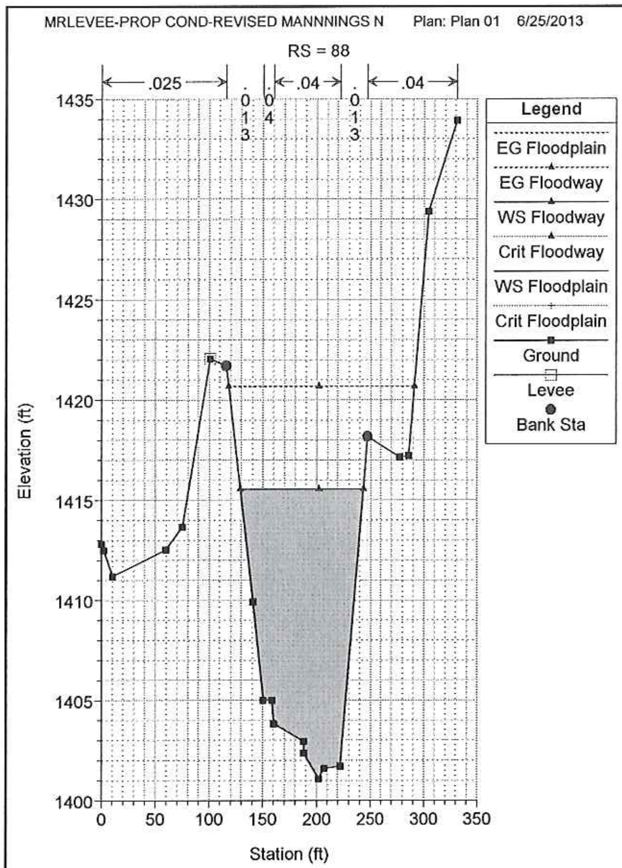
WS Floodplain
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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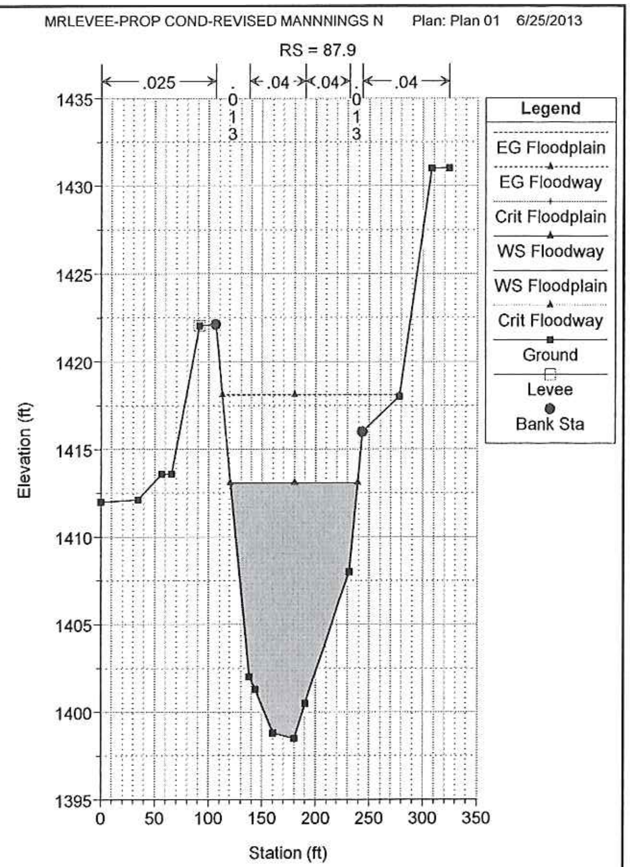
EG Floodway
WS Floodway
Crit Floodway
WS Floodplain
Crit Floodplain
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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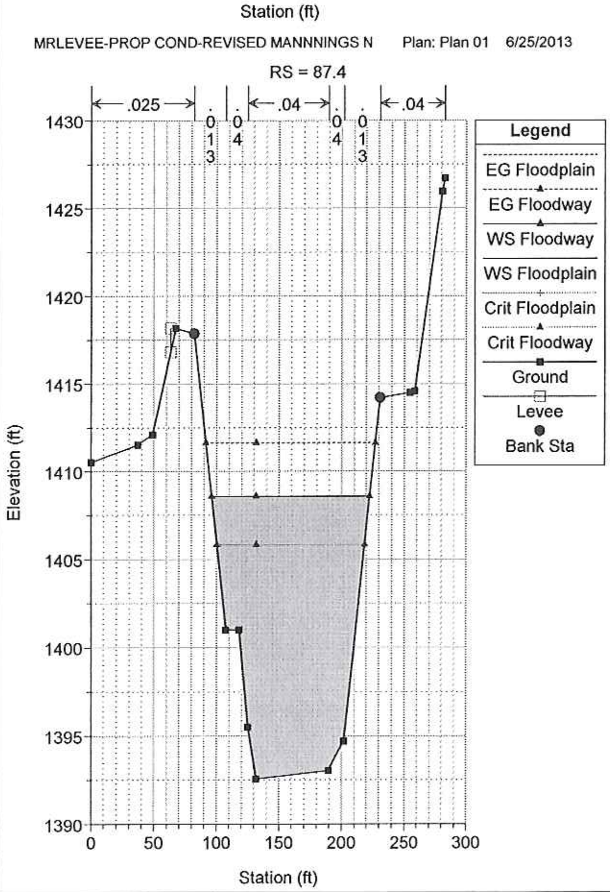
