CITY OF ALBUQUERQUE

July 31, 2015

Alandren Etlantus, P.E.
Bohannan Huston Inc.
7500 Jefferson NE
Albuquerque, NM 87107

Re: Amendment No 3 DMP for Mirehaven Arroyo Improvements
Engineer's Stamp Date 7-17-15 (H09D017)

Dear Ms. Etlantus,

Based upon the information provided in your submittal received 7-17-15, the above referenced DMP is approved for Work Order.

If you have any questions, you can contact me at 924-3420.

Sincerely,

Curtis Cherne, P.E.
Stormwater Quality for Hydrology
Planning Dept.

C: e-mail

PO Box 1293

Albuquerque

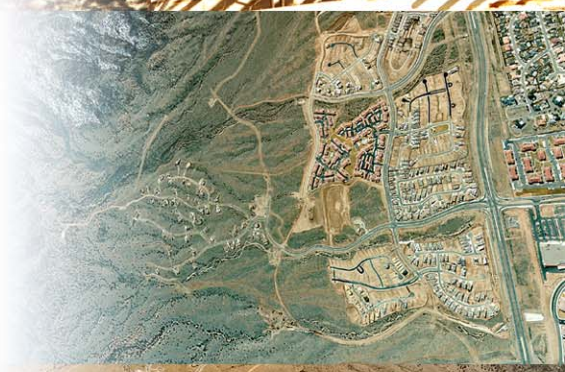
New Mexico 87103

www.cabq.gov

AMENDMENT NO. 3

DRAINAGE MASTER PLAN FOR THE MIREHAVEN MASTER PLANNED COMMUNITY

(TRACTS N-2 & M OF THE WATERSHED SUBDIVISION)



JULY 2015

Prepared for:

Pulte Homes of New Mexico
7601 Jefferson St NE – Suite 320
Albuquerque, NM 87109

Prepared by:

Bohannan Huston
Engineering
Spatial Data
Advanced Technologies

AMENDMENT NO. 3
DRAINAGE MASTER PLAN
FOR THE MIREHAVEN MASTER PLANNED COMMUNITY
(TRACTS N-2 & M OF THE WATERSHED SUBDIVISION)

JULY 17, 2015

Prepared for:

PULTE HOMES OF NEW MEXICO
7601 JEFFERSON BLVD NE, SUITE 320
ALBUQUERQUE, NM 87109

Prepared by:

BOHANNAN HUSTON, INC.
COURTYARD I
7500 JEFFERSON STREET NE
ALBUQUERQUE, NM 87109

Prepared by:

7-17-15

Alandren Etlantus, PE — Date
Project Manager

07-17-15

Kareem Saint-Lot, EI — Date
Drainage Engineer

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PURPOSE

This report is Amendment No. 3 to the Drainage Master Plan (DMP) for the Mirehaven Master Planned Community, Bohannan Huston Inc., November 2013, which was prepared for Pulte Homes of New Mexico. The DMP provided master drainage analysis to support the future backbone drainage infrastructure for the proposed development that will consist of approximately 950 single family residential lots on approximately 285 acres. The DMP was approved by the City of Albuquerque on December 4, 2013, with Amendment No. 1 being approved on April 9, 2014, and Amendment No. 2 being approved on May 20, 2015. As discussed in the DMP, there is a proposed crossing of the Mirehaven Arroyo; this amendment provides the analysis to support the design of the arroyo crossing and changes to the arroyo improvements to accommodate the crossing. These modifications include lowering a portion the Mirehaven Arroyo between two drop structures and a concrete box culvert (CBC) at the proposed crossing. This Amendment provides the updated analysis for the Mirehaven Arroyo Improvements and provides analysis of the crossing structure at Willow Canyon Trail.

VI. PROPOSED MIREHAVEN ARROYO IMPROVEMENT MODIFICATIONS

The modifications to the Mirehaven Arroyo are from Grade Control Structure (GCS) 6 to approximately 20 feet downstream of GCS 7. The proposed improvements include: increasing the height of GCS 6 by 1 foot on the downstream end, lowering the channel between GCS's 6 and 7, adding a concrete box culvert at the proposed crossing, reducing the vertical height at GCS 7 by 1 foot and moving GCS 7 downstream approximately 20 feet. The proposed improvements can be seen in the HEC-RAS profile in Appendix A. The proposed channel will be consistent with the previous design: a composite trapezoidal channel with the side slopes of the channel being constructed of shotcrete and the bottom of the channel being earthen. A HEC-RAS model was created for the proposed improvements to aid in the design of the proposed channel, scour protection, crossing structure and drop structures. This model uses Manning's "n" values of 0.018, 0.035, and 0.045, corresponding to shotcrete, natural channel, and gravel mulch portions of the channel and Manning's "n" of 0.013 for the CBC. HEC-RAS model outputs, select cross sections, a figure showing HEC-RAS sections in plan view, and a profile showing existing ground (based on the previous design described in Amendment No. 2), interim ground, and proposed ground are included in Appendix A.

A. PROPOSED CHANNEL

The proposed channel flowrate and characteristics are discussed in Amendment No. 2 to the original DMP. Amendment No. 2 describes the channel bottom width as varying between 64 ft and 115 ft upstream to the proposed future roadway crossing where the channel bottom width is reduced to 46 feet. The channel bottom width in a section between GCS's 6 and 7 will be reduced to a width of 42 feet as a result of lowering the channel 1 foot to accommodate the CBC crossing. The height of GCS 6 will be increased by 1 foot and the height of GCS 7 will be reduced by 1 foot to accommodate the proposed crossing. Four 10 feet span and 6 feet high concrete box culverts (CBC) are proposed for the crossing at Willow Canyon Trail and are discussed further in this report.

The channel improvements are designed to include freeboard above the 100-yr WSEL. The channel depth is designed to contain the water surface elevation in the channel as well as superelevation. The channel section has also been designed with a gravel mulch lined section to extend from the top of the channel depth at a slope of 3:1 (horizontal to vertical) vertically 2 feet to account for freeboard. Freeboard was calculated per Section 22.3.C.4 of the COA DPM (see Appendix A of Amendment No. 2). Exhibit 2 of Amendment No. 2 shows a portion of the plan view and details of the proposed channel.

1. EQUILIBRIUM SLOPE ANALYSIS

The equilibrium slope was established previously with the original DMP and is discussed in that report.

2. SUPERELEVATION ANALYSIS

A superelevation analysis was established previously with Amendment No. 2 to the original DMP and is discussed in that report.

B. SHOTCRETE DROP STRUCTURES

Grade control (drop) structures are required for the proposed channel described above, as discussed in Amendment No. 2, to control the grade in the channel and maintain the channel design slope of 0.7 percent. Changes from the drop structures described in Amendment No. 2 are for GCS's 6 and 7; all other GCS geometry described in Amendment No. 2 remains the same. The height of GCS 6 was increased by 1 foot and the height of GCS 7 was lowered by 1 foot to accommodate the lowering of the channel between GCS's 6 and 7. Changes in the drop heights and lengths for structures 6 and 7 are highlighted in Table 1 below. See Exhibit 3 for plan and sections for proposed drop structures.

Table 1: Drop Structure Dimensions

	Drop Structure Location	Crest Width (ft)	Drop Height (ft)	Required Length of Drop (ft)	Design Length of Drop (ft)
Amendment No. 2 Design	Sta. 28+18	68	4	31.9	32.0
	Sta. 23+22	46	5	39.4	40.0
Proposed Design	Sta. 28+18	68	5	34.8	35.0
	Sta. 23+22	42	4	37.4	38.0

1. DROP STRUCTURE DIMENSION ANALYSIS

To determine the length of the drop structures, a drop structure dimension analysis was performed for drop structures 6 and 7. This analysis uses the equations for drop structure lengths in the document *Open Channel Flow*, Henderson, 1966, and requires input of crest width, design flow rate (1,500 cfs), critical depth (determined from HEC-RAS) and height of vertical drop (varies from 4 feet to 5 feet). For the 4 feet and 5 feet drop structures, the required lengths of protection downstream are 38 feet and 35 feet, respectively. Calculations for this analysis are included in Appendix A.

C. ROADWAY CROSSING STRUCTURE

As discussed previously in the DMP, the proposed crossing at Willow Canyon Trail required additional analysis which is the subject of this amendment and discussed in this section. The proposed crossing structure consists of four 10 feet span by 6 feet high CBCs. The crossing will include aesthetic elements, which have been accounted for in this analysis. The CBCs have been modeled with reduced widths to account for fascia along the upstream and downstream portions of the box which result in reduced effective flow areas for the boxes. The fascia will not exceed one inch along each side edge of the CBCs. Additionally beveled corners will be placed in the top right and left corners of each opening with a height and length of six inches. The effective width of each box was reduced by two inches to account for the fascia on either side wall of the CBCs, and lids were added to the cross sections upstream and downstream of the CBC crossing to account for the area of the beveled edges along the top corners of each box.

The concrete box culvert inverts were lowered from the existing channel design, which resulted in decreasing the bottom width of the proposed channel in a section just upstream of the box to 42 feet. HEC-RAS modeling results show that lowering the channel by one foot contains the 100-yr water surface elevation within the shotcrete lined portion of the

channel. An additional two feet of freeboard is provided above the 100-year water surface elevation.

D. SCOUR PROTECTION

The modified section of channel will include scour protection as discussed in Amendment No. 2. Proposed modifications within the channel from station 28+33 to station 22+60 will provide 3 feet of scour protection as established in Table 2 of Amendment No. 2, of which a portion is provided below corresponding to the area of the proposed modifications.

Table 2: Scour Depth

Location	Design Scour Depth (ft)
Sta. 28+33 to 22+60	3

1. SCOUR DEPTH ANALYSIS

Scour depths were established in Amendment No. 2, and the calculations and references for this analysis are included in Appendix B of Amendment No. 2.

E. PROJECT PHASING

The design changes discussed in this report are predominantly to the channel improvements which are part of an approved work order currently starting construction. Channel modifications are planned to be change ordered into the current construction project. The complete bridge crossing design will be a new work order; however, the current construction, channel modifications, and bridge crossing are planned to be completed simultaneously and closed out at the same time.

APPENDIX A: MIREHAVEN ARROYO HYDRAULIC CALCULATIONS/ANALYSIS

MIREHAVEN ARROYO IMPROVEMENTS
HEC-RAS PLAN
07/2015

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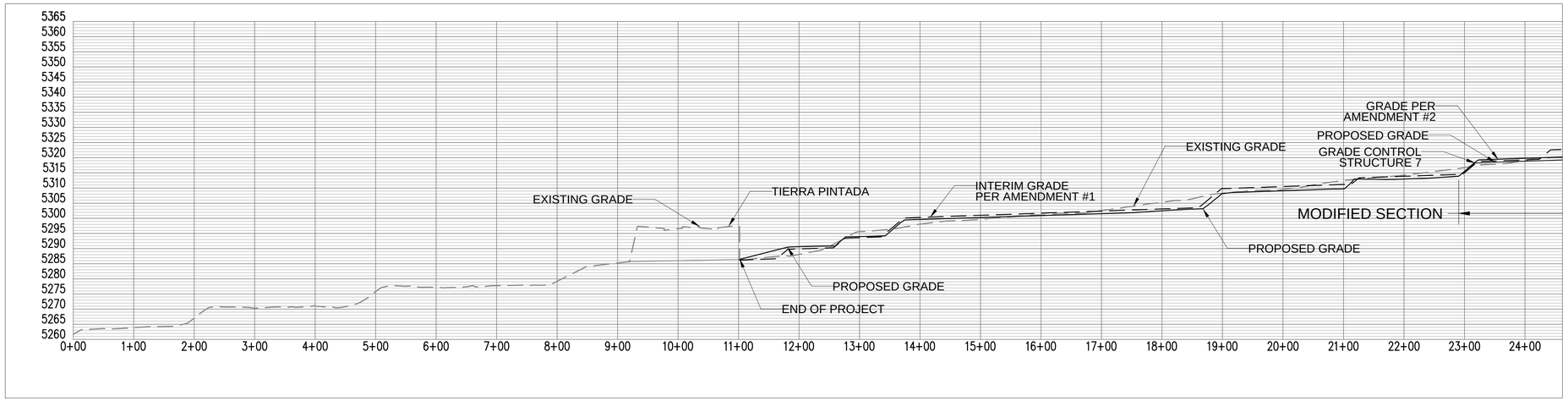
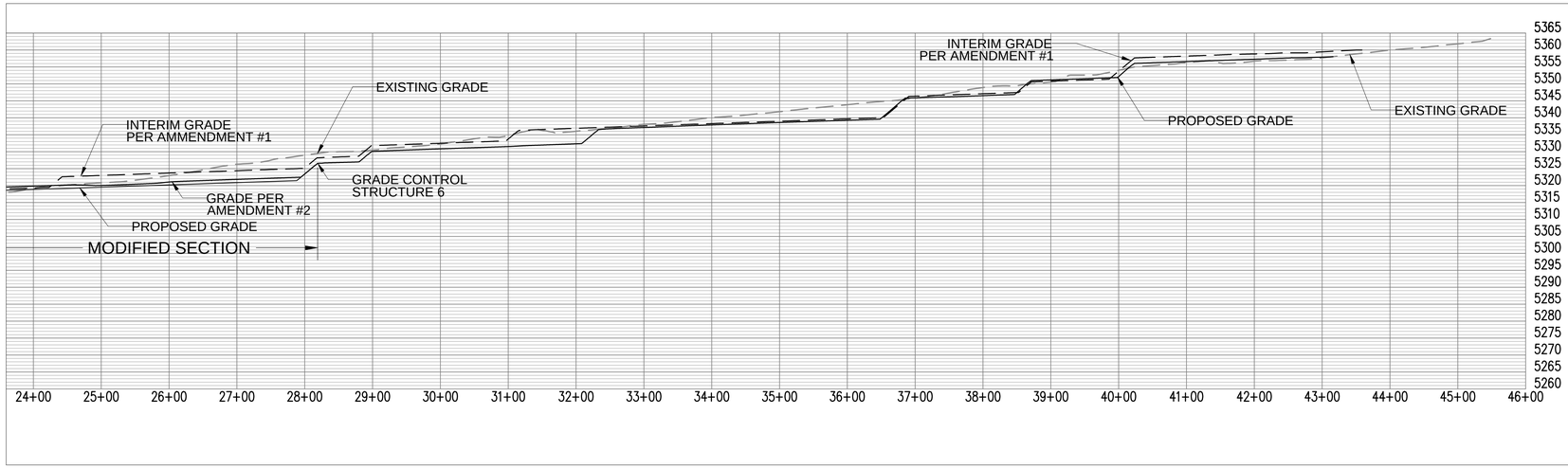
Bohannan Huston
www.bhinc.com 800.877.5332





HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=20'

MIREHAVEN ARROYO IMPROVEMENTS HEC-RAS PROFILE

07/2015

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HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev

Reach	River Sta	Profile	Plan	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	4535.000	100-yr Dev	10x6_CBC_Sub	1501.00	5362.56	5365.78	5365.78	5366.83	0.014414	8.22	182.79	90.07	1.01
Reach	4535.000	100-yr Dev	10x6_CBC_Mix	1501.00	5362.56	5365.55	5365.78	5366.87	0.020208	9.22	162.77	85.92	1.18
Reach	4460.000	100-yr Dev	10x6_CBC_Sub	1501.00	5360.96	5364.26	5364.26	5365.22	0.014831	7.84	191.39	102.18	1.01
Reach	4460.000	100-yr Dev	10x6_CBC_Mix	1501.00	5360.96	5363.99	5364.27	5365.29	0.022067	9.15	164.04	93.62	1.22
Reach	4410.000	100-yr Dev	10x6_CBC_Sub	1501.00	5359.97	5362.82	5362.82	5363.77	0.014749	7.82	191.87	102.41	1.01
Reach	4410.000	100-yr Dev	10x6_CBC_Mix	1501.00	5359.97	5362.37	5362.82	5363.97	0.030942	10.15	147.86	93.09	1.42
Reach	4360.000	100-yr Dev	10x6_CBC_Sub	1501.00	5358.95	5361.44	5361.44	5362.31	0.015285	7.51	199.97	116.73	1.01
Reach	4360.000	100-yr Dev	10x6_CBC_Mix	1501.00	5358.95	5361.13	5361.45	5362.42	0.027410	9.12	164.55	111.15	1.32
Reach	4310.000	100-yr Dev	10x6_CBC_Sub	1501.00	5357.99	5360.92		5361.30	0.006552	4.97	304.53	185.38	0.68
Reach	4310.000	100-yr Dev	10x6_CBC_Mix	1501.00	5357.99	5360.92	5360.49	5361.30	0.006552	4.97	304.53	185.38	0.68
Reach	4260.000	100-yr Dev	10x6_CBC_Sub	1501.00	5357.70	5360.82		5361.05	0.002675	3.82	389.19	173.73	0.44
Reach	4260.000	100-yr Dev	10x6_CBC_Mix	1501.00	5357.70	5360.82		5361.05	0.002675	3.82	389.19	173.73	0.44
Reach	4210.000	100-yr Dev	10x6_CBC_Sub	1501.00	5357.35	5360.80		5360.95	0.001563	3.22	484.88	199.48	0.35
Reach	4210.000	100-yr Dev	10x6_CBC_Mix	1501.00	5357.35	5360.80		5360.95	0.001563	3.22	484.88	199.48	0.35
Reach	4153.776	100-yr Dev	10x6_CBC_Sub	1501.00	5356.96	5360.59		5360.82	0.002184	3.85	389.64	143.48	0.41
Reach	4153.776	100-yr Dev	10x6_CBC_Mix	1501.00	5356.96	5360.59		5360.82	0.002184	3.85	389.64	143.48	0.41
Reach	4122.257	100-yr Dev	10x6_CBC_Sub	1501.00	5356.73	5360.44		5360.74	0.002717	4.39	341.65	121.55	0.46
Reach	4122.257	100-yr Dev	10x6_CBC_Mix	1501.00	5356.73	5360.44		5360.74	0.002717	4.39	341.65	121.55	0.46
Reach	4086.582	100-yr Dev	10x6_CBC_Sub	1501.00	5356.48	5360.19		5360.61	0.003824	5.24	286.67	101.03	0.55
Reach	4086.582	100-yr Dev	10x6_CBC_Mix	1501.00	5356.48	5360.19		5360.61	0.003824	5.24	286.67	101.03	0.55
Reach	4053.607	100-yr Dev	10x6_CBC_Sub	1501.00	5356.25	5359.93	5359.04	5360.46	0.004817	5.84	257.17	91.45	0.61
Reach	4053.607	100-yr Dev	10x6_CBC_Mix	1501.00	5356.25	5359.93	5359.04	5360.46	0.004817	5.84	257.17	91.45	0.61
Reach	4022.959	100-yr Dev	10x6_CBC_Sub	1501.00	5356.00	5358.92	5358.92	5360.17	0.012389	8.96	167.46	68.00	1.01
Reach	4022.959	100-yr Dev	10x6_CBC_Mix	1501.00	5356.00	5358.92	5358.92	5360.17	0.012389	8.96	167.46	68.00	1.01
Reach	4016.958	100-yr Dev	10x6_CBC_Sub	1501.00	5352.15	5356.54	5356.54	5357.74	0.003925	8.81	170.30	71.45	1.01
Reach	4016.958	100-yr Dev	10x6_CBC_Mix	1501.00	5352.15	5355.28	5356.53	5359.74	0.024302	16.95	88.58	55.01	2.35
Reach	3970.000	100-yr Dev	10x6_CBC_Sub	1501.00	5351.67	5355.12		5355.92	0.006079	7.21	208.22	69.51	0.73
Reach	3970.000	100-yr Dev	10x6_CBC_Mix	1501.00	5351.67	5353.34	5354.53	5357.69	0.095670	16.73	89.74	64.18	2.49
Reach	3920.000	100-yr Dev	10x6_CBC_Sub	1501.00	5351.32	5354.73	5354.24	5355.60	0.006777	7.45	201.48	69.41	0.77
Reach	3920.000	100-yr Dev	10x6_CBC_Mix	1501.00	5351.32	5354.73	5354.24	5355.60	0.006777	7.45	201.48	69.41	0.77
Reach	3871.282	100-yr Dev	10x6_CBC_Sub	1501.00	5350.98	5353.87	5353.87	5355.12	0.012652	8.97	167.29	67.84	1.01

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

Reach	River Sta	Profile	Plan	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	3871.282	100-yr Dev	10x6_CBC_Mix	1501.00	5350.98	5353.87	5353.87	5355.12	0.012652	8.97	167.29	67.84	1.01
Reach	3865.282	100-yr Dev	10x6_CBC_Sub	1501.00	5347.40	5351.57	5351.57	5352.78	0.003968	8.84	169.76	71.70	1.01
Reach	3865.282	100-yr Dev	10x6_CBC_Mix	1501.00	5347.40	5350.37	5351.59	5354.70	0.024188	16.72	89.80	56.96	2.35
Reach	3846.415	100-yr Dev	10x6_CBC_Sub	1501.00	5346.86	5350.03	5349.85	5351.10	0.002974	8.33	180.14	69.28	0.91
Reach	3846.415	100-yr Dev	10x6_CBC_Mix	1501.00	5346.86	5348.53	5349.85	5354.01	0.040172	18.78	79.94	64.76	2.98
Reach	3820.000	100-yr Dev	10x6_CBC_Sub	1501.00	5346.66	5350.04		5350.93	0.007045	7.54	199.10	69.32	0.78
Reach	3820.000	100-yr Dev	10x6_CBC_Mix	1501.00	5346.66	5348.57	5349.59	5352.06	0.067063	15.01	100.03	64.88	2.13
Reach	3770.000	100-yr Dev	10x6_CBC_Sub	1501.00	5346.31	5349.68		5350.57	0.007131	7.57	198.38	69.30	0.79
Reach	3770.000	100-yr Dev	10x6_CBC_Mix	1501.00	5346.31	5349.68	5349.23	5350.57	0.007131	7.57	198.38	69.30	0.79
Reach	3720.000	100-yr Dev	10x6_CBC_Sub	1501.00	5345.96	5349.25	5348.88	5350.19	0.007792	7.77	193.10	69.11	0.82
Reach	3720.000	100-yr Dev	10x6_CBC_Mix	1501.00	5345.96	5349.25	5348.88	5350.19	0.007792	7.77	193.10	69.11	0.82
Reach	3685.282	100-yr Dev	10x6_CBC_Sub	1501.00	5345.72	5348.58	5348.58	5349.83	0.011954	8.95	167.73	67.78	1.00
Reach	3685.282	100-yr Dev	10x6_CBC_Mix	1501.00	5345.72	5348.58	5348.58	5349.83	0.011954	8.95	167.73	67.78	1.00
Reach	3676.157	100-yr Dev	10x6_CBC_Sub	1501.00	5340.47	5345.27	5345.27	5346.47	0.004005	8.79	170.80	72.36	1.01
Reach	3676.157	100-yr Dev	10x6_CBC_Mix	1501.00	5340.47	5343.48	5345.27	5349.22	0.021802	19.24	78.03	35.76	2.29
Reach	3648.004	100-yr Dev	10x6_CBC_Sub	1501.00	5339.53	5342.97		5343.90	0.002293	7.76	193.43	67.85	0.81
Reach	3648.004	100-yr Dev	10x6_CBC_Mix	1501.00	5339.53	5341.07	5342.56	5348.15	0.058327	21.34	70.32	62.15	3.54
Reach	3620.000	100-yr Dev	10x6_CBC_Sub	1501.00	5339.30	5342.96		5343.77	0.005701	7.23	207.70	66.86	0.72
Reach	3620.000	100-yr Dev	10x6_CBC_Mix	1501.00	5339.30	5341.13	5342.31	5345.35	0.084467	16.48	91.09	61.12	2.38
Reach	3570.000	100-yr Dev	10x6_CBC_Sub	1501.00	5338.97	5342.09	5342.02	5343.34	0.011002	8.95	167.64	63.08	0.97
Reach	3570.000	100-yr Dev	10x6_CBC_Mix	1501.00	5338.97	5342.09	5342.03	5343.34	0.011002	8.95	167.64	63.08	0.97
Reach	3520.000	100-yr Dev	10x6_CBC_Sub	1501.00	5338.57	5341.50	5341.50	5342.76	0.012402	9.00	166.73	67.33	1.01
Reach	3520.000	100-yr Dev	10x6_CBC_Mix	1501.00	5338.57	5341.50	5341.50	5342.76	0.012402	9.00	166.73	67.33	1.01
Reach	3470.000	100-yr Dev	10x6_CBC_Sub	1501.00	5338.09	5341.26		5342.11	0.008454	7.36	203.91	80.57	0.82
Reach	3470.000	100-yr Dev	10x6_CBC_Mix	1501.00	5338.09	5341.26	5340.91	5342.11	0.008454	7.36	203.91	80.57	0.82
Reach	3420.000	100-yr Dev	10x6_CBC_Sub	1501.00	5337.61	5341.14		5341.70	0.004925	6.00	250.12	89.42	0.63
Reach	3420.000	100-yr Dev	10x6_CBC_Mix	1501.00	5337.61	5341.14		5341.70	0.004925	6.00	250.12	89.42	0.63
Reach	3370.000	100-yr Dev	10x6_CBC_Sub	1501.00	5337.25	5340.97		5341.46	0.003967	5.59	268.75	91.09	0.57
Reach	3370.000	100-yr Dev	10x6_CBC_Mix	1501.00	5337.25	5340.97		5341.46	0.003967	5.59	268.75	91.09	0.57
Reach	3320.000	100-yr Dev	10x6_CBC_Sub	1501.00	5337.01	5340.60		5341.22	0.005287	6.31	238.06	83.60	0.66
Reach	3320.000	100-yr Dev	10x6_CBC_Mix	1501.00	5337.01	5340.60		5341.22	0.005287	6.31	238.06	83.60	0.66

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

Reach	River Sta	Profile	Plan	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	3270.000	100-yr Dev	10x6_CBC_Sub	1501.00	5336.76	5340.14	5339.58	5340.92	0.006314	7.05	212.87	74.43	0.73
Reach	3270.000	100-yr Dev	10x6_CBC_Mix	1501.00	5336.76	5340.14	5339.58	5340.92	0.006314	7.05	212.87	74.43	0.73
Reach	3233.282	100-yr Dev	10x6_CBC_Sub	1501.00	5336.52	5339.34	5339.34	5340.56	0.012449	8.84	169.74	70.56	1.00
Reach	3233.282	100-yr Dev	10x6_CBC_Mix	1501.00	5336.52	5339.34	5339.34	5340.56	0.012449	8.84	169.74	70.56	1.00
Reach	3227.282	100-yr Dev	10x6_CBC_Sub	1501.00	5333.06	5337.05	5337.05	5338.24	0.003967	8.74	171.80	74.20	1.01
Reach	3227.282	100-yr Dev	10x6_CBC_Mix	1501.00	5333.06	5335.86	5337.05	5340.14	0.024717	16.61	90.38	59.14	2.37
Reach	3208.590	100-yr Dev	10x6_CBC_Sub	1501.00	5332.38	5335.37	5335.26	5336.48	0.003230	8.45	177.69	71.39	0.94
Reach	3208.590	100-yr Dev	10x6_CBC_Mix	1501.00	5332.38	5333.96	5335.27	5339.43	0.041988	18.77	79.98	67.15	3.03
Reach	3170.000	100-yr Dev	10x6_CBC_Sub	1501.00	5332.04	5335.39	5334.90	5336.22	0.006790	7.32	204.93	72.15	0.77
Reach	3170.000	100-yr Dev	10x6_CBC_Mix	1501.00	5332.04	5334.06	5334.90	5336.87	0.049863	13.46	111.49	68.15	1.86
Reach	3120.000	100-yr Dev	10x6_CBC_Sub	1501.00	5331.68	5334.52	5334.52	5335.73	0.012670	8.83	169.92	71.26	1.01
Reach	3120.000	100-yr Dev	10x6_CBC_Mix	1501.00	5331.68	5334.52	5334.53	5335.73	0.012670	8.83	169.92	71.26	1.01
Reach	3070.000	100-yr Dev	10x6_CBC_Sub	1501.00	5331.16	5334.17		5334.89	0.007282	6.84	219.52	88.31	0.76
Reach	3070.000	100-yr Dev	10x6_CBC_Mix	1501.00	5331.16	5334.17	5333.73	5334.89	0.007282	6.84	219.52	88.31	0.76
Reach	3020.000	100-yr Dev	10x6_CBC_Sub	1501.00	5330.72	5334.07		5334.55	0.004146	5.55	270.62	97.71	0.59
Reach	3020.000	100-yr Dev	10x6_CBC_Mix	1501.00	5330.72	5334.07		5334.55	0.004146	5.55	270.62	97.71	0.59
Reach	2970.000	100-yr Dev	10x6_CBC_Sub	1501.00	5330.39	5333.91		5334.35	0.003466	5.28	284.03	96.76	0.54
Reach	2970.000	100-yr Dev	10x6_CBC_Mix	1501.00	5330.39	5333.91		5334.35	0.003466	5.28	284.03	96.76	0.54
Reach	2920.000	100-yr Dev	10x6_CBC_Sub	1501.00	5330.17	5333.42	5332.82	5334.10	0.005912	6.60	227.55	83.37	0.70
Reach	2920.000	100-yr Dev	10x6_CBC_Mix	1501.00	5330.17	5333.42	5332.82	5334.10	0.005912	6.60	227.55	83.37	0.70
Reach	2898.282	100-yr Dev	10x6_CBC_Sub	1501.00	5329.98	5332.70	5332.70	5333.87	0.012857	8.70	172.61	74.50	1.01
Reach	2898.282	100-yr Dev	10x6_CBC_Mix	1501.00	5329.98	5332.70	5332.70	5333.87	0.012857	8.70	172.61	74.50	1.01
Reach	2894.282	100-yr Dev	10x6_CBC_Sub	1501.00	5327.85	5331.13	5331.13	5332.29	0.003880	8.63	173.96	76.71	1.01
Reach	2894.282	100-yr Dev	10x6_CBC_Mix	1501.00	5327.85	5330.17	5331.15	5333.58	0.022256	14.82	101.30	74.06	2.23
Reach	2880.837	100-yr Dev	10x6_CBC_Sub	1501.00	5327.08	5330.02	5329.89	5331.08	0.003126	8.25	182.05	74.08	0.93
Reach	2880.837	100-yr Dev	10x6_CBC_Mix	1501.00	5327.08	5328.74	5329.89	5333.13	0.030904	16.81	89.28	70.22	2.63
Reach	2855.037	100-yr Dev	10x6_CBC_Sub	1501.00	5326.82	5330.00	5329.65	5330.91	0.008069	7.67	195.70	72.82	0.82
Reach	2855.037	100-yr Dev	10x6_CBC_Mix	1501.00	5326.82	5328.81	5329.66	5331.65	0.051731	13.52	111.03	69.25	1.88
Reach	2818.282	100-yr Dev	10x6_CBC_Sub	1501.00	5326.44	5329.29	5329.29	5330.52	0.012528	8.89	168.91	69.90	1.01
Reach	2818.282	100-yr Dev	10x6_CBC_Mix	1501.00	5326.44	5329.29	5329.30	5330.52	0.012528	8.89	168.91	69.90	1.01

