SANBAG Redlands Passenger Rail Project

Job Name: Hydraulic Impact Analysis – Twin Creek
Job Number: 170063
Client: SANBAG
Consultant: HDR Engineering, Inc.

This report and the analysis and design calculations contained herein have been prepared under the supervision of the following Registered Civil Engineer:

_____ August 2012

Mark Seits, P.E. Date
CA 41103

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1. Purpose

The rail from historic Warm Creek (that portion of Warm Creek that was not combined with East Twin Creek and Warm Creek Improvements) to Mill Creek Zanja is proposed to be improved as part of the Redlands Passenger Rail Project (RPRP) (see Exhibit 1). This report covers the hydraulic impact analysis on the rail from Twin Creek to the Santa Ana River. AT&SF Bridge 2.2 (Bridge 2.2) is the rail crossing over Twin Creek. No improvements will be made for the existing bridge. The rail operation will change from its existing freight-only operation to current standards required for regular passenger rail operations. As part of this project, recommendations, including hydraulic analysis, are being provided to assist in this process.

The purpose of the hydraulic modeling is: (1) to evaluate the hydraulic impact of Twin Creek on the rail from the Twin Creek crossing to the Santa Ana River crossing, analyze the existing hydraulic condition of the Twin Creek crossing to establish current conditions, considering Federal Emergency Management Agency (FEMA) models and updated site conditions; and (2) to evaluate the hydraulic impact of Twin Creek on Bridge 2.2.

2. Background

The RPRP will design a double track alignment for passenger and freight service from the proposed San Bernardino Transit Center east to the University of Redlands. The Redlands Corridor Strategic Plan (RCSP) was developed by San Bernardino Associated Governments (SANBAG) to address the transportation needs of the Redlands Corridor, assess the capability of transit service and multimodal improvements to meet mobility needs, and describe a course of action to implement transit service in the Redlands Corridor in a cost effective manner. The first phase of the RCSP calls for the development of a passenger rail service operating between the San Bernardino Transit Center and the University of Redlands, a distance of approximately nine miles.

The general hydraulic modeling approach was to initially review hydraulic models from FEMA to examine flooding conditions in the Twin Creek reach with AT&SF Bridge 2.2. A revised hydraulic model was developed of the project area based on additional information to model existing conditions through the bridge and to evaluate the water surface elevation for the 100-year flood.

The Twin Creek study reach is located from the confluence with the Santa Ana River downstream to approximately 500 feet upstream of Bridge 2.2. Exhibit 2 shows the limits of the analysis. Total reach length is approximately 9,200 feet. The reach upstream of Bridge 2.2 is a rectangular concrete channel. The channel transitions to a trapezoidal soft-bottom channel with riprap side slopes just downstream of Bridge 2.2. The channel was constructed in the late 1950s by the U.S. Army Corps of Engineers (USACE). Figure 1 shows a typical section of Twin Creek downstream of Bridge 2.2. Figure 2 shows the downstream face of existing AT&SF Bridge 2.2. Hydraulic analysis is required to evaluate whether the existing bridge meets current design requirements. There are four bridge structures in this reach. Table 1 shows the locations of the structures by HEC-RAS river station (RS).

Figure 1: Twin Creek Downstream of AT&SF Bridge 2.2

Figure 2: Existing AT&SF Bridge 2.2 – Downstream Face

Table 1: Structures in Twin Creek Reach

Structure	Approximate RS Location
AT&SF Railroad Bridge 2.2	8705.59
Central Ave	6654.79
Orange Show Rd	4340
Golf Cart Bridge	1410

The existing effective FEMA HEC-2 model was obtained for Twin Creek which was named as Warm Creek in the model. It is dated August 1991. The HEC-2 model covers from the Santa Ana River confluence to Bridge 2.2. A more recent model prepared by Tetra Tech covers from the Santa Ana River confluence to downstream of Orange Show Road for the Lower Warm Creek levee certification project (Tetra Tech 2009). Tetra Tech provided the topographic map which was based on a January 14, 2008, flight. The topographic map covers from the Santa Ana River confluence to Central Avenue. The horizontal control is based on North American Datum (NAD) 1983 (National Geodetic Survey 1986) and the vertical control is based on North American Vertical Datum (NAVD) 1988 (National Geodetic Survey 1991).