WS Floodplain
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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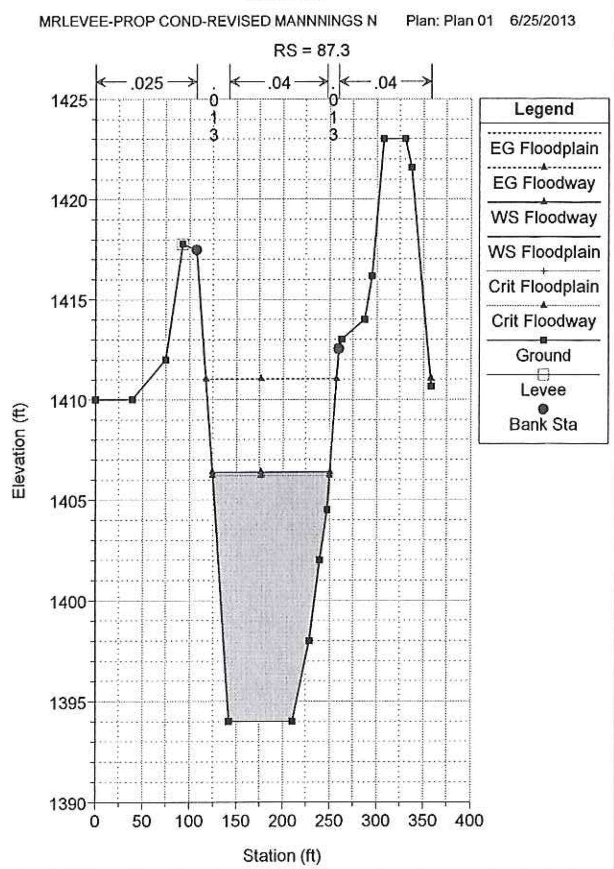
WS Floodway
WS Floodplain
Crit Floodplain
Crit Floodway
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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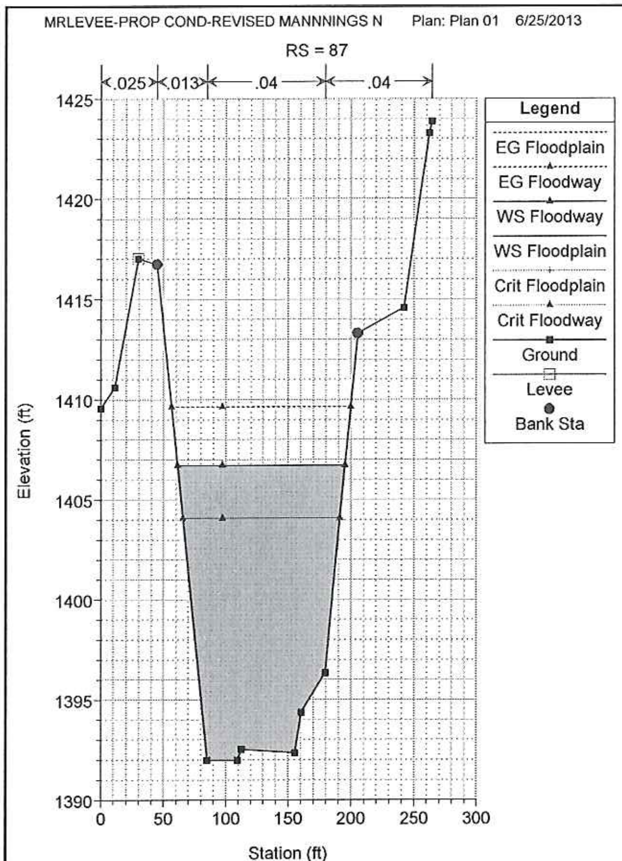