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

Reach	River Sta	Profile	Plan	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	2813.282	100-yr Dev	10x6_CBC_Sub	1501.00	5322.02	5326.78	5326.78	5327.98	0.003996	8.79	170.74	71.93	1.01
Reach	2813.282	100-yr Dev	10x6_CBC_Mix	1501.00	5322.02	5325.22	5326.78	5330.09	0.016975	17.70	84.80	36.24	2.04
Reach	2794.821	100-yr Dev	10x6_CBC_Sub	1501.00	5321.52	5324.91	5324.67	5325.95	0.002785	8.18	183.55	67.82	0.88
Reach	2794.821	100-yr Dev	10x6_CBC_Mix	1501.00	5321.52	5323.24	5324.66	5329.47	0.045432	20.02	74.97	59.56	3.15
Reach	2770.000	100-yr Dev	10x6_CBC_Sub	1501.00	5321.25	5325.08		5325.76	0.004501	6.61	227.23	69.66	0.64
Reach	2770.000	100-yr Dev	10x6_CBC_Mix	1501.00	5321.25	5323.02	5324.19	5327.33	0.092944	16.67	90.04	63.47	2.47
Reach	2720.000	100-yr Dev	10x6_CBC_Sub	1501.00	5320.79	5325.12		5325.52	0.002215	5.02	299.17	81.18	0.46
Reach	2720.000	100-yr Dev	10x6_CBC_Mix	1501.00	5320.79	5325.12	5323.54	5325.52	0.002215	5.02	299.17	81.18	0.46
Reach	2670.000	100-yr Dev	10x6_CBC_Sub	1501.00	5320.35	5325.14		5325.39	0.001252	4.03	372.77	91.51	0.35
Reach	2670.000	100-yr Dev	10x6_CBC_Mix	1501.00	5320.35	5325.14		5325.39	0.001252	4.03	372.77	91.51	0.35
Reach	2620.000	100-yr Dev	10x6_CBC_Sub	1501.00	5319.93	5325.14		5325.32	0.000789	3.42	439.50	111.69	0.28
Reach	2620.000	100-yr Dev	10x6_CBC_Mix	1501.00	5319.93	5325.14		5325.32	0.000789	3.42	439.50	111.69	0.28
Reach	2570.000	100-yr Dev	10x6_CBC_Sub	1501.00	5319.36	5325.14		5325.27	0.000594	2.87	523.54	116.97	0.24
Reach	2570.000	100-yr Dev	10x6_CBC_Mix	1501.00	5319.36	5325.14		5325.27	0.000594	2.87	523.54	116.97	0.24
Reach	2520.000	100-yr Dev	10x6_CBC_Sub	1501.00	5319.22	5325.12		5325.24	0.000556	2.84	528.92	114.55	0.23
Reach	2520.000	100-yr Dev	10x6_CBC_Mix	1501.00	5319.22	5325.12		5325.24	0.000556	2.84	528.92	114.55	0.23
Reach	2470.000	100-yr Dev	10x6_CBC_Sub	1501.00	5319.21	5324.88		5325.18	0.001261	4.39	342.15	74.71	0.36
Reach	2470.000	100-yr Dev	10x6_CBC_Mix	1501.00	5319.21	5324.88		5325.18	0.001261	4.39	342.15	74.71	0.36
Reach	2420.000	100-yr Dev	10x6_CBC_Sub	1501.00	5318.97	5324.63		5325.09	0.001711	5.47	274.43	58.60	0.45
Reach	2420.000	100-yr Dev	10x6_CBC_Mix	1501.00	5318.97	5324.63		5325.09	0.001711	5.47	274.43	58.60	0.45
Reach	2387.282	100-yr Dev	10x6_CBC_Sub	1501.00	5318.80	5324.62		5325.03	0.001374	5.13	292.45	59.25	0.41
Reach	2387.282	100-yr Dev	10x6_CBC_Mix	1501.00	5318.80	5324.62		5325.03	0.001374	5.13	292.45	59.25	0.41
Reach	2377.282	100-yr Dev	10x6_CBC_Sub	1501.00	5318.75	5324.35	5322.19	5324.98	0.004231	6.39	235.02	56.30	0.48
Reach	2377.282	100-yr Dev	10x6_CBC_Mix	1501.00	5318.75	5324.35	5322.19	5324.98	0.004231	6.39	235.02	56.30	0.48
Reach	2373.282			Culvert									
Reach	2317.389	100-yr Dev	10x6_CBC_Sub	1501.00	5318.44	5321.87	5321.87	5323.56	0.014193	10.41	144.23	52.30	0.99
Reach	2317.389	100-yr Dev	10x6_CBC_Mix	1501.00	5318.44	5321.61	5321.87	5323.58	0.018187	11.26	133.32	51.52	1.11
Reach	2313.389	100-yr Dev	10x6_CBC_Sub	1501.00	5318.17	5321.59	5321.59	5323.08	0.011041	9.79	153.29	52.06	1.01
Reach	2313.389	100-yr Dev	10x6_CBC_Mix	1501.00	5318.17	5320.88	5321.59	5323.43	0.026420	12.82	117.04	49.93	1.48
Reach	2305.282	100-yr Dev	10x6_CBC_Sub	1501.00	5314.68	5319.89	5319.89	5321.21	0.004125	9.23	162.70	62.23	1.01
Reach	2305.282	100-yr Dev	10x6_CBC_Mix	1501.00	5314.68	5318.66	5319.89	5323.05	0.023785	16.81	89.30	53.60	2.30

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

Reach	River Sta	Profile	Plan	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	2275.493	100-yr Dev	10x6_CBC_Sub	1501.00	5313.89	5316.79	5316.79	5317.95	0.004810	8.63	173.99	76.18	1.01
Reach	2275.493	100-yr Dev	10x6_CBC_Mix	1501.00	5313.89	5315.43	5316.80	5321.76	0.064635	20.18	74.38	69.16	3.43
Reach	2220.000	100-yr Dev	10x6_CBC_Sub	1501.00	5313.10	5316.63		5317.10	0.004127	5.48	273.92	98.02	0.58
Reach	2220.000	100-yr Dev	10x6_CBC_Mix	1501.00	5313.10	5316.63	5315.70	5317.10	0.004127	5.48	273.92	98.02	0.58
Reach	2170.000	100-yr Dev	10x6_CBC_Sub	1501.00	5312.78	5316.46		5316.89	0.003590	5.26	285.40	97.98	0.54
Reach	2170.000	100-yr Dev	10x6_CBC_Mix	1501.00	5312.78	5316.46		5316.89	0.003590	5.26	285.40	97.98	0.54
Reach	2120.282	100-yr Dev	10x6_CBC_Sub	1501.00	5312.68	5315.36	5315.36	5316.52	0.012212	8.66	173.38	75.07	1.00
Reach	2120.282	100-yr Dev	10x6_CBC_Mix	1501.00	5312.68	5315.36	5315.36	5316.52	0.012212	8.66	173.38	75.07	1.00
Reach	2115.282	100-yr Dev	10x6_CBC_Sub	1501.00	5309.96	5313.51	5313.51	5314.64	0.003866	8.55	175.46	77.58	1.00
Reach	2115.282	100-yr Dev	10x6_CBC_Mix	1501.00	5309.96	5312.44	5313.49	5316.18	0.022431	15.52	96.70	65.76	2.26
Reach	2101.362	100-yr Dev	10x6_CBC_Sub	1501.00	5309.51	5312.33	5312.33	5313.49	0.003776	8.65	173.44	75.80	1.01
Reach	2101.362	100-yr Dev	10x6_CBC_Mix	1501.00	5309.51	5311.17	5312.33	5315.72	0.034000	17.11	87.74	72.31	2.74
Reach	2070.000	100-yr Dev	10x6_CBC_Sub	1501.00	5309.22	5312.23		5313.09	0.009056	7.44	201.86	82.87	0.84
Reach	2070.000	100-yr Dev	10x6_CBC_Mix	1501.00	5309.22	5311.15	5311.94	5313.81	0.055464	13.09	114.63	77.31	1.90
Reach	2020.000	100-yr Dev	10x6_CBC_Sub	1501.00	5308.70	5312.14		5312.67	0.004844	5.83	257.29	94.55	0.62
Reach	2020.000	100-yr Dev	10x6_CBC_Mix	1501.00	5308.70	5312.14	5311.34	5312.67	0.004844	5.83	257.29	94.55	0.62
Reach	1970.000	100-yr Dev	10x6_CBC_Sub	1501.00	5308.42	5311.91		5312.43	0.004694	5.82	258.12	93.22	0.62
Reach	1970.000	100-yr Dev	10x6_CBC_Mix	1501.00	5308.42	5311.91		5312.43	0.004694	5.82	258.12	93.22	0.62
Reach	1920.000	100-yr Dev	10x6_CBC_Sub	1501.00	5308.20	5311.11	5310.91	5312.06	0.009658	7.81	192.11	79.22	0.88
Reach	1920.000	100-yr Dev	10x6_CBC_Mix	1501.00	5308.20	5311.11	5310.91	5312.06	0.009658	7.81	192.11	79.22	0.88
Reach	1898.282	100-yr Dev	10x6_CBC_Sub	1501.00	5307.96	5310.65	5310.65	5311.81	0.012909	8.64	173.75	75.91	1.01
Reach	1898.282	100-yr Dev	10x6_CBC_Mix	1501.00	5307.96	5310.65	5310.65	5311.81	0.012909	8.64	173.75	75.91	1.01
Reach	1891.051	100-yr Dev	10x6_CBC_Sub	1501.00	5303.74	5307.69	5307.69	5308.83	0.003968	8.55	175.59	78.43	1.01
Reach	1891.051	100-yr Dev	10x6_CBC_Mix	1501.00	5303.74	5306.14	5307.69	5311.29	0.022647	18.21	82.43	43.64	2.33
Reach	1868.360	100-yr Dev	10x6_CBC_Sub	1501.00	5303.00	5305.73	5305.73	5306.89	0.003756	8.64	173.69	75.77	1.01
Reach	1868.360	100-yr Dev	10x6_CBC_Mix	1501.00	5303.00	5304.41	5305.72	5310.44	0.053899	19.71	76.15	71.80	3.37
Reach	1820.000	100-yr Dev	10x6_CBC_Sub	1501.00	5302.50	5305.19	5305.19	5306.32	0.013091	8.52	176.19	79.12	1.01
Reach	1820.000	100-yr Dev	10x6_CBC_Mix	1501.00	5302.50	5304.46	5305.19	5306.93	0.047592	12.61	119.01	76.93	1.79
Reach	1770.000	100-yr Dev	10x6_CBC_Sub	1501.00	5302.03	5304.57	5304.57	5305.60	0.013595	8.16	183.89	90.02	1.01
Reach	1770.000	100-yr Dev	10x6_CBC_Mix	1501.00	5302.03	5304.57	5304.57	5305.60	0.013595	8.16	183.89	90.02	1.01