Modeling of Twin Creek and Bridge 2.2 was conducted using the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS v4.1) program (USACE 2010). All reference topography is based on the NAVD 1988 datum (National Geodetic Survey 1991). Due to the limitation of the recent data, the reach is broken into three sub-reaches. See Table 2 for reach description and limits.

Table 2: Reach Limits

Channel Reach (River Station)	Limits	Source
Lower Reach (RS 31-4340)	Santa Ana River Confluence to downstream of Orange Show Road	Tetra Tech Lower Warm Creek Levee Certification
Middle Reach (RS 4479-6793)	Orange Show Road to Central Avenue	HDR model based on the topo provided by Tetra Tech
Upper Reach (RS 6843-9236)	Central Avenue to upstream of AT&SF Bridge 2.2	FEMA HEC-2 model and As-built plans

The standard freeboard criteria selected for the bridge (in the following priority) are shown below. For this project, the 50-year flow rate is not available; therefore, only the 100-year flow rate was evaluated.

1. 100-year water surface elevation below bridge low chord;
2. 100-year energy grade line (EGL) elevation below top of track subgrade and 50-year water surface [hydraulic grade line (HGL)] elevation below bridge low chord;
3. 50-year water surface (HGL) elevation below bridge low chord; and
4. No increase of water surface elevations within project area.

This report presents hydraulic analysis results; however, it does contain some assumptions and approximations. Prior to 100% design, the assumptions and approximations made within this report should be verified.

3. Hydrology

The Twin Creek 100-year flowrate from the FEMA 2008 Flood Insurance Study (FIS) is 13,500 cfs upstream of Santa Ana River confluence (Twin Creek is listed as Lower Warm Creek) which agrees with the discharge used in the effective HEC-2 model. Tetra Tech performed hydrologic analysis for Lower Warm Creek and the flowrate was determined to be 12,300 cfs at Orange Show Road and 70,000 cfs at the Santa Ana River. The 100-year discharge of 13,500 cfs was used for this evaluation of Bridge 2.2. With the Seven Oaks Dam in place, the Santa Ana River at E Street flood discharges have been reduced.

4. Hydraulic Modeling

4.1 Modeling Overview

Hydraulic modeling was conducted using the USACE HEC-RAS (v.4.1) program. Existing FEMA effective modeling was available for the Twin Creek reach. Tetra Tech prepared the Lower Warm Creek Levee certification in 2009. The hydraulic analysis from that study covers from the Santa Ana River confluence to downstream of Orange Show Road. It was used for the lower reach of the HDR model. Tetra Tech provided the topographic map flown in 2008 from Orange Show Road to Central Avenue. HDR developed the middle reach model based on this topographic information. The FEMA HEC-2 model was used for as the basis for the upper reach – from Central Avenue to the AT&SF bridge. Based on the as-built plan (USACE 1958a), the HEC-RAS model was then extended approximately 540 feet upstream of Bridge 2.2. The three reaches were combined to create the HDR HEC-RAS model. There are four bridge structures in this reach: Golf Cart bridge, Orange Show Road, Central Avenue, and the AT&SF railroad bridge.

For the middle reach modeling, channel geometry was generated based on the topographic map by using HEC-GeoRAS program (v.4.1.1), an extension for support of HEC-RAS using ArcGIS. An approximate centerline was laid out along the channel. Cross-sections were cut and perpendicular to the channel centerline. The cross-section interval is approximately 300 feet. Additional cross-sections were added at bridge locations.

The combined model is used to evaluate the hydraulic conditions of the existing Bridge 2.2 and the impact of Twin Creek on the railroad between Bridge 2.2 and the Santa Ana River confluence.