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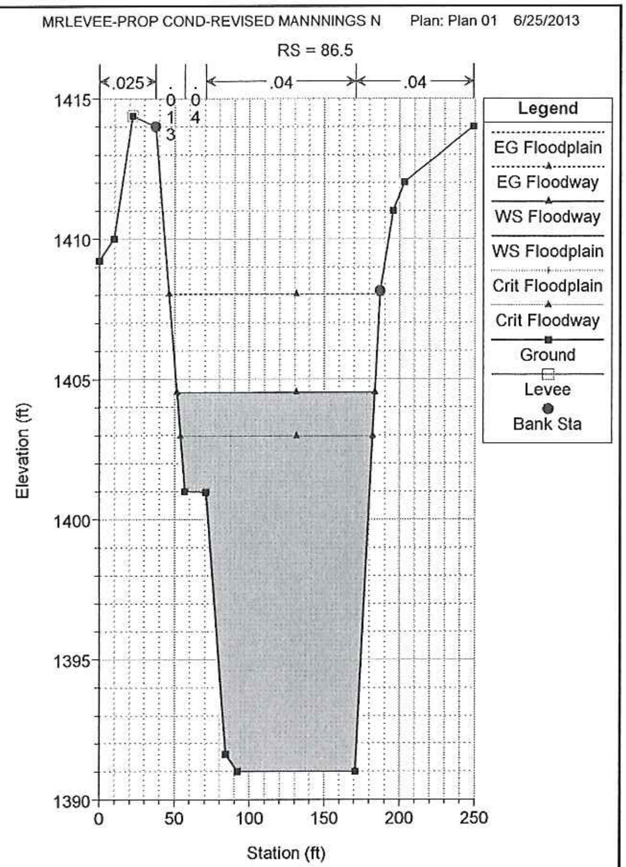
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Ground
Levee
Bank Sta
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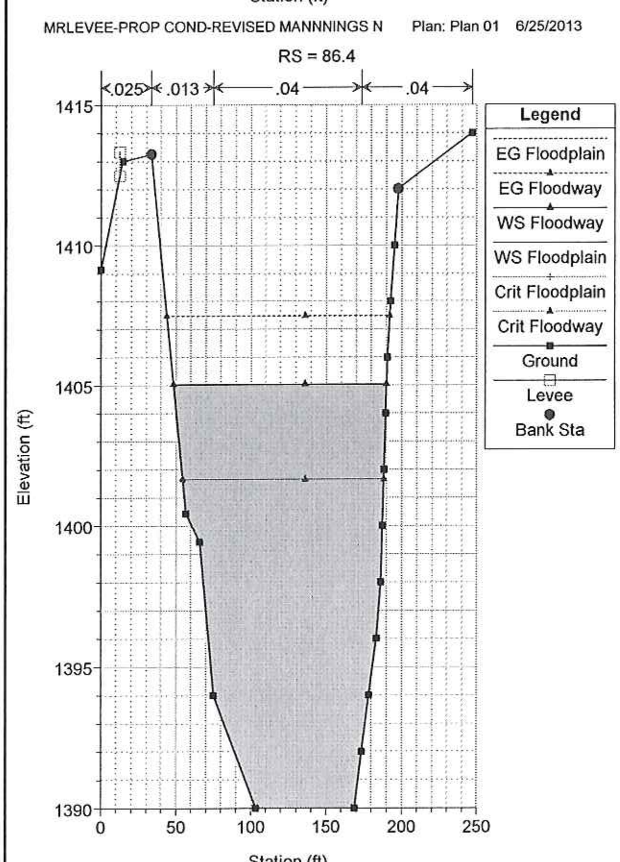
Station (ft)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Levee