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

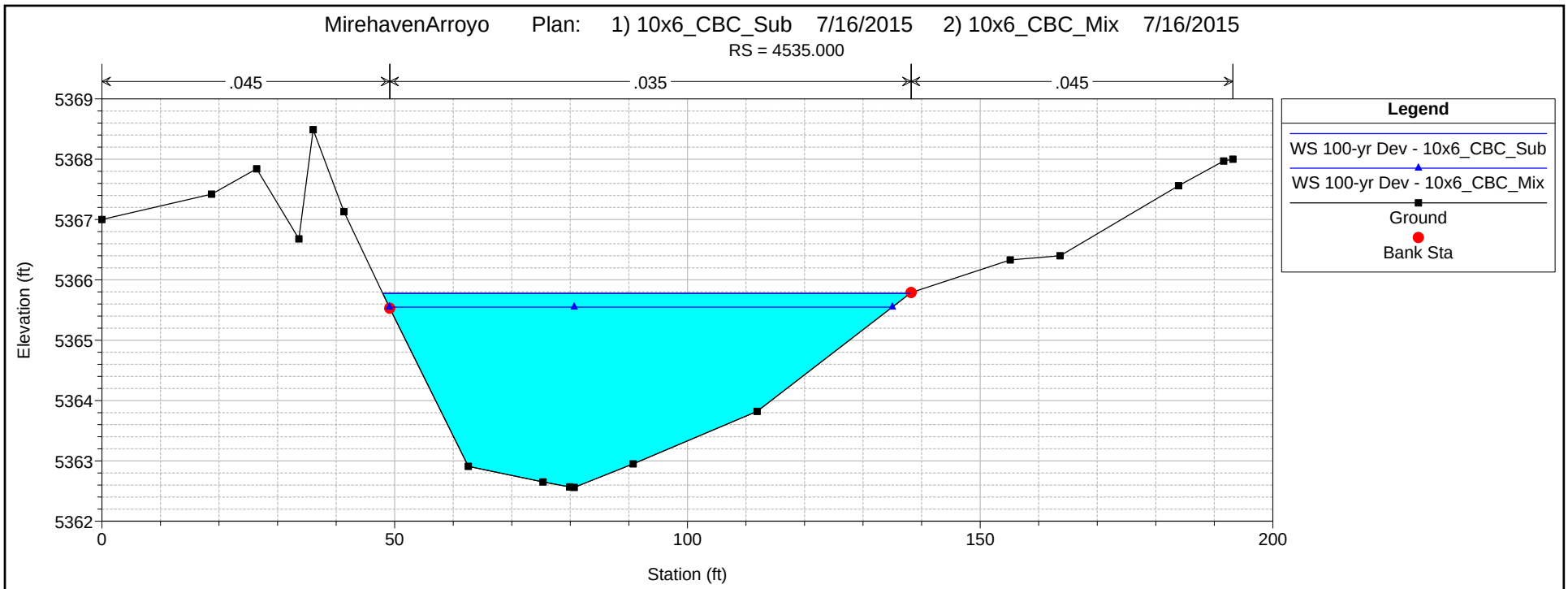
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	1720.000	100-yr Dev	10x6_CBC_Sub	1501.00	5301.50	5304.22		5304.91	0.009037	6.65	225.67	107.97	0.81
Reach	1720.000	100-yr Dev	10x6_CBC_Mix	1501.00	5301.50	5304.22	5303.93	5304.91	0.009037	6.65	225.67	107.97	0.81
Reach	1670.000	100-yr Dev	10x6_CBC_Sub	1501.00	5300.95	5304.12		5304.52	0.004327	5.09	295.17	121.50	0.57
Reach	1670.000	100-yr Dev	10x6_CBC_Mix	1501.00	5300.95	5304.12		5304.52	0.004327	5.09	295.17	121.50	0.57
Reach	1620.000	100-yr Dev	10x6_CBC_Sub	1501.00	5300.52	5304.05		5304.32	0.002498	4.18	359.03	131.39	0.45
Reach	1620.000	100-yr Dev	10x6_CBC_Mix	1501.00	5300.52	5304.05		5304.32	0.002498	4.18	359.03	131.39	0.45
Reach	1570.000	100-yr Dev	10x6_CBC_Sub	1501.00	5300.17	5303.97		5304.20	0.001862	3.82	393.16	132.47	0.39
Reach	1570.000	100-yr Dev	10x6_CBC_Mix	1501.00	5300.17	5303.97		5304.20	0.001862	3.82	393.16	132.47	0.39
Reach	1520.000	100-yr Dev	10x6_CBC_Sub	1501.00	5299.92	5303.87		5304.11	0.001804	3.88	386.64	124.36	0.39
Reach	1520.000	100-yr Dev	10x6_CBC_Mix	1501.00	5299.92	5303.87		5304.11	0.001804	3.88	386.64	124.36	0.39
Reach	1470.000	100-yr Dev	10x6_CBC_Sub	1501.00	5299.78	5303.68		5303.99	0.002440	4.50	333.35	108.06	0.45
Reach	1470.000	100-yr Dev	10x6_CBC_Mix	1501.00	5299.78	5303.68		5303.99	0.002440	4.50	333.35	108.06	0.45
Reach	1420.000	100-yr Dev	10x6_CBC_Sub	1501.00	5299.71	5303.16		5303.79	0.005041	6.40	234.56	80.51	0.66
Reach	1420.000	100-yr Dev	10x6_CBC_Mix	1501.00	5299.71	5303.16		5303.79	0.005041	6.40	234.56	80.51	0.66
Reach	1378.282	100-yr Dev	10x6_CBC_Sub	1501.00	5299.47	5302.23	5302.23	5303.42	0.012646	8.74	171.66	72.74	1.00
Reach	1378.282	100-yr Dev	10x6_CBC_Mix	1501.00	5299.47	5302.23	5302.23	5303.42	0.012646	8.74	171.66	72.74	1.00
Reach	1373.282	100-yr Dev	10x6_CBC_Sub	1501.00	5299.32	5302.13	5302.13	5303.32	0.012743	8.76	171.25	72.82	1.01
Reach	1373.282	100-yr Dev	10x6_CBC_Mix	1501.00	5299.32	5301.99	5302.13	5303.34	0.015675	9.34	160.76	72.38	1.10
Reach	1365.281	100-yr Dev	10x6_CBC_Sub	1501.00	5294.78	5299.04	5299.04	5300.21	0.003977	8.65	173.60	75.90	1.01
Reach	1365.281	100-yr Dev	10x6_CBC_Mix	1501.00	5294.78	5297.40	5299.05	5302.79	0.022345	18.63	80.57	40.41	2.33
Reach	1342.651	100-yr Dev	10x6_CBC_Sub	1501.00	5294.24	5297.57		5298.41	0.002146	7.35	204.29	74.40	0.78
Reach	1342.651	100-yr Dev	10x6_CBC_Mix	1501.00	5294.24	5295.77	5297.13	5301.96	0.053355	19.96	75.19	68.97	3.37
Reach	1320.000	100-yr Dev	10x6_CBC_Sub	1501.00	5294.07	5297.60		5298.30	0.005331	6.73	223.12	74.71	0.69
Reach	1320.000	100-yr Dev	10x6_CBC_Mix	1501.00	5294.07	5295.80	5296.88	5299.75	0.090125	15.94	94.18	69.19	2.41
Reach	1280.283	100-yr Dev	10x6_CBC_Sub	1501.00	5293.62	5296.65	5296.65	5297.94	0.012073	9.11	164.74	64.28	1.00
Reach	1280.283	100-yr Dev	10x6_CBC_Mix	1501.00	5293.62	5296.62	5296.64	5297.94	0.012455	9.20	163.17	64.21	1.02
Reach	1275.282	100-yr Dev	10x6_CBC_Sub	1501.00	5293.45	5296.52	5296.52	5297.84	0.012025	9.22	162.73	62.38	1.01
Reach	1275.282	100-yr Dev	10x6_CBC_Mix	1501.00	5293.45	5296.38	5296.52	5297.85	0.014349	9.74	154.13	61.98	1.09
Reach	1270.281	100-yr Dev	10x6_CBC_Sub	1501.00	5290.98	5296.71		5297.17	0.000736	5.44	275.81	67.60	0.47
Reach	1270.281	100-yr Dev	10x6_CBC_Mix	1501.00	5290.98	5296.71	5294.98	5297.17	0.000736	5.44	275.81	67.60	0.47
Reach	1260.172	100-yr Dev	10x6_CBC_Sub	1501.00	5290.84	5296.77		5297.14	0.000449	4.83	310.59	63.41	0.38

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

Reach	River Sta	Profile	Plan	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	1260.172	100-yr Dev	10x6_CBC_Mix	1501.00	5290.84	5296.77		5297.14	0.000449	4.83	310.59	63.41	0.38
Reach	1220.000	100-yr Dev	10x6_CBC_Sub	1501.00	5290.74	5295.96		5297.02	0.004219	8.26	181.62	43.31	0.71
Reach	1220.000	100-yr Dev	10x6_CBC_Mix	1501.00	5290.74	5295.96		5297.02	0.004219	8.26	181.62	43.31	0.71
Reach	1181.535	100-yr Dev	10x6_CBC_Sub	1501.00	5290.50	5295.70		5296.91	0.001901	8.84	169.84	41.15	0.77
Reach	1181.535	100-yr Dev	10x6_CBC_Mix	1501.00	5290.50	5295.70		5296.91	0.001901	8.84	169.84	41.15	0.77
Reach	1170.000	100-yr Dev	10x6_CBC_Sub	1501.00	5289.91	5295.98		5296.76	0.001017	7.08	212.05	60.43	0.57
Reach	1170.000	100-yr Dev	10x6_CBC_Mix	1501.00	5289.91	5295.98		5296.76	0.001017	7.08	212.05	60.43	0.57
Reach	1120.000	100-yr Dev	10x6_CBC_Sub	1501.00	5287.37	5296.36	5291.23	5296.58	0.000152	3.76	399.05	82.90	0.24
Reach	1120.000	100-yr Dev	10x6_CBC_Mix	1501.00	5287.37	5296.36	5291.23	5296.58	0.000152	3.76	399.05	82.90	0.24
Reach	1106.630	100-yr Dev	10x6_CBC_Sub	1501.00	5286.68	5296.36	5290.52	5296.57	0.000134	3.74	401.39	77.99	0.23
Reach	1106.630	100-yr Dev	10x6_CBC_Mix	1501.00	5286.68	5296.36	5290.52	5296.57	0.000134	3.74	401.39	77.99	0.23
Reach	1003.396			Culvert									
Reach	899.1468	100-yr Dev	10x6_CBC_Sub	1501.00	5285.21	5288.84	5288.84	5290.35	0.015159	10.82	155.82	50.37	1.09
Reach	899.1468	100-yr Dev	10x6_CBC_Mix	1501.00	5285.21	5288.84	5288.84	5290.35	0.015159	10.82	155.82	50.37	1.09
Reach	847.1920	100-yr Dev	10x6_CBC_Sub	1501.00	5283.90	5286.96	5286.96	5288.35	0.013326	9.43	159.20	58.22	1.00
Reach	847.1920	100-yr Dev	10x6_CBC_Mix	1501.00	5283.90	5286.18	5286.97	5288.84	0.036586	13.08	114.78	55.09	1.60
Reach	772.1919	100-yr Dev	10x6_CBC_Sub	1501.00	5277.59	5281.67		5282.41	0.005619	6.92	216.98	66.17	0.67
Reach	772.1919	100-yr Dev	10x6_CBC_Mix	1501.00	5277.59	5279.57	5280.83	5284.12	0.092833	17.13	87.62	56.87	2.43
Reach	699.9867	100-yr Dev	10x6_CBC_Sub	1501.00	5277.41	5281.31		5281.98	0.005826	6.54	229.68	79.08	0.68
Reach	699.9867	100-yr Dev	10x6_CBC_Mix	1501.00	5277.41	5281.31	5280.56	5281.98	0.005826	6.54	229.68	79.08	0.68
Reach	599.9421	100-yr Dev	10x6_CBC_Sub	1501.00	5277.00	5280.09	5279.95	5281.14	0.011538	8.22	182.53	74.53	0.93
Reach	599.9421	100-yr Dev	10x6_CBC_Mix	1501.00	5277.00	5280.09	5279.95	5281.14	0.011538	8.22	182.53	74.53	0.93
Reach	500.0074	100-yr Dev	10x6_CBC_Sub	1501.00	5275.50	5278.69	5278.69	5279.87	0.013886	8.69	172.73	74.74	1.01
Reach	500.0074	100-yr Dev	10x6_CBC_Mix	1501.00	5275.50	5278.69	5278.69	5279.87	0.013886	8.69	172.73	74.74	1.01
Reach	400.0000	100-yr Dev	10x6_CBC_Sub	1501.00	5270.51	5274.77		5275.45	0.005687	6.61	227.06	75.45	0.67
Reach	400.0000	100-yr Dev	10x6_CBC_Mix	1501.00	5270.51	5272.87	5273.99	5276.78	0.083879	15.87	94.59	64.04	2.30
Reach	300.0000	100-yr Dev	10x6_CBC_Sub	1501.00	5270.27	5273.42	5273.42	5274.56	0.013782	8.56	175.43	77.41	1.00
Reach	300.0000	100-yr Dev	10x6_CBC_Mix	1501.00	5270.27	5273.42	5273.42	5274.56	0.013835	8.57	175.20	77.38	1.00
Reach	200.0000	100-yr Dev	10x6_CBC_Sub	1501.00	5266.92	5270.21	5270.21	5271.49	0.013423	9.07	165.40	65.26	1.00
Reach	200.0000	100-yr Dev	10x6_CBC_Mix	1501.00	5266.92	5269.36	5270.21	5272.13	0.043324	13.36	112.36	59.97	1.72

HEC-RAS River: Stream Reach: Reach Profile: 100-yr Dev (Continued)