4.2 Model Inputs

4.2.1 Existing Condition

The original effective model used the HEC-2 (v. 1990) program. The model files were provided by FEMA. The reach is shown on the FEMA Flood Insurance Rate Map (FIRM) 06071C8683H. See Exhibit 4- FEMA FIRM 06071C8683H. The FIRM panel shows that the rail is located in FEMA

Zone A. The Twin Creek channel downstream of Bridge 2.2 is in Zone AE and the channel upstream of Bridge 2.2 is in Zone A. The limit of detailed study ends at just downstream of Bridge 2.2. The channel transitions from a trapezoid shape downstream of Bridge 2.2 to a concrete rectangular channel upstream of the Bridge. The model was modified as following:

- The HEC-2 model was assumed to be on NGVD 29 datum. The lower and middle reach were based on NAVD 88. The upper reach was converted to NAVD 88 by adding 2.5 feet to elevations in NGVD 29. The Corpscon program was used to determine the conversion factor (USACE 2004). The middle point coordinates (N34.089, W117.284) between Central Avenue and Bridge 2.2 were used to determine the conversion factor.
- Manning's *n* values were kept consistent with the existing models and verified with aerial imagery.
- Ineffective flow areas were added to cross-sections as needed.
- The lowest base of rail is at Elevation 1008.68 (NGVD29), which is at Elevation 1011.18 (NAVD 88) (P.E. RY. Bridge to Central Avenue Plans [USACE 1958b]).
- The bridge was modeled using the energy equation for low flow and the pressure/weir option for high flow.
- A rating curve from the Tetra Tech HEC-RAS levee certification model was used as the downstream boundary condition at the Santa Ana River.
- The model was run under mixed flow condition, because upstream of the bridge is concrete channel and downstream of the bridge is trapezoidal soft-bottom channel. The flow regime changes from supercritical to subcritical after passing through the bridge.
- Existing bridge geometries were kept the same as in the original levee certification and HEC-2 model.
- Orange Show Road bridge was not modeled due to no information was available. The bridge is over 4,000 feet downstream of the Bridge 2.2. The supercritical flow goes through the Bridge 2.2 and has a hydraulic jump downstream of the Bridge 2.2. Therefore, Orange Show Road bridge will not have an impact on the water surface at Bridge 2.2.

4.3 Model Results

A hydraulic analysis was conducted to generate a water surface profile for the channel and Bridge 2.2 for the 100-year flowrate. The flow runs supercritical upstream of the bridge and has a hydraulic jump just downstream of the bridge. The hydraulic jump occurs because the channel transitions from a 60-foot wide rectangular concrete channel upstream of the bridge and to an approximately 200-foot wide trapezoidal earthen bottom channel downstream of the bridge. Hydraulic results at river station 8713.44 which is just upstream of Bridge 2.2 are shown in Table 3. Figure 3 shows the profile at existing Bridge 2.2. Full hydraulic model results are shown in Attachment 2 (Hydraulic Analysis Results).

Table 3: Hydraulic Results at Cross Section 8713.44

		Existing Bridge
100-Yr event	WSE	995.63
	EGL	1009.65
	Velocity	30.05
	Froude #	1.93

WSE = water surface elevation (ft); EGL = energy grade line elevation (ft); VCH = main channel average velocity (ft/s); All elevations are NAVD 1988.