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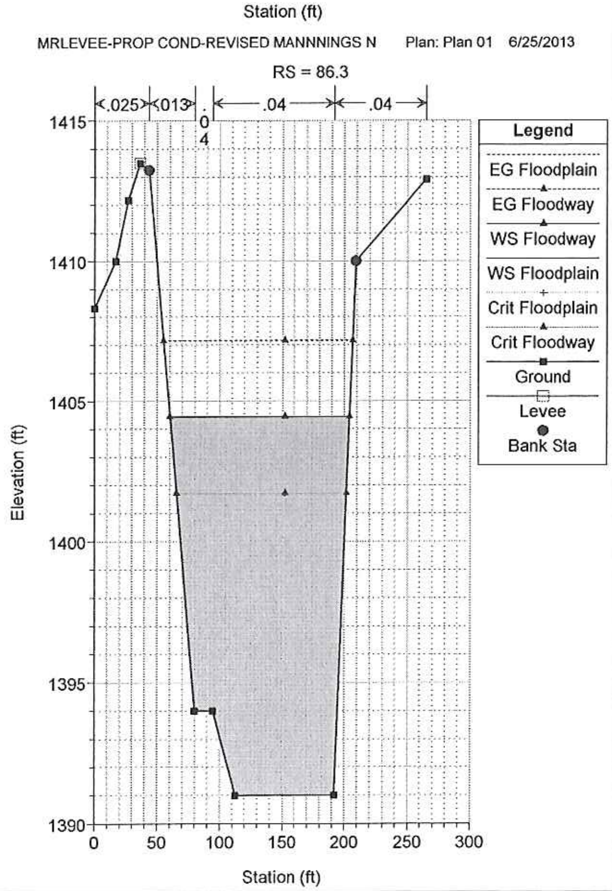
Elevation (ft)
Station (ft)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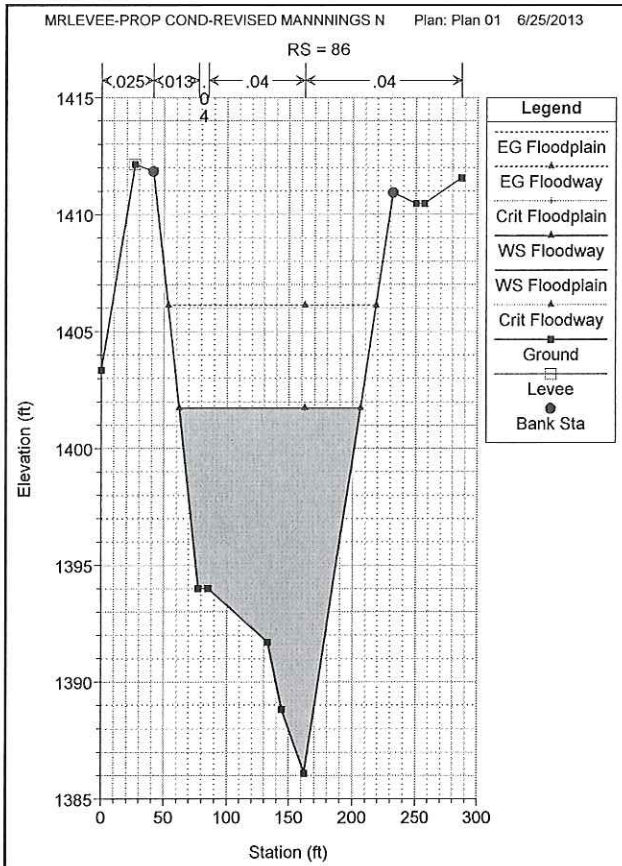
Elevation (ft)
Station (ft)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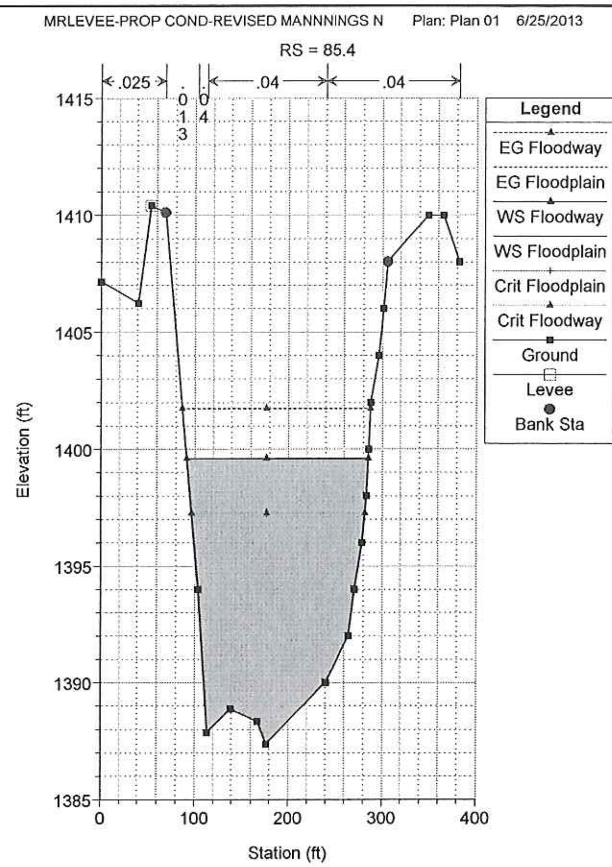