Reach	River Sta	Profile	Plan	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	100.0000	100-yr Dev	10x6_CBC_Sub	1501.00	5263.85	5266.83	5266.83	5268.11	0.013497	9.08	165.38	65.38	1.01
Reach	100.0000	100-yr Dev	10x6_CBC_Mix	1501.00	5263.85	5266.24	5266.83	5268.39	0.029736	11.75	127.72	62.12	1.44
Reach	0.0000	100-yr Dev	10x6_CBC_Sub	1501.00	5261.62	5265.09	5265.09	5266.41	0.013329	9.22	162.86	62.30	1.00
Reach	0.0000	100-yr Dev	10x6_CBC_Mix	1501.00	5261.62	5265.08	5265.08	5266.41	0.013374	9.23	162.68	62.28	1.01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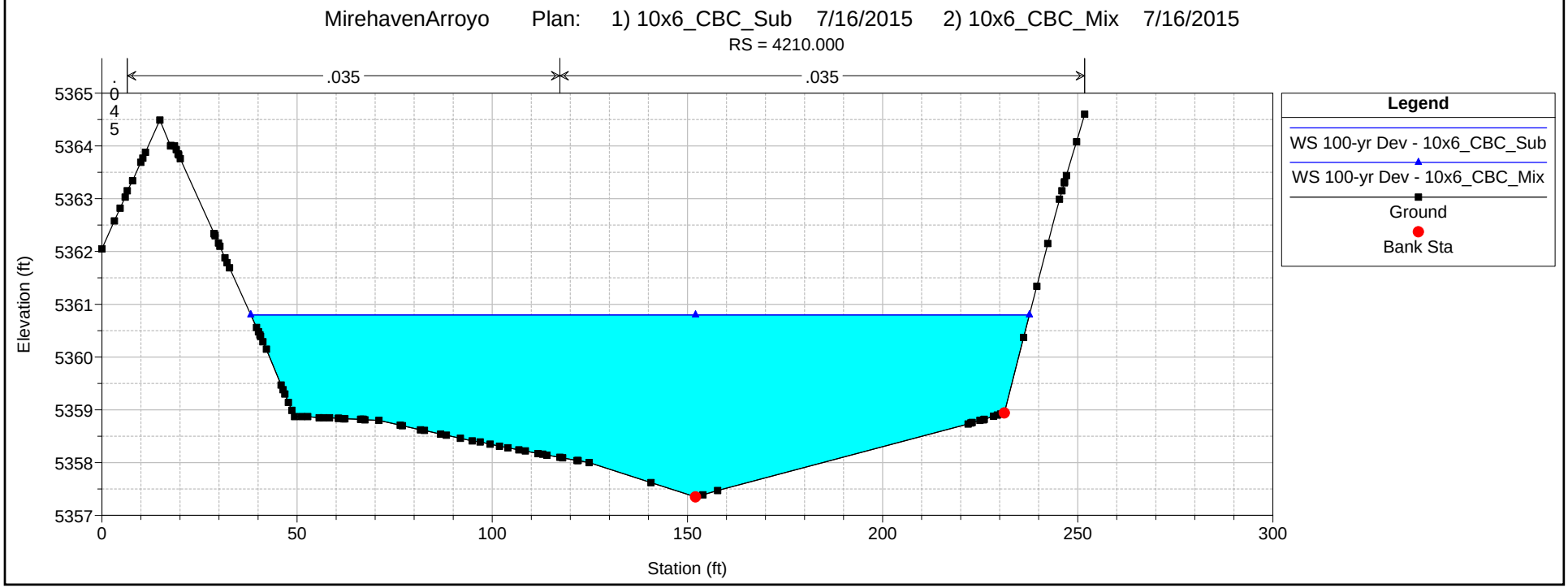
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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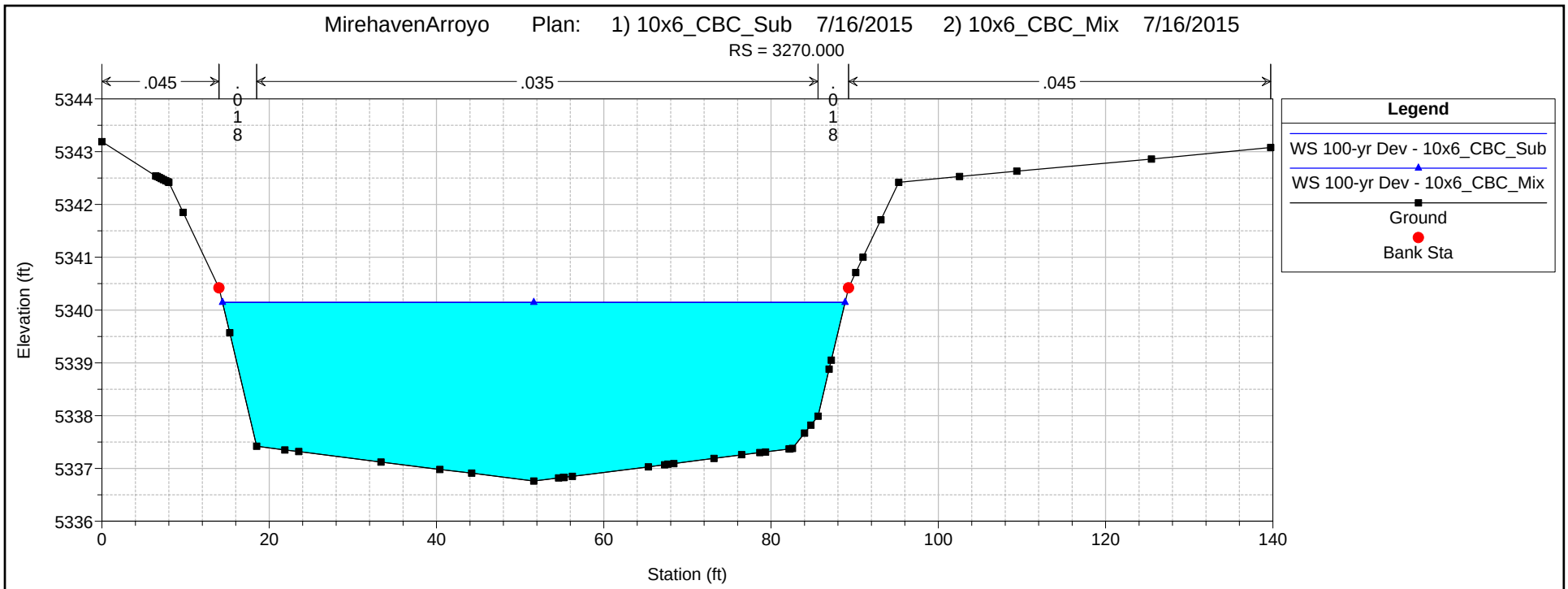
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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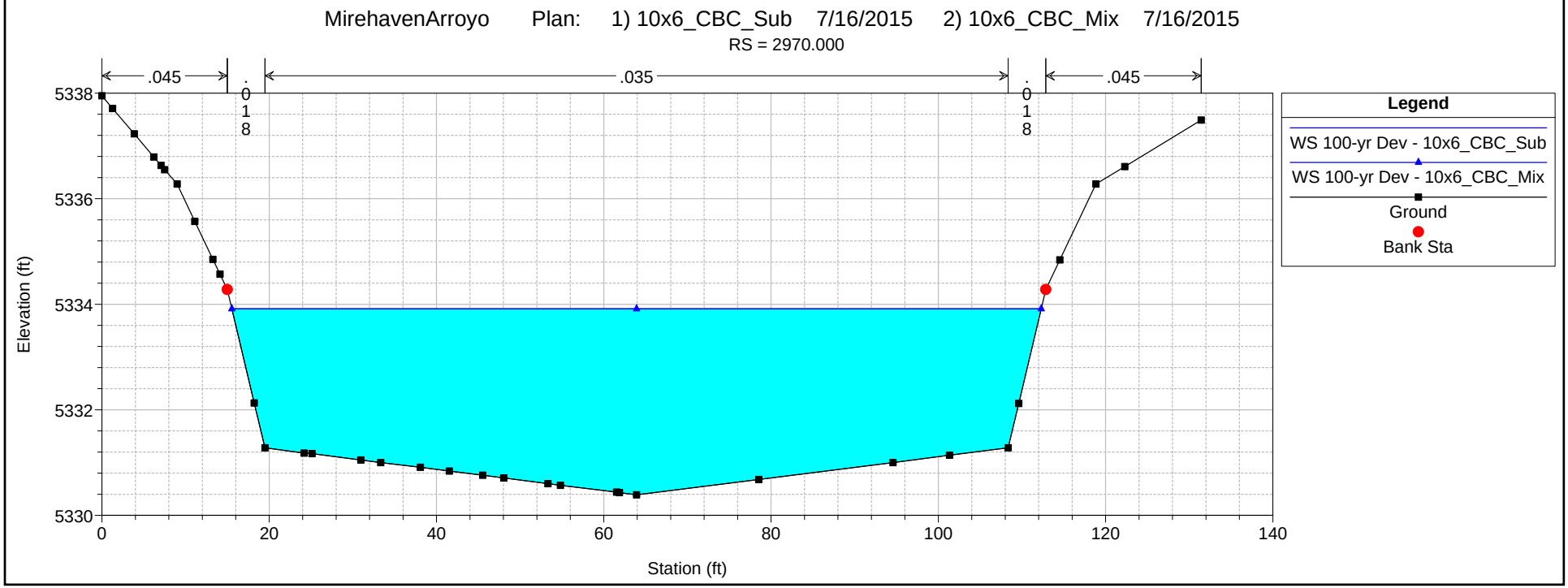
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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.018
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Elevation (ft)
Station (ft)
Legend
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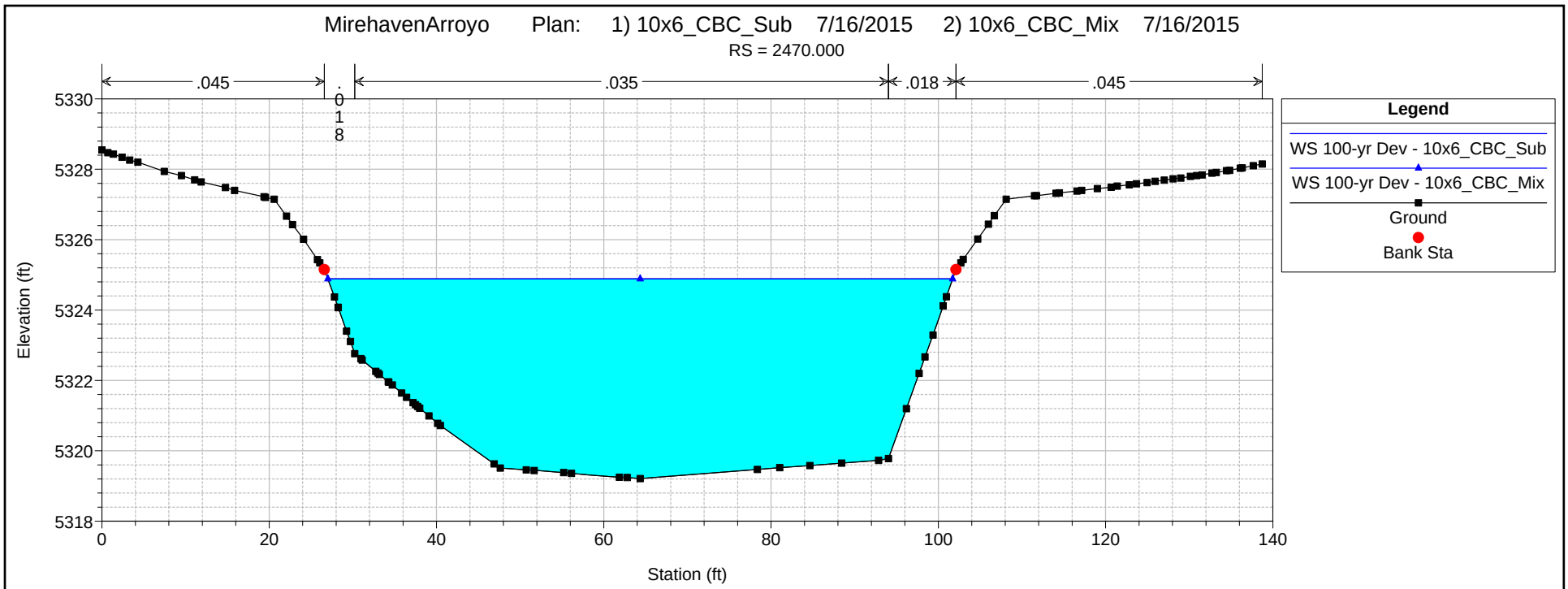
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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RS = 2470.000
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.018
.035
.018
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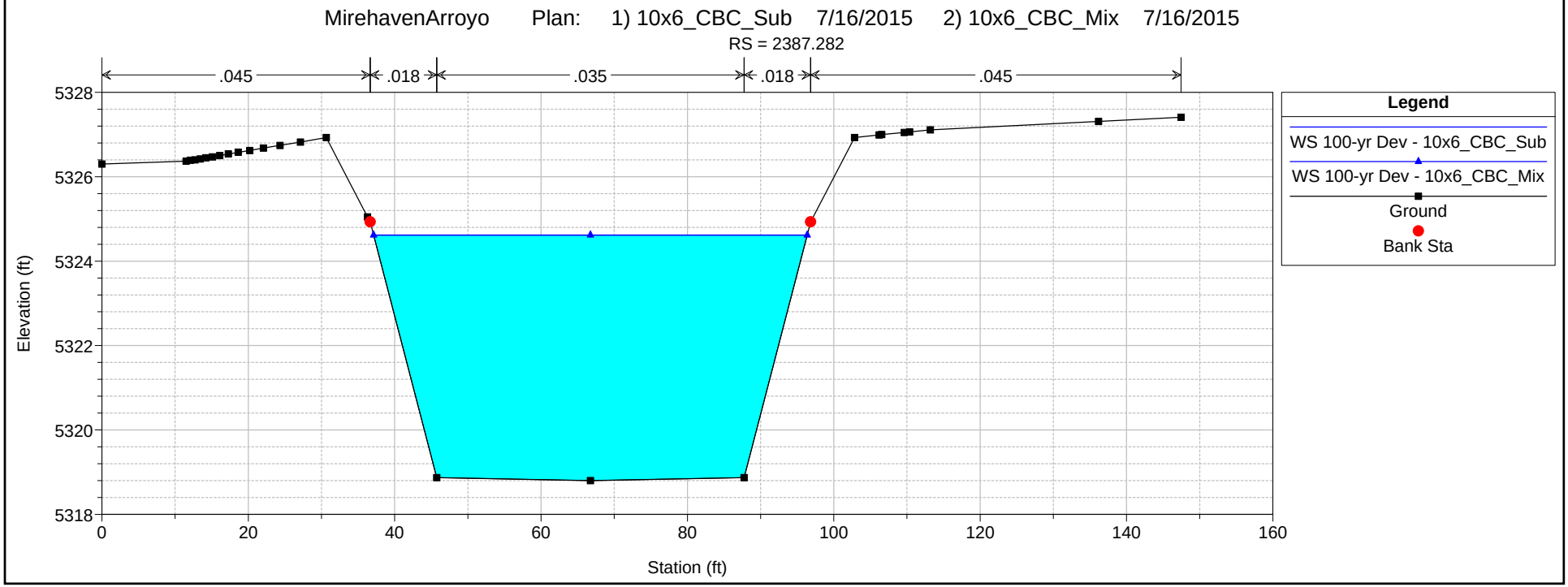
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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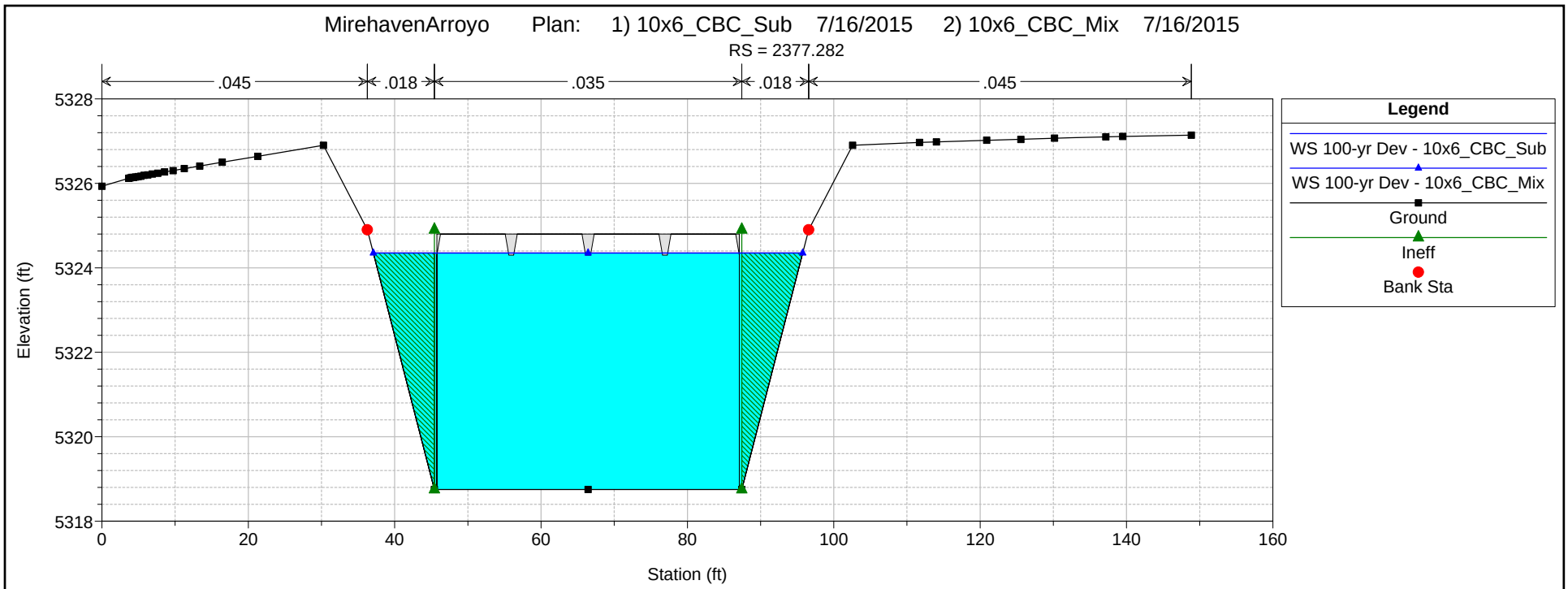
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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RS = 2377.282