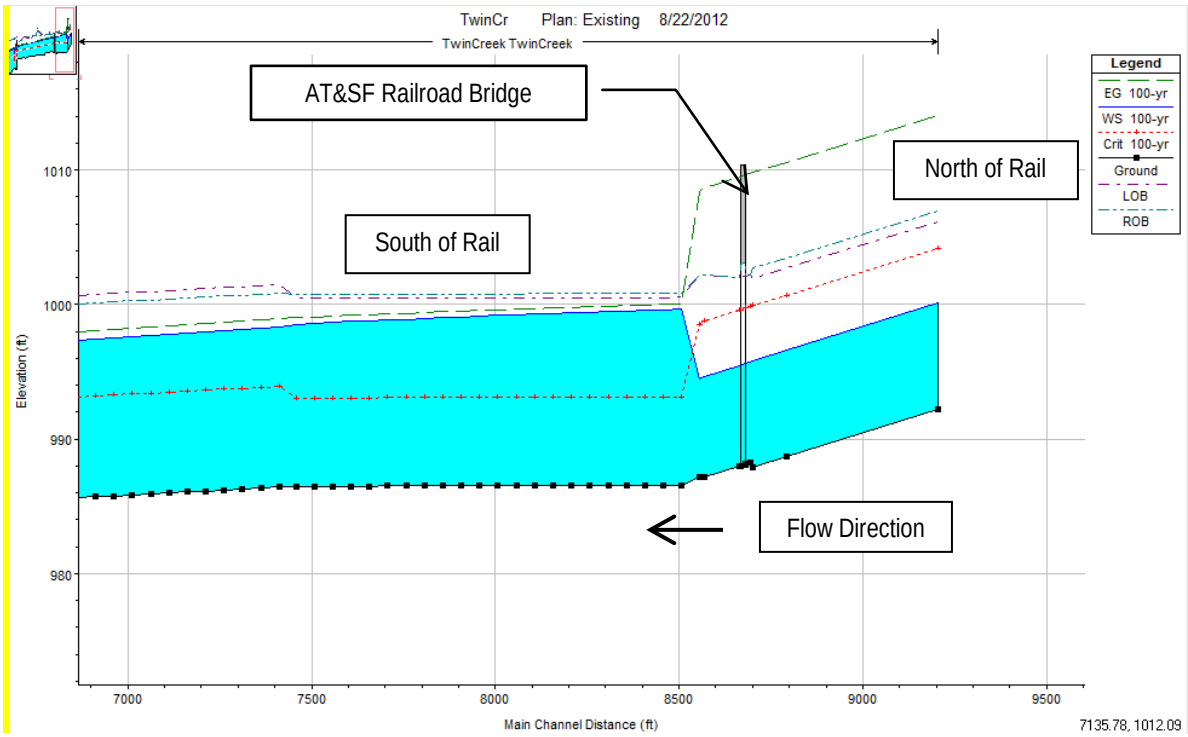


Figure 3: Profile of Existing Condition

The hydraulic criteria selected for the bridge (in the following priority) are presented below in Table 4. The existing bridge meets all criteria except the Energy Grade Line Elevation (EGL) criterion. Meeting 100 year criteria therefore meets 50-year by default. The reach upstream of Bridge 2.2 is a concrete channel. A high EGL is expected because the high velocity of approximately 30 feet per second creates a large velocity head. Because there is over 6 feet of freeboard between the 100-year water surface elevation and the bridge low chord, it would not be anticipated for debris to lodge under the bridge and cause the water surface elevation to reach the EGL. The EGL criterion could be exempted for this bridge over a concrete channel.

Table 4: Hydraulic Freeboard Criteria (Existing Condition)

Criterion	Standard	Existing Model Results	Criterion Met?
1. 100-yr WSE < Low Chord	Low Chord = 1002.01	100-yr WSE = 995.63	Yes
2. 100-yr EGL < Top of SBGD	Top of SBGD = 1007.5*	100-yr EGL = 1009.65	No
3. Proposed WSE ≤ Existing WSE	Existing 100-yr WSE = 995.63	Proposed 100-yr WSE = N/A	Yes
WSE = water surface elevation (ft); EGL = energy grade line elevation (ft); SBGD = subgrade. All elevations are NAVD 1988. * Estimated based on the 1'countour. Top of rail is at 1010, subtract 2.5' to obtain the Top of SBGD at 1007.5			

4.4 Comparisons

Table 5 shows the comparison between FEMA Base Flood Elevation (BFE) and HDR model results. The most upstream BFE is available at Station 8250 and the existing AT&SF Bridge 2.2 is located at Station 8705. Based on the results, the HDR model water surface is higher than the BFE at upstream and middle portion, and lower than BFE at lower reach. The existing and proposed rail is at least 8.6 feet above the water surface elevation. The rail from downstream of Bridge 2.2 to Santa Ana confluence will not affect or be affected by the hydraulic impact of Twin Creek.