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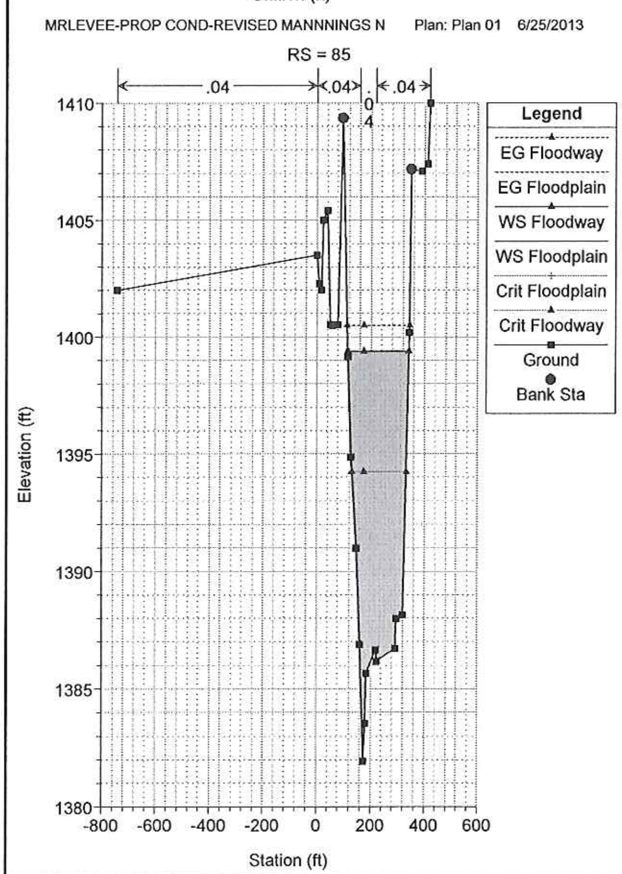
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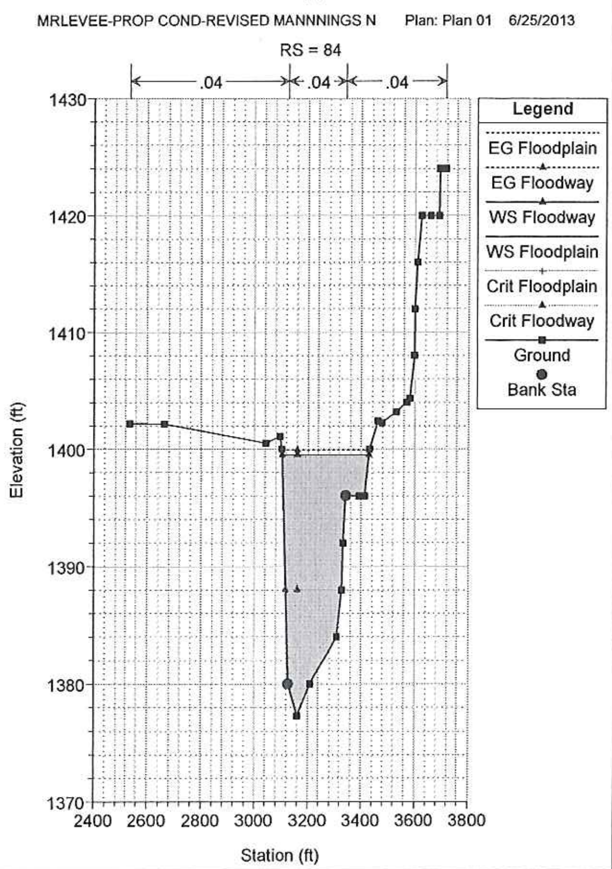
Elevation (ft)
Station (ft)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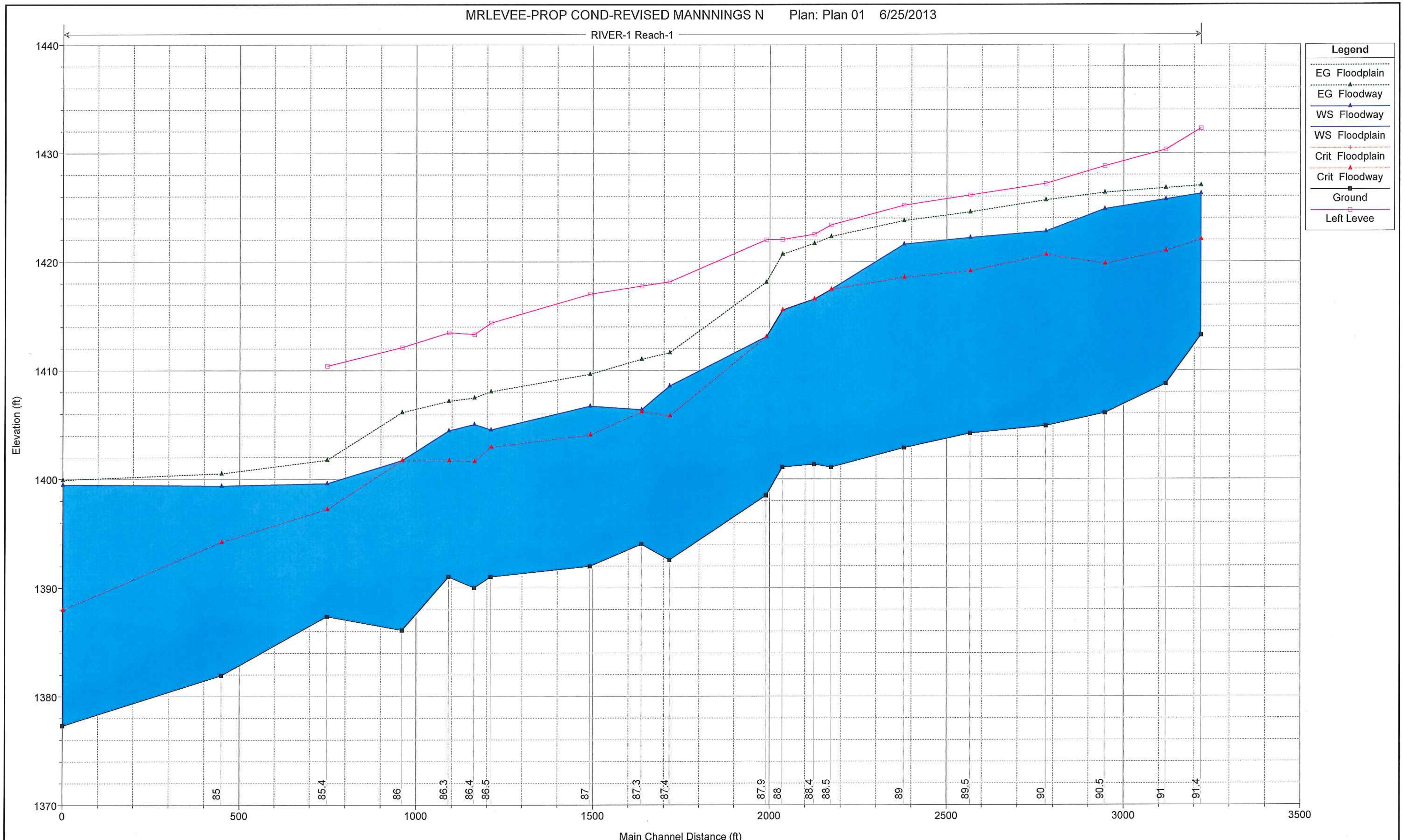
WS Floodway
WS Floodplain
Crit Floodplain
Crit Floodway
Ground
Bank Sta
Elevation (ft)
Station (ft)