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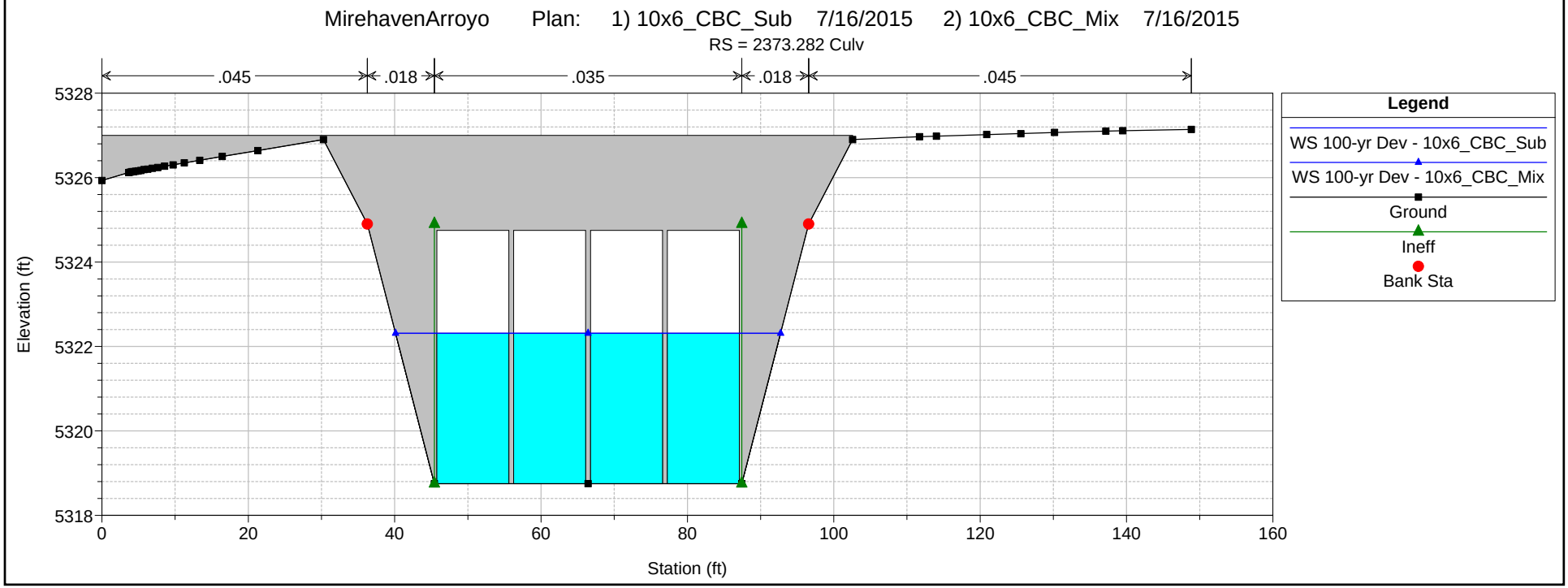
.018
.035
.018
.045
Elevation (ft)
5328
5326
5324
5322
5320
5318
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Ineff
Bank Sta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RS = 2373.282 Culv
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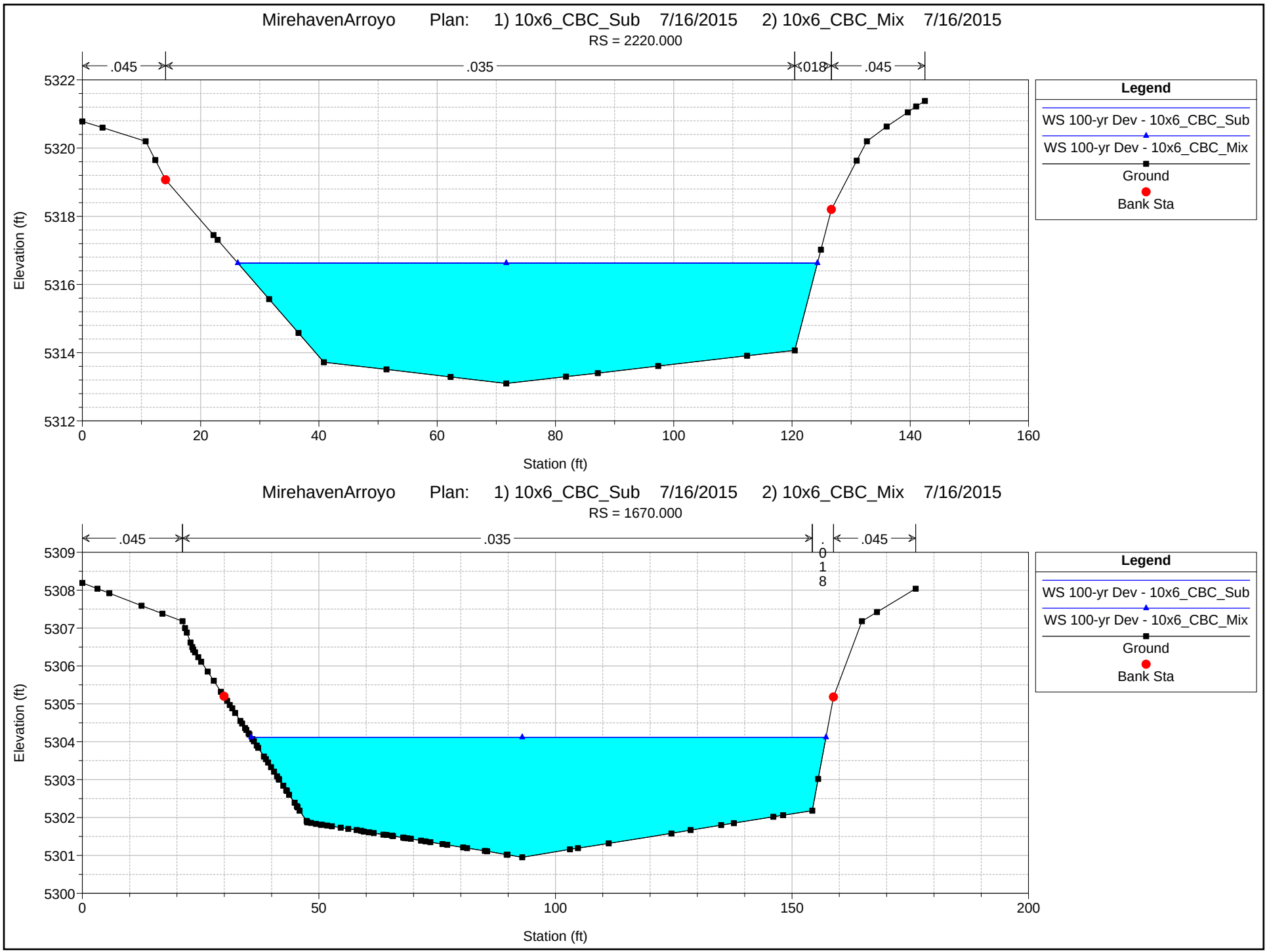
.018
.045
Elevation (ft)
5328
5326
5324
5322
5320
5318
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Ineff
Bank Sta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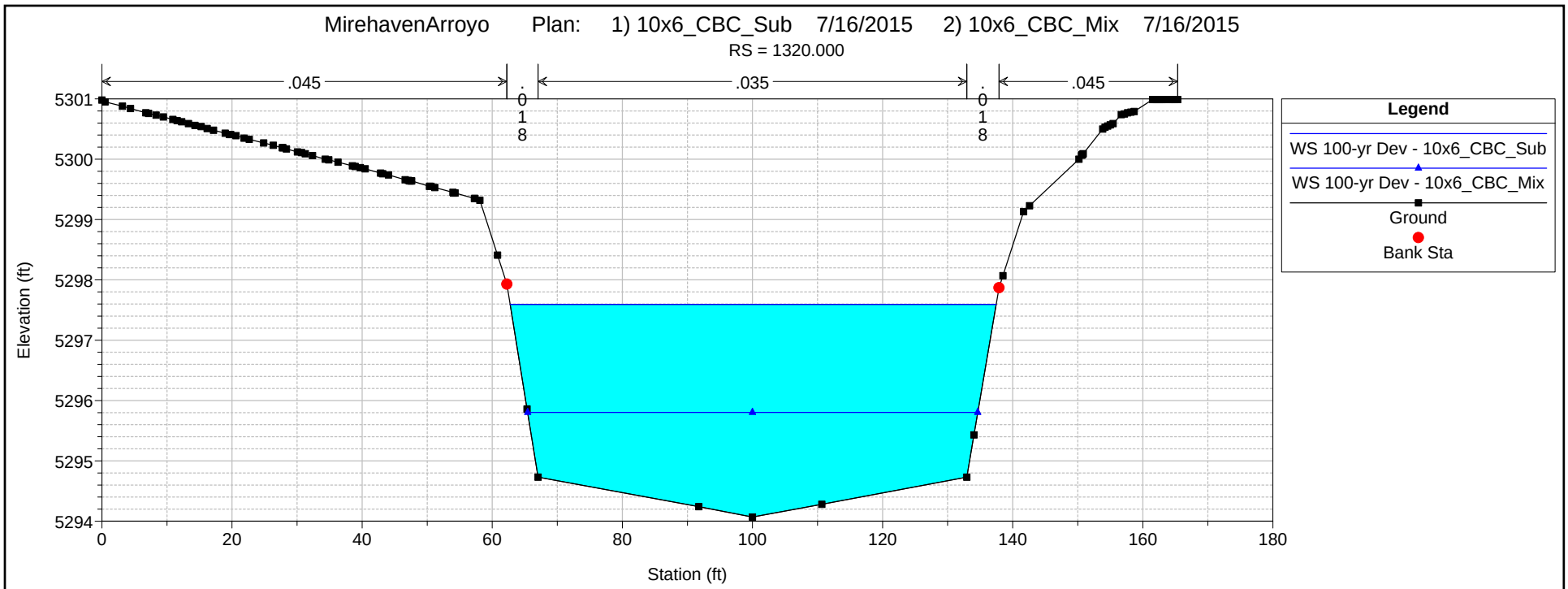
.035
.018
.045
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta
MirehavenArroyo Plan: 1) 10x6_CBC_Sub 7/16/2015 2) 10x6_CBC_Mix 7/16/2015
RS = 1670.000
.045
.035
.018
.045
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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RS = 1320.000
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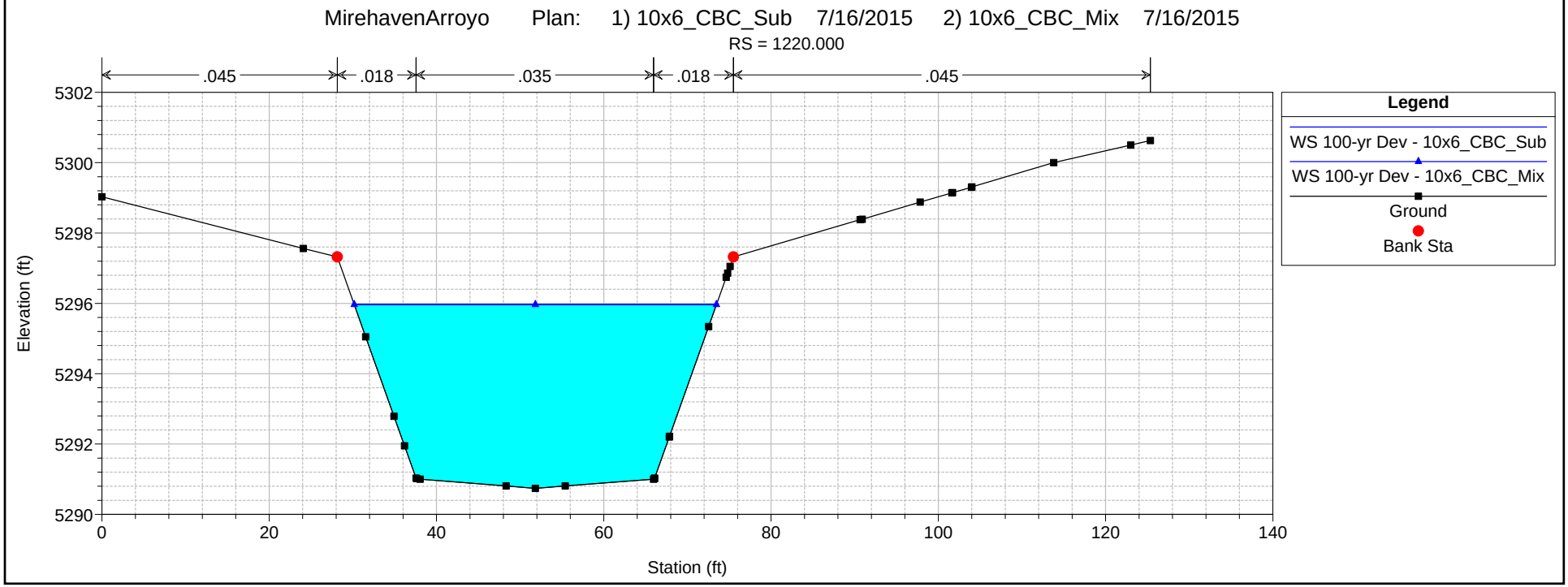
.018
.035
.018
.045
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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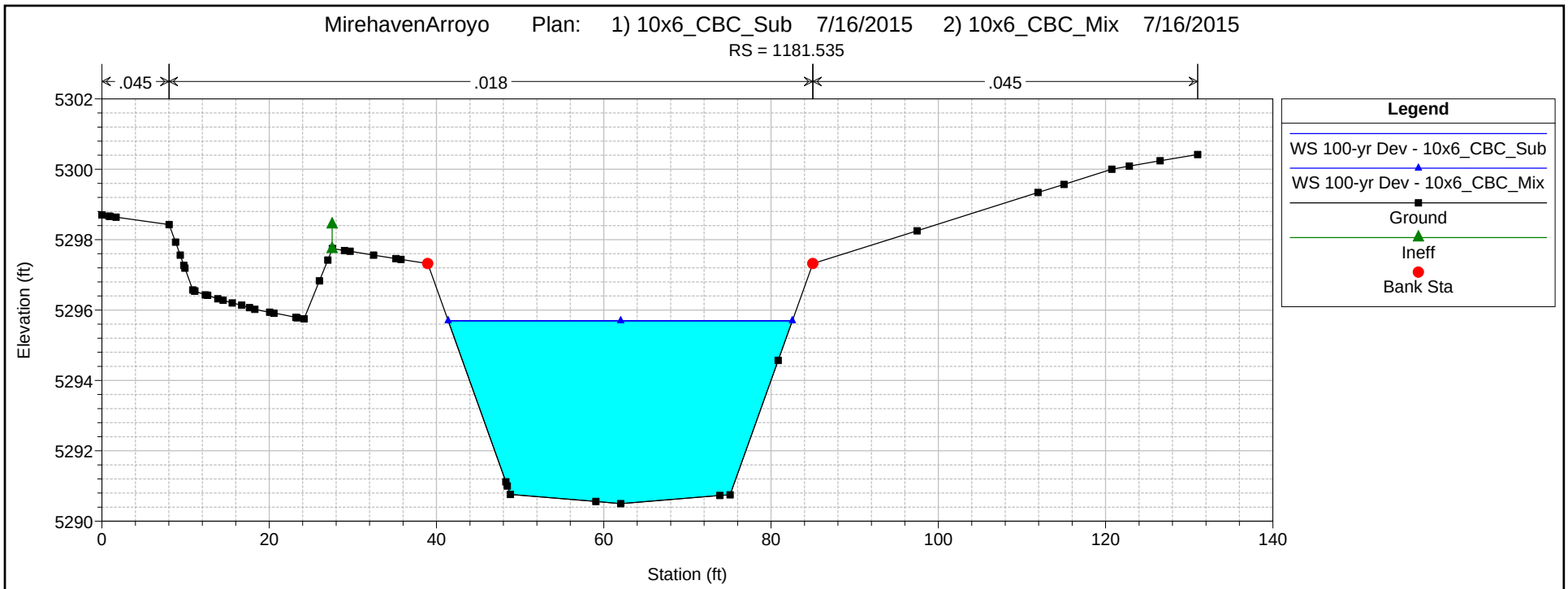
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Bank Sta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.018
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Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
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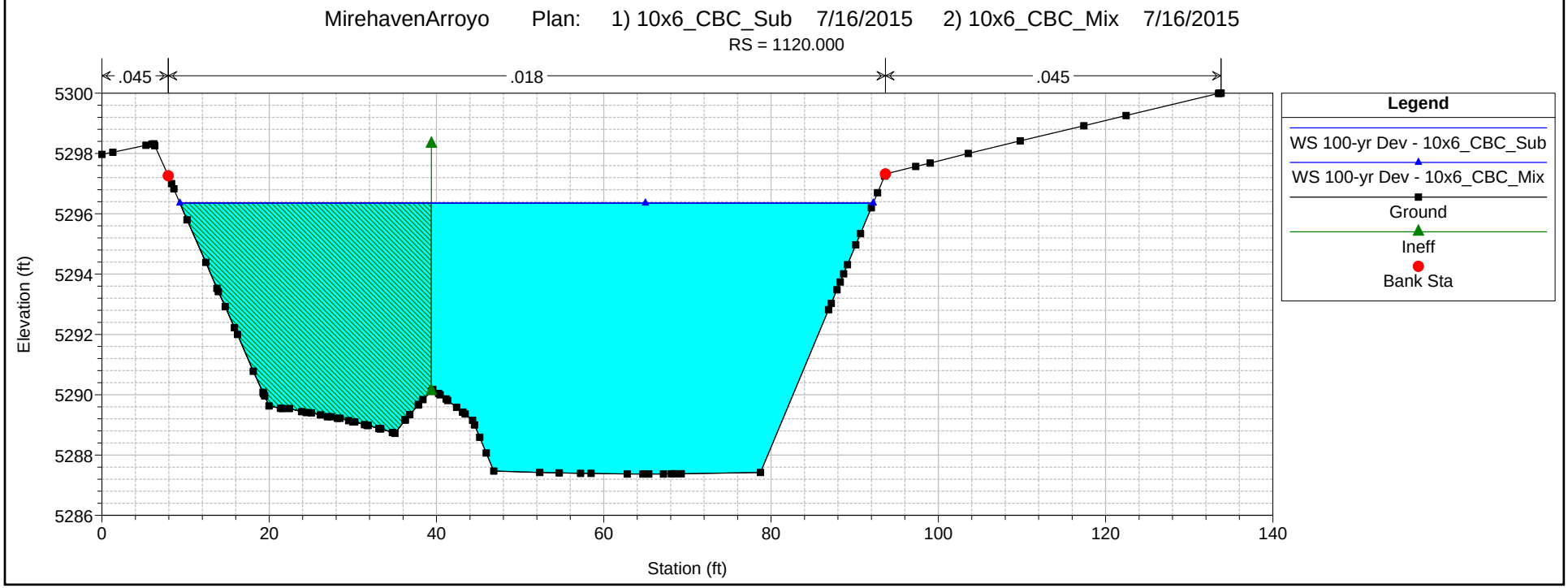
Ground
Ineff
Bank Sta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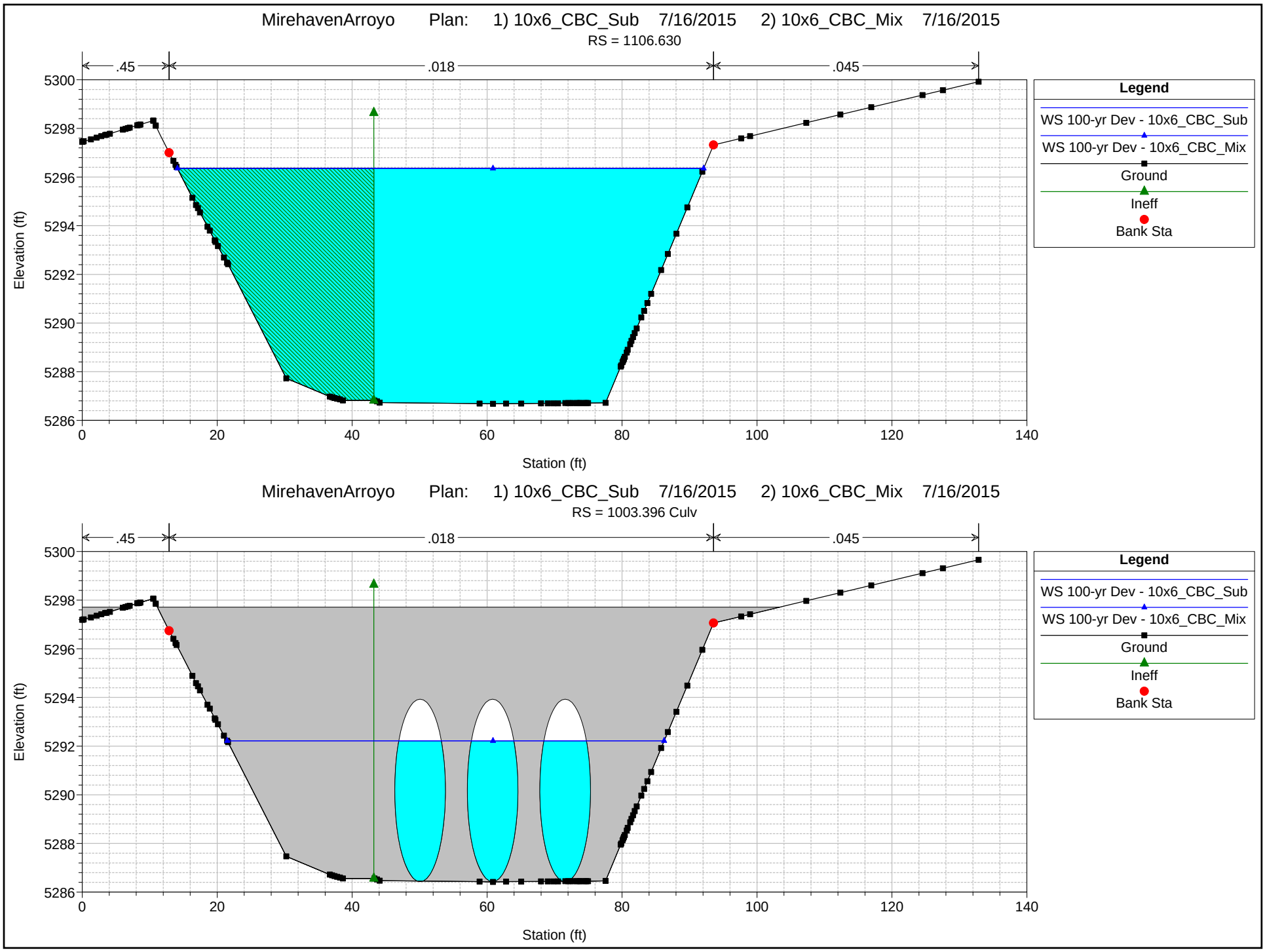
RS = 1120.000
.045
.018
.045
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Ineff
Bank Sta