Table 5: Comparison Between BFE and HDR Model

Station	BFE (feet)	HDR WS (feet)	Difference (feet)	Existing Rail Elevation (feet)*	Proposed TOR (feet)
1530	992	990.38	-1.62	N/A	N/A
2124	993	991.53	-1.47	N/A	N/A
4114	994	994.04	0.04	1011	1013.0
between (5625,5854)	995	996.15	1.14	1007	1006.6
6793	996	997.10	1.10	1008	1008.6
7210	997	997.92	0.92	1008	1007.2
7646	998	998.75	0.75	1008	1007.3
8250	999	999.40	0.40	1008	1010
*Rail elevations are approximate. They were measured from the contour along the rail.					

Based on the hydraulic analysis, the 100-year flow is contained in the channel for the study reach. The FIRM shows the railroad is in Zone A. It shows a breakout just upstream of Bridge 2.2. This might be due to the subcritical flow regime used in the original HEC-2 model. Since there is a concrete channel upstream and through Bridge 2.2, a mixed flow regime is considered appropriate to use to calculate the water surface. In that case, flow is within the channel upstream of Bridge 2.2 also.

5. Conclusions

Using the data and resources available, the hydraulic conditions were modeled for Bridge 2.2 for existing condition. The existing bridge meets hydraulic criteria.

The rail and water surface elevation from downstream of Bridge 2.2 to Santa Ana confluence were compared; the rail will not affect or be affected by Twin Creek at existing condition. The 100-year water surface is contained within the channel for the study reach.

If there were a flow breakout from the channel as shown on the FIRM panel, the area outside of the channel is higher on both sides (including the rail), so overflow will be contained within channel section (i.e., no breakout to the south); it is uncertain if breakout could occur further upstream from the bridge (would require additional data to extend model). If an upstream breakout did occur, it would likely flow south in a shallow flow condition to the Santa Ana River.

6. References

County of San Bernardino. 1986. San Bernardino County Hydrology Manual.

Federal Emergency Management Agency (FEMA).1991. FEMA Effective Model for Santa Ana River. HEC-2 format.

Federal Emergency Management Agency. 2008. San Bernardino County Flood Insurance Study.

National Geodetic Survey. 1986. North American Datum (NAD) 1983.

National Geodetic Survey. 1991. North American Vertical Datum (NAVD) 88.

Tetra Tech. 2009. Lower Warm Creek Levees Levee Certification Report.