HEC-RAS Plan: Plan 01 River: RIVER-1 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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	91.4	Floodplain	21400.00	1413.22	1426.26	1422.04	1427.00	0.002092	6.89	3103.96	378.79	0.42
Reach-1	91.4	Floodway	21400.00	1413.22	1426.26	1422.04	1427.00	0.002092	6.89	3103.96	378.79	0.42
Reach-1	91	Floodplain	21400.00	1408.74	1425.75	1420.99	1426.77	0.002014	8.08	2647.36	258.51	0.45
Reach-1	91	Floodway	21400.00	1408.74	1425.75	1420.99	1426.77	0.002014	8.08	2647.36	258.51	0.45
Reach-1	90.5	Floodplain	21400.00	1406.06	1424.85	1419.83	1426.34	0.002373	9.80	2183.86	183.15	0.50
Reach-1	90.5	Floodway	21400.00	1406.06	1424.85	1419.82	1426.34	0.002373	9.80	2183.86	183.15	0.50
Reach-1	90	Floodplain	21400.00	1404.89	1422.80	1420.63	1425.66	0.004776	13.57	1576.51	149.12	0.74
Reach-1	90	Floodway	21400.00	1404.89	1422.80	1420.63	1425.66	0.004776	13.57	1576.51	149.12	0.74
Reach-1	89.5	Floodplain	21400.00	1404.19	1422.22	1419.14	1424.56	0.004116	12.27	1743.82	164.58	0.66
Reach-1	89.5	Floodway	21400.00	1404.19	1422.22	1419.14	1424.56	0.004116	12.27	1743.82	164.58	0.66
Reach-1	89	Floodplain	21400.00	1402.86	1421.61	1418.55	1423.76	0.003807	11.76	1820.48	176.95	0.65
Reach-1	89	Floodway	21400.00	1402.86	1421.61	1418.55	1423.76	0.003807	11.76	1820.48	176.95	0.65
Reach-1	88.5	Floodplain	21400.00	1401.08	1417.46	1417.46	1422.30	0.009651	17.67	1211.24	124.15	1.00
Reach-1	88.5	Floodway	21400.00	1401.08	1417.46	1417.46	1422.30	0.009651	17.67	1211.24	124.15	1.00
Reach-1	88.4	Floodplain	21400.00	1401.35	1416.57	1416.57	1421.67	0.006268	18.12	1180.79	115.88	1.00
Reach-1	88.4	Floodway	21400.00	1401.35	1416.57	1416.57	1421.67	0.006268	18.12	1180.79	115.88	1.00
Reach-1	88	Floodplain	21400.00	1401.09	1415.56	1415.56	1420.68	0.006841	18.16	1178.19	114.36	1.00
Reach-1	88	Floodway	21400.00	1401.09	1415.56	1415.56	1420.68	0.006834	18.16	1178.58	114.37	1.00
Reach-1	87.9	Floodplain	21400.00	1398.48	1413.09	1413.09	1418.10	0.008639	17.95	1192.02	118.75	1.00
Reach-1	87.9	Floodway	21400.00	1398.48	1413.09	1413.09	1418.10	0.008639	17.95	1192.02	118.75	1.00
Reach-1	87.4	Floodplain	21400.00	1392.56	1408.58	1405.83	1411.63	0.003956	14.01	1527.36	126.41	0.71
Reach-1	87.4	Floodway	21400.00	1392.56	1408.58	1405.83	1411.63	0.003956	14.01	1527.36	126.41	0.71
Reach-1	87.3	Floodplain	21400.00	1394.00	1406.39	1406.20	1411.02	0.008681	17.28	1238.59	126.19	0.97
Reach-1	87.3	Floodway	21400.00	1394.00	1406.39	1406.20	1411.02	0.008681	17.28	1238.59	126.19	0.97
Reach-1	87	Floodplain	21400.00	1391.98	1406.72	1404.08	1409.63	0.004405	13.70	1562.01	134.32	0.71
Reach-1	87	Floodway	21400.00	1391.98	1406.72	1404.07	1409.63	0.004405	13.70	1562.01	134.32	0.71
Reach-1	86.5	Floodplain	21400.00	1391.00	1404.53	1402.96	1408.02	0.007144	14.99	1427.76	132.19	0.80
Reach-1	86.5	Floodway	21400.00	1391.00	1404.53	1402.96	1408.02	0.007144	14.99	1427.76	132.19	0.80
Reach-1	86.4	Floodplain	21400.00	1390.00	1405.04	1401.65	1407.48	0.003543	12.53	1708.56	141.85	0.64
Reach-1	86.4	Floodway	21400.00	1390.00	1405.04	1401.65	1407.48	0.003543	12.53	1708.56	141.85	0.64
Reach-1	86.3	Floodplain	21400.00	1391.00	1404.45	1401.71	1407.16	0.004570	13.20	1621.12	144.02	0.69
Reach-1	86.3	Floodway	21400.00	1391.00	1404.45	1401.71	1407.16	0.004570	13.20	1621.12	144.02	0.69
Reach-1	86	Floodplain	21400.00	1386.09	1401.73	1401.73	1406.13	0.010296	16.82	1272.18	144.03	1.00
Reach-1	86	Floodway	21400.00	1386.09	1401.73	1401.73	1406.13	0.010296	16.82	1272.18	144.03	1.00
Reach-1	85.4	Floodplain	21400.00	1387.36	1399.60	1397.25	1401.74	0.004806	11.72	1825.30	193.92	0.67
Reach-1	85.4	Floodway	21400.00	1387.36	1399.60	1397.25	1401.74	0.004806	11.72	1825.35	193.92	0.67
Reach-1	85	Floodplain	21400.00	1381.93	1399.39	1394.23	1400.50	0.002160	8.45	2531.08	227.03	0.45
Reach-1	85	Floodway	21400.00	1381.93	1399.39	1394.23	1400.50	0.002160	8.45	2531.11	227.03	0.45
Reach-1	84	Floodplain	21400.00	1377.30	1399.50	1388.00	1399.92	0.000447	5.29	4333.04	325.74	0.22
Reach-1	84	Floodway	21400.00	1377.30	1399.50	1388.00	1399.92	0.000447	5.29	4333.04	325.74	0.22