MirehavenArroyo Plan: 1) 10x6_CBC_Sub 7/16/2015 2) 10x6_CBC_Mix 7/16/2015
RS = 1106.630
.45
.018
.045
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Ineff
Bank Sta
MirehavenArroyo Plan: 1) 10x6_CBC_Sub 7/16/2015 2) 10x6_CBC_Mix 7/16/2015
RS = 1003.396 Culv
.45
.018
.045
Elevation (ft)
Station (ft)
Legend
WS 100-yr Dev - 10x6_CBC_Sub
WS 100-yr Dev - 10x6_CBC_Mix
Ground
Ineff
Bank Sta

up to a distance L_f from the brink equal to a few pipe diameters. The figures given by Smith are:

$Q/D^2\sqrt{gD}$	0.65	0.54	0.47
y_c/D	0.82	0.75	0.70
L_f/D	0.25	0.65	2.6

from which it appears that y_c/D would have to be less than 0.6 for a free surface to exist over a substantial distance back from the brink. Vennard [23] suggests that the flow should be ventilated by holes drilled along the top of the pipe; this would have the effect of increasing L_f. Of course, no measures of this sort would be effective unless the slope and roughness of the pipe are such that uniform flow is possible when the pipe runs part full.

The Base of the Overfall

The situation is illustrated in Fig. 6-16, which shows a complete "drop structure" such as is installed at intervals in steep channels in order to dissipate energy without scouring the channel. We are concerned here with the events occurring where the jet strikes the floor and turns downstream at section 1.

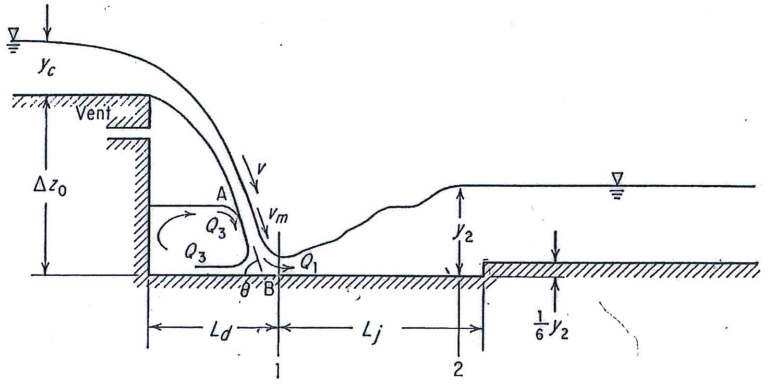


Figure 6-16. *The Drop Structure*

In this region there will be a great deal of energy loss because of circulation induced by the jet in the pool which forms beneath the nappe. The function of this pool is to supply the horizontal thrust required to turn the jet into the horizontal direction. The amount of the energy loss has been determined by the experiments of Moore [24], results of which are plotted in Fig. 6-17. Interesting comment on these results is provided by the analysis of White, who in a discussion of Ref. [24] assumed the following mechanism by which the jet sets up circulation in the pool: near the point A, a thin layer of water,

with experiment is remarkably good considering the approximations that must be inherent in this formulation of the problem.