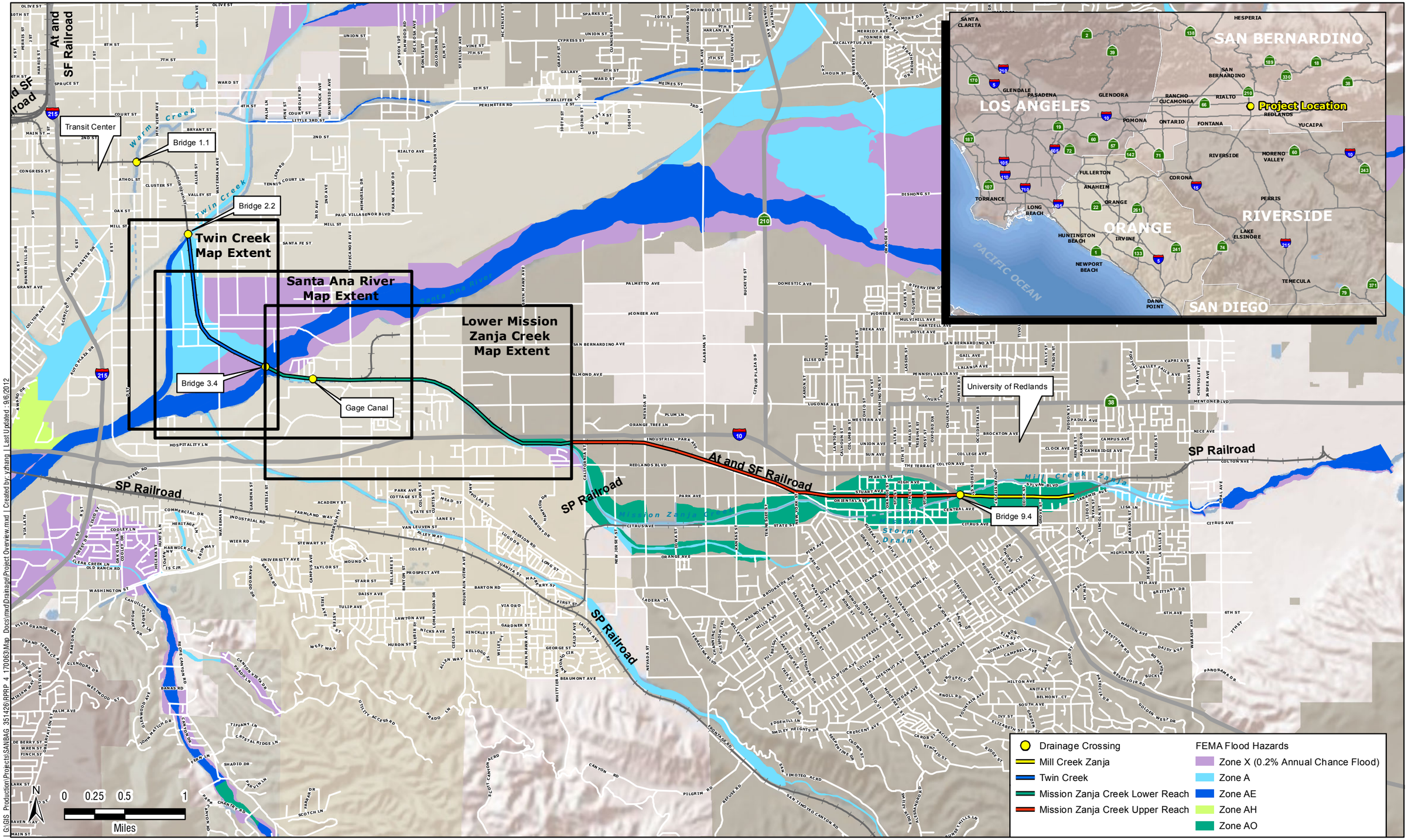
U.S. Army Corps of Engineers (USACE). 1958a. East Twin and Warm Creeks Channel, Central Avenue to Santa Ana River, Sta 159+16.05 to Sta 90+00 (Mile 1.50 to Mile 0.19).

U.S. Army Corps of Engineers. 1958b. East Twin and Warm Creeks Channel, P.E. RY. Bridge to Central Avenue Plans.

U.S. Army Corps of Engineers. 2004. Corpscon 6.0.1.

U.S. Army Corps of Engineers. 2010. HEC-RAS v.4.1 User's Manual and Technical Reference Manual.

Exhibit 1: RPRP Project Overview



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Project Overview

EXHIBIT 1

SANBAG | Redlands Passenger Rail Project | Hydraulic Impact Report

Exhibit 2: Twin Creek Reach Limits

Path:ath:G:\GIS_Production\Projects\SANBAG_351426\RPRP_4_170063\Map_Docs\mxd\Drainage\TwinCr931.mxd | Created by:VZhang | Last Updated : 08-03-12