MRLEVEE-PROP COND-REVISED MANNNINGS N Plan: Plan 01 6/25/2013
RIVER-1 Reach-1
Legend
EG Floodplain
EG Floodway
WS Floodway
WS Floodplain
Crit Floodplain
Crit Floodway
Ground
Left Levee
Elevation (ft)
1440
1430
1420
1410
1400
1390
1380
1370
Main Channel Distance (ft)
0
500
1000
1500
2000
2500
3000
3500
85
85.4
86
86.3
86.4
86.5
87
87.3
87.4
87.9
88
88.4
88.5
89
89.5
90
90.5
91
91.4

6. ELECTRONIC FILES (ON CD)

Report PDF
GIS Shape Files
CLOMR
HEC-RAS Models
Topography

October 26, 2018

Mr. John Catanese
Associate Engineer
Clark County Public Works Department
500 South Grand Central Parkway
Las Vegas, NV 89106

IN REPLY REFER TO:
Case No.: 18-09-2135P
Community: Unincorporated Areas of Clark County, NV
Community No.: 320003

316-AD

Dear Mr. Catanese:

This responds to your request dated August 4, 2018, that the Department of Homeland Security's Federal Emergency Management Agency (FEMA) issue a revision to the Flood Insurance Rate Map (FIRM) for Clark County, Nevada and Incorporated Areas. Pertinent information about the request is listed below.

Identifier:	Muddy River Logandale Levee
Flooding Source:	Muddy River
FIRM Panel Affected:	32003C1105F

The data required to complete our review, which must be submitted within 90 days of the date of this letter, are listed on the enclosed summary.

If we do not receive the required data within 90 days, we will suspend our processing of your request. Any data submitted after 90 days will be treated as an original submittal and will be subject to all submittal/payment procedures, including the flat review and processing fee for requests of this type established by the current fee schedule. A copy of the notice summarizing the current fee schedule, which was published in the *Federal Register,* is enclosed for your information.

FEMA receives a very large volume of requests and cannot maintain inactive requests for an indefinite period of time. Therefore, we are unable to grant extensions for the submission of required data/fee for revision requests. If a requester is informed by letter that additional data are required to complete our review of a request, the data/fee **must** be submitted within 90 days of the date of the letter. Any fees already paid will be forfeited for any request for which the requested data are not received within 90 days.

If you have general questions about your request, FEMA policy, or the National Flood Insurance Program, please call the FEMA Map Information Exchange (FMIX), toll free, at 1-877-FEMA MAP (1-877-336-2627). If you have specific questions concerning your request, please contact your case reviewer, Ms. Maryam Akhavan, by e-mail at Maryam.akhavan@atkinsglobal.com or by telephone at

(240) 264-8930, or the Revisions Coordinator for your request, Mr. Preetham Thotakuri, P.E., CFM, at Preetham.Thotakuri@atkinsglobal.com or at (919) 431-5275.

Sincerely,

Daven Patel

Daven Patel, P.E., CFM
MT-2 Technical Manager
STARR II

cc: Mr. Stephen Jones, P.E.
Vice President, Flood Control Division Manager, GCW, Inc

Mr. Kevin Eubanks, P.E., CFM
Assistant General Manager, Clark County Regional Flood Control District

October 26, 2018

Summary of Additional Data Required to Support a
Letter of Map Revision (LOMR)

Case No.: 18-09-2135P | Requestor: Mr. John Catanese

Community: Unincorporated Areas of Clark County, NV | Community No.: 320003

The issues listed below must be addressed before we can continue the review of your request.

1. The "Certification" block under Section E. Certification on page 11 of the Application/Certification Form 3 entitled "Riverine Structures Form" has not been signed and sealed by a registered professional engineer. Please submit revised copy of the MT-2 Form 3.

2. According to FEMA Procedure Memorandum 63 for all levee accreditation requests, the submittal must adequately address all applicable Federal, State, and local laws, regulations and requirements, including, but not limited to, Federal and local floodplain management laws, environmental laws, and permit requirements. Please verify that all applicable Federal, State, and local laws, regulations and requirements, including, but not limited to, Federal and local floodplain management laws, environmental laws, and permit requirements have been addressed.