This analysis by White is commended to the reader as a good example of the way in which skilful formulation and a grasp of fundamentals can yield surprisingly exact solutions of problems which may at first glance appear intractable by theoretical methods. The details can be worked out by the reader as an exercise (Probs. 6.10 and 6.11).

The Drop Structure

Figure 6-17 shows that the energy loss E_L at the base of an overfall may be 50 percent or more of the initial energy, referred to the basin floor as datum. If, as in Fig. 6-16, there is a hydraulic jump downstream of section 1 dissipating further energy, the energy loss in the entire "drop structure" may be very substantial. The loss due to the hydraulic jump is readily calculated (Prob. 6.12) in terms of the parameters of Fig. 6-17, and a curve is plotted on that figure displaced to the left of the E_1/y_c curve by the amount E_J/y_c, where E_J is the loss in the jump. This left-hand curve then indicates the remaining specific energy E_2 downstream of the jump. It is seen that the ratio E_2/y_c does not vary greatly with $\Delta z_0/y_c$; this suggests that a value of 2.5 for E_2/y_c may form a satisfactory basis for a preliminary design (Probs. 6.13 and 6.14).

Rand [25] assembled the results of experimental measurements made by himself, by Moore [24], and others, and from them obtained the following exponential equations, which fit the data with errors of 5 percent or less:

$$\frac{y_1}{\Delta z_0} = 0.54\left(\frac{y_c}{\Delta z_0}\right)^{1.275} \tag{6-37a}$$

or

$$\frac{y_1}{y_c} = 0.54\left(\frac{y_c}{\Delta z_0}\right)^{0.275} \tag{6-37b}$$

$$\frac{y_2}{\Delta z_0} = 1.66\left(\frac{y_c}{\Delta z_0}\right)^{0.81} \tag{6-38}$$

$$\frac{L_d}{\Delta z_0} = 4.30\left(\frac{y_c}{\Delta z_0}\right)^{0.09} \tag{6-39}$$

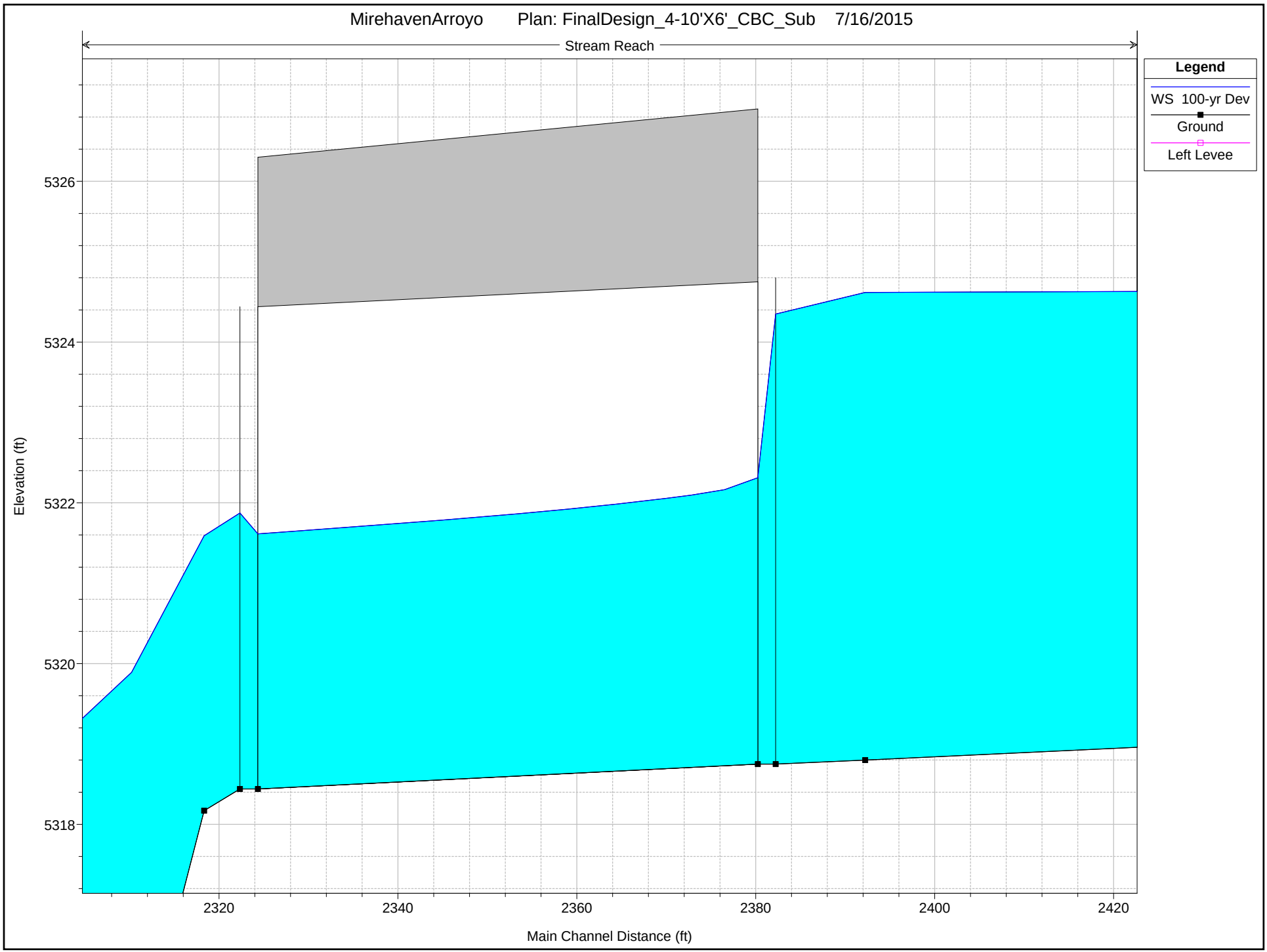
$$L_j = 6.9(y_2 - y_1) \tag{6-40}$$

where L_d and L_j are the horizontal distances covered by the jet and the hydraulic jump respectively, as shown in Fig. 6-16. With the help of these equations the designer can proportion the simple drop structure completely. The upward step of $y_2/6$ at the end of the structure, shown in Fig. 6-16, is a standard design feature which helps to localize the jump immediately below the overfall.

MIREHAVEN ARROYO DROP STRUCTURE ANALYSIS
BH JOB NO. 20160120
Last Updated: *7/16/2015*
HYDRAULIC COMPUTATIONS TO DETERMINE THE DROP STRUCTURE DIMENSIONS

								Last			Rounded		**1.5:1**	HENDERSON, pg 200			Total	Design
Drop	Drop	Crest		x-section	Critical	Brink	Brink	Step	Length of	Slope of	Total drop	Number	**Length**				Length of	Length of
Structure	Structure	Width (ft)	2011 DMP	side slope	Depth (ft)	Depth (ft)	Vel (fps)	height (ft)	bench (ft)	steps	height (ft)	of		eq. 6-37b	eq. 6-38	eq. 6-40	Drop	Drop
No.	Location	B	Q100 (cfs)	1V:zH	Yc	Yb	Vb	h	LD	S	Hd	drops		Y1	Y2	Lj	Struct. (ft)	Struct. (ft)
6*	Sta. 28+18	64	1500	1.5	2.9	2.1	11.38	4	7.0	0.57	4.0	1.0	6.0	1.4	5.1	25.3	32.3	33.0
7*	Sta. 23+22	46	1500	1.5	3.3	2.4	13.65	5	9.3	0.54	5.0	1.0	7.5	1.6	6.0	30.2	39.4	40.0
6	Sta. 28+18	64	1500	1.5	2.8	2.0	11.54	5	7.7	0.65	5.0	1.0	7.5	1.3	5.2	27.2	34.8	35.0
7	Sta. 23+22	42	1500	1.5	3.4	2.4	14.61	4	9.3	0.43	4.0	1.0	6.0	1.8	5.8	28.2	37.4	38.0

Notes:
* Denotes design from Amendment No. 2, whereas the other drops are proposed
1. The crest width shown is the maximum crest width for any drop
2. Q100 from the 2011 DMP for Developed Conditions.
3. Cross-Sectional Area 1.5:1 for Drops 6-7
4. Total Drop Height of each Drop Structure
5. Max height of drop is 5 feet.
6. Total length of structure = number of drops times the length of a step plus jump length.
7. "L", length of step, was computed using the Trajectory Method, per Black Arroyo Physical Model Study by R. Heggen, Oct. 20, 1990
8. Yc from Momentum Program and Brink Velocity read off Output from Momentum based on Brink Depth calculation.
9. Yb is calculated as 0.715 Yc Henderson, pg194
10. If 1.5:1 slope of drop is greater than LD, then add slope length difference from LD (horizontal component) to Total Length of Drop


MirehavenArroyo Plan: FinalDesign_4-10'X6'_CBC_Sub 7/16/2015
Stream Reach
Legend
WS 100-yr Dev
Ground
Left Levee
5326
5324
5322
5320
5318
Elevation (ft)
2320
2340
2360
2380
2400
2420
Main Channel Distance (ft)

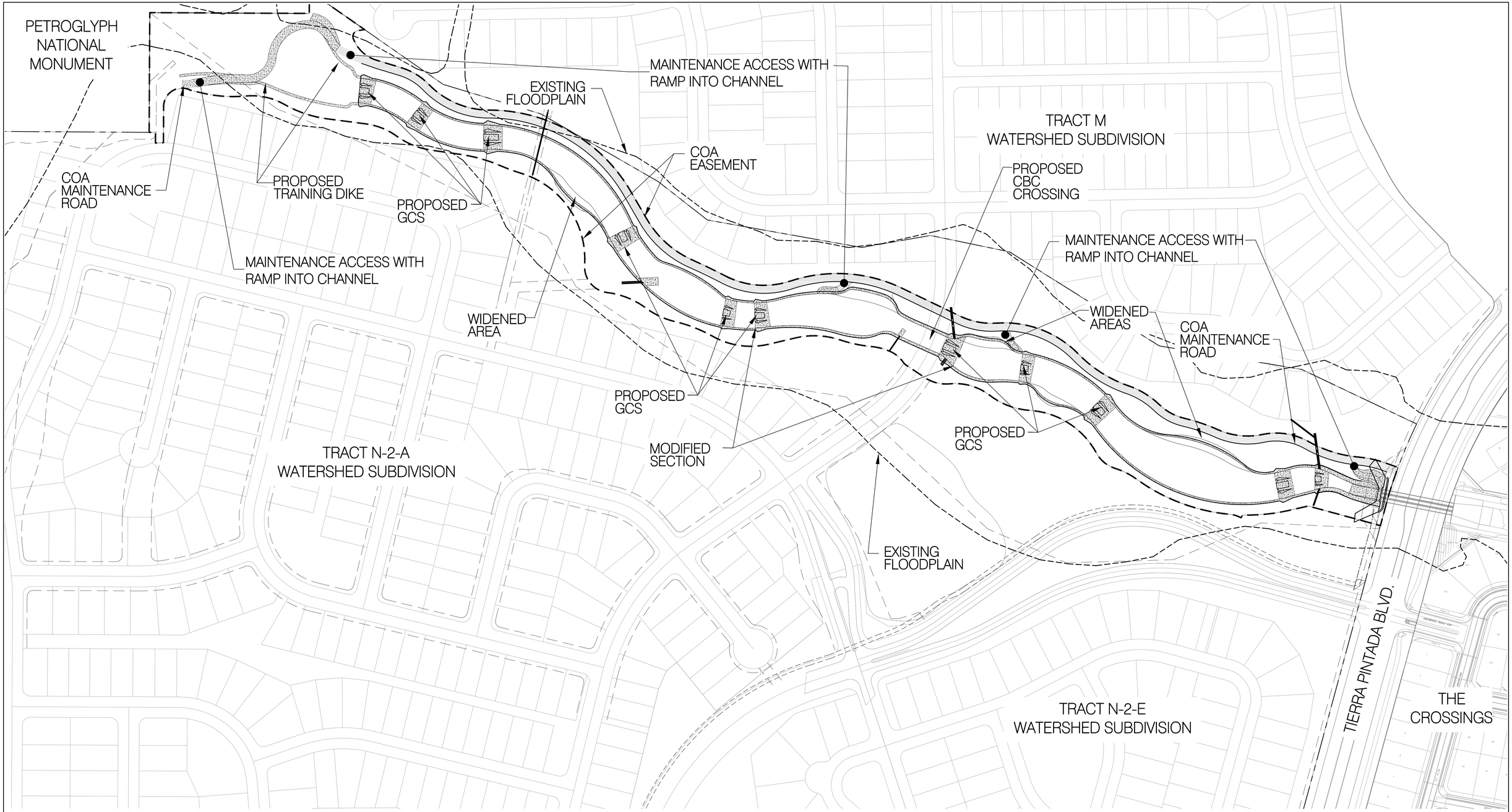
Plan: 10x6_CBC_Sub Stream Reach RS: 2373.282 Culv Group: Culvert #1 Profile: 100-yr Dev

Q Culv Group (cfs)	1501.00	Culv Full Len (ft)	
# Barrels	4	Culv Vel US (ft/s)	10.71
Q Barrel (cfs)	375.25	Culv Vel DS (ft/s)	12.02
E.G. US. (ft)	5324.99	Culv Inv El Up (ft)	5318.75
W.S. US. (ft)	5324.35	Culv Inv El Dn (ft)	5318.44
E.G. DS (ft)	5323.56	Culv Frctn Ls (ft)	0.24
W.S. DS (ft)	5321.87	Culv Exit Loss (ft)	0.30
Delta EG (ft)	1.43	Culv Entr Loss (ft)	0.89
Delta WS (ft)	2.47	Q Weir (cfs)	
E.G. IC (ft)	5324.48	Weir Sta Lft (ft)	
E.G. OC (ft)	5324.99	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	5322.31	Weir Max Depth (ft)	
Culv WS Outlet (ft)	5321.61	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	2.97	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.56	Min El Weir Flow (ft)	5326.91

EXHIBIT 1

MIREHAVEN ARROYO IMPROVEMENTS PLAN

Bohannan Huston



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N.T.S.

MIREHAVEN ARROYO IMPROVEMENTS
WATERSHED @ MIREHAVEN
07/2015

Thu, 16-Jul-2015 – 3:11:pm, Plotted by: KSAINTLOT
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