3. The submittal includes unsigned copy of the Operation and Maintenance (O & M) Manual said to be adopted November 9. 1990 / September 9, 2010, as mentioned on page 2-1 and title page, respectively. Please submit an officially adopted copy of the O & M Plan which is signed by the CEO of the community or the appropriate head of the agency that is accepting the ultimate responsibility of all the tasks and actions. Also, the submitted O & M plan must specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

4. The submittal includes draft unsigned copy of geotechnical report titled, "Geotechnical Evaluation Report, Muddy River Logandale Levee, Moapa Valley, Clark County, Nevada", prepared by Kleinfelder, dated June 21, 2013. Please submit signed and sealed copy of the geotechnical report. Please also provide certification that the findings of the above-referenced draft report are still valid and fulfill the requirements of 44 CFR 65.10(b)(4).

5. A formal settlement analysis is not submitted due to following reasons, as explained in the above-referenced draft copy of the geotechnical.
   a. Load-related settlement within the clay foundation soils is expected to have already occurred in all areas.
   b. Rebound settlement resulting from the removal and replacement of the embankment loads is expected to be elastic and to occur during reconstruction.

   Our review indicates that there is a marginal freeboard of 3 feet between levee stations 23+00 and

24+30. Therefore, an engineering analysis must be submitted as laid down under CFR 65.10(b)(5), to assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrates that freeboard will be maintained within the minimum standards set forth in 65.10(b)(1)

6. Please provide a copy of the emergency preparedness plan for the Muddy River Logandale Levee. The emergency preparedness plan should address procedures for emergency operation and public evacuations for the leveed area, and be adopted by the community. If these requirements are covered in the existing O&M plan, no additional document is needed. For examples and additional suggested direction, review the following documents:
    - DHS Document entitled "Emergency Preparedness Guidelines for Levees, A Guide for Owners and Operators," dated July 2012, website: https://www.fema.gov/media-library/assets/documents/131081, and
    - The Silver Jackets, "Emergency Action Plan, Guidebook, Version 2.0," dated August 2016, website: http://www.mvp.usace.army.mil/Portals/57/docs/Operations%20Center/EM/EAP%20Guidebook/EAP_Combined_Ver2.0_including_appendices_Aug16.pdf?ver=2016-09-16-120924-387.

7. Please submit the FEMA effective HEC-2 model for Muddy river and provide paper and digital copies of the input and output files for this model.

8. Our review revealed that Normal depth (S=0.005) was used as the downstream boundary conditions in the submitted post-project conditions HEC-RAS hydraulic analysis along Muddy River. Downstream tie-in location (XS 21.97) is located inside an area designated as Zone AE with effective BFEs established. Please revise and resubmit a post project conditions hydraulic model using known water surface elevation (KWSEL) of 1,399.50 feet as the downstream boundary conditions.

9. Our review of the post-project hydraulic model shows interpolated cross-sections. Interpolated cross sections should not be used in the LOMR submittals. Please replace the interpolated cross sections with new cross sections based on the data derived from the revised topographic data and the revised certified profile. Please also revise the topographic work map and only show the locations and alignments of cross sections used in the hydraulic model.

10. The submitted topographic work map entitled "Muddy River Logandale Levee LOMR HEC-RAS Work Map", prepared by GCW, dated June 18, 2018, does not provide essential information required to complete our review of this request. Submitted effective boundary delineations are not clear, topographic contour information should be extended until 0.2 percent annual chance boundary delineation and contoures should be cleary labeled. Please submit a revised topographic work map, certified by a registered professional engineer, that shows all applicable items listed in Section C of Application/Certification Form 2, entitled "Riverine Hydrology & Hydraulics Form," including the following information:

    a. Boundary delineations of the currently effective base floodplain, 0.2-percent-annual-chance floodplain, and regulatory floodway;
    b. Topographic contour information used for the boundary delineations of the base floodplain and 0.2-percent-annual-chance floodplain;
    c. Logical tie-ins between the revised and effective flood hazard boundary delineations;

d. Certification by a registered professional engineer; and
e. Reference to a datum, such as the Noth American Vertical Datum of 1988.

11. The submitted as-built plans entitled "2016 Improvement Plans for Muddy River Logandale Levee," prepared by GCW were not sealed or signed by a professional engineer. Please provide as-built plans, certified by a registered professional engineer.

12. Our review revealed that revised area limits described in the draft copy of newspaper notification do not match the actual area of revision for this LOMR. Also, submitted draft notifications did not include information on establishment of BFEs. Please confirm if there are any BFEs being established with this LOMR. Please use one of the following options for the notifications. In either case, **please submit a draft copy of the notification for verification of content, prior to publication or distribution**. The attached templates may be used to prepare the draft notification.

    a. Combine this notification of proposed floodway modifications with the notifications of increase in BFE and/or SFHA in a public notification. Provide a copy of the newspaper notice distributed by the Clark County stating its intent to revise the regulatory floodway along Muddy River and revise the SFHA.
    b. Combine this notification of proposed floodway modifications with the notifications of increase in BFE and/or SFHA in individual letters to the property owners. Documentation of legal notice may take the form of a copy of the letter sent (letter must be on community letterhead) along with either a mailing list or certified mailing receipts. Please use template entitled "SAMPLE NOTIFICATION LETTER FOR LOMRs".

Please send the required data and/or fee directly to us at the address shown at the bottom of the first page attention to Ms. Maryam Akhavan, STARR II. For identification purposes, please include the case number referenced above on all correspondence.