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Twin Creek

EXHIBIT 2

SANBAG | Redlands Passenger Rail Project | Twin Creek Report

Exhibit 3: Modeling Overview – Cross-Sections

Exhibit 3 – Modeling Overview – Cross Sections

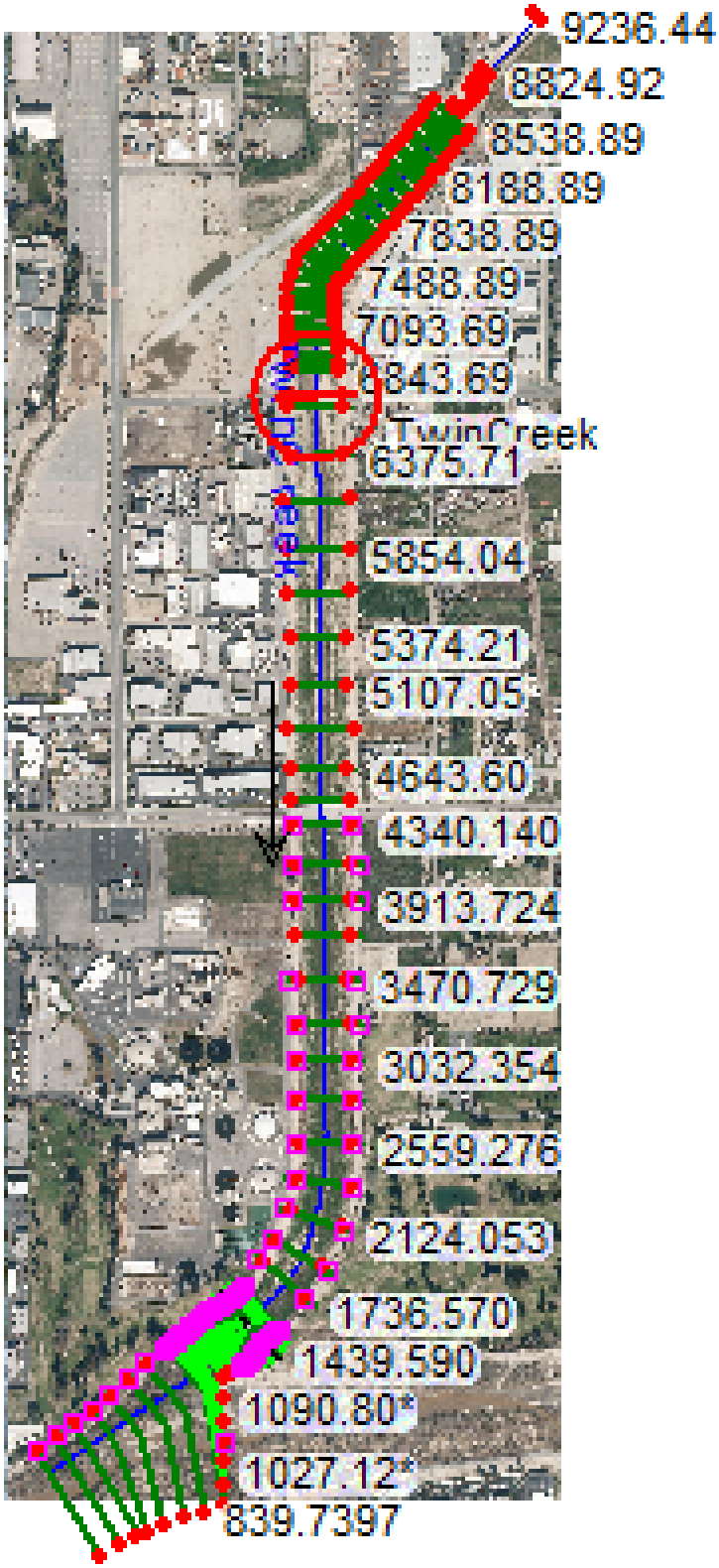
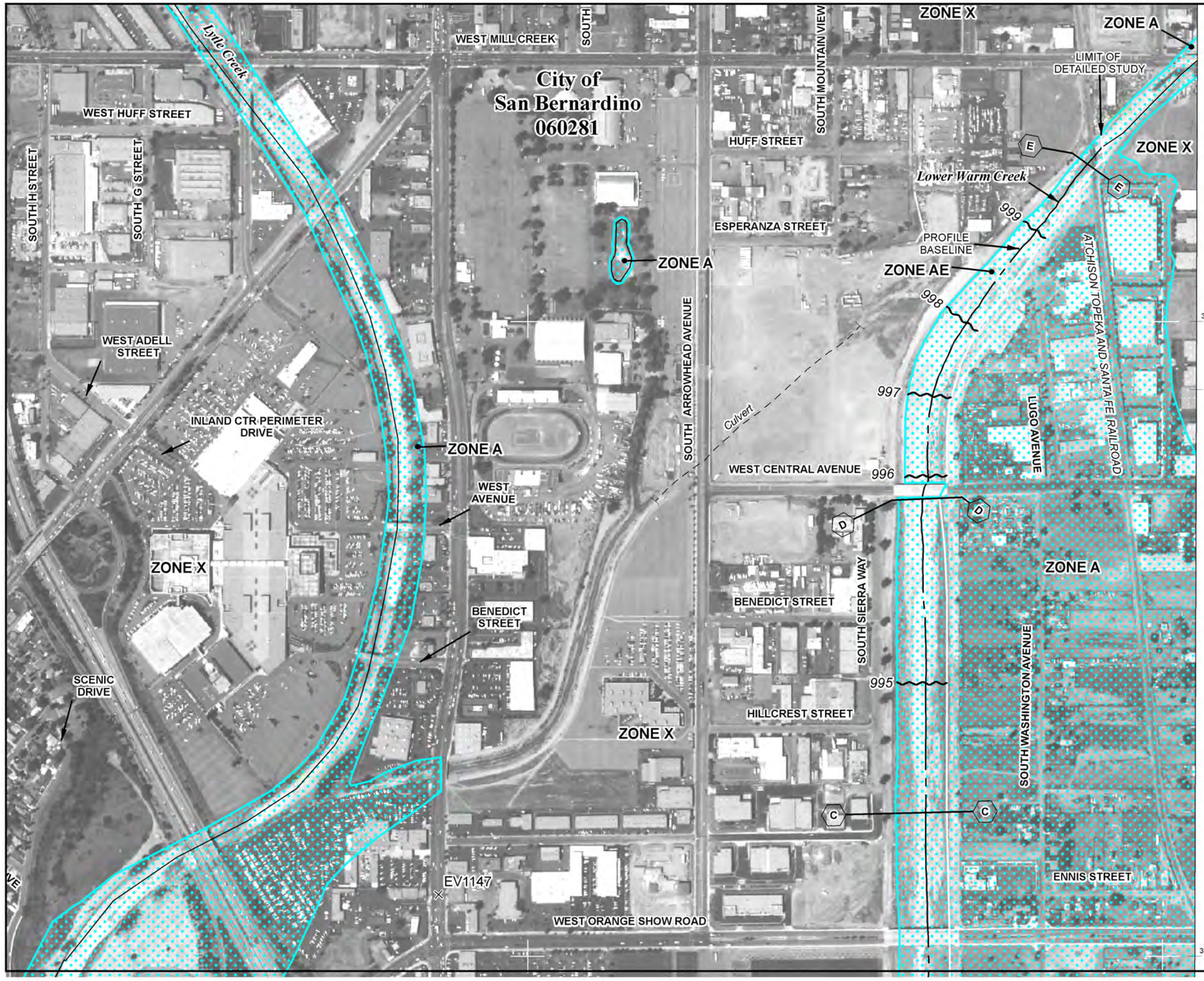


Exhibit 4: FEMA FIRM 06071C Panel 8683H



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

MAP SCALE 1" = 500'

50 0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 8683H

FIRM

FLOOD INSURANCE RATE MAP

SAN BERNARDINO COUNTY, CALIFORNIA

AND INCORPORATED AREAS

PANEL 8683 OF 9400

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLTON, CITY OF	060273	8683	H
SAN BERNARDINO, CITY OF	060281	8683	H

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

MAP NUMBER
06071C8683H

MAP REVISED
AUGUST 28, 2008

Federal Emergency Management Agency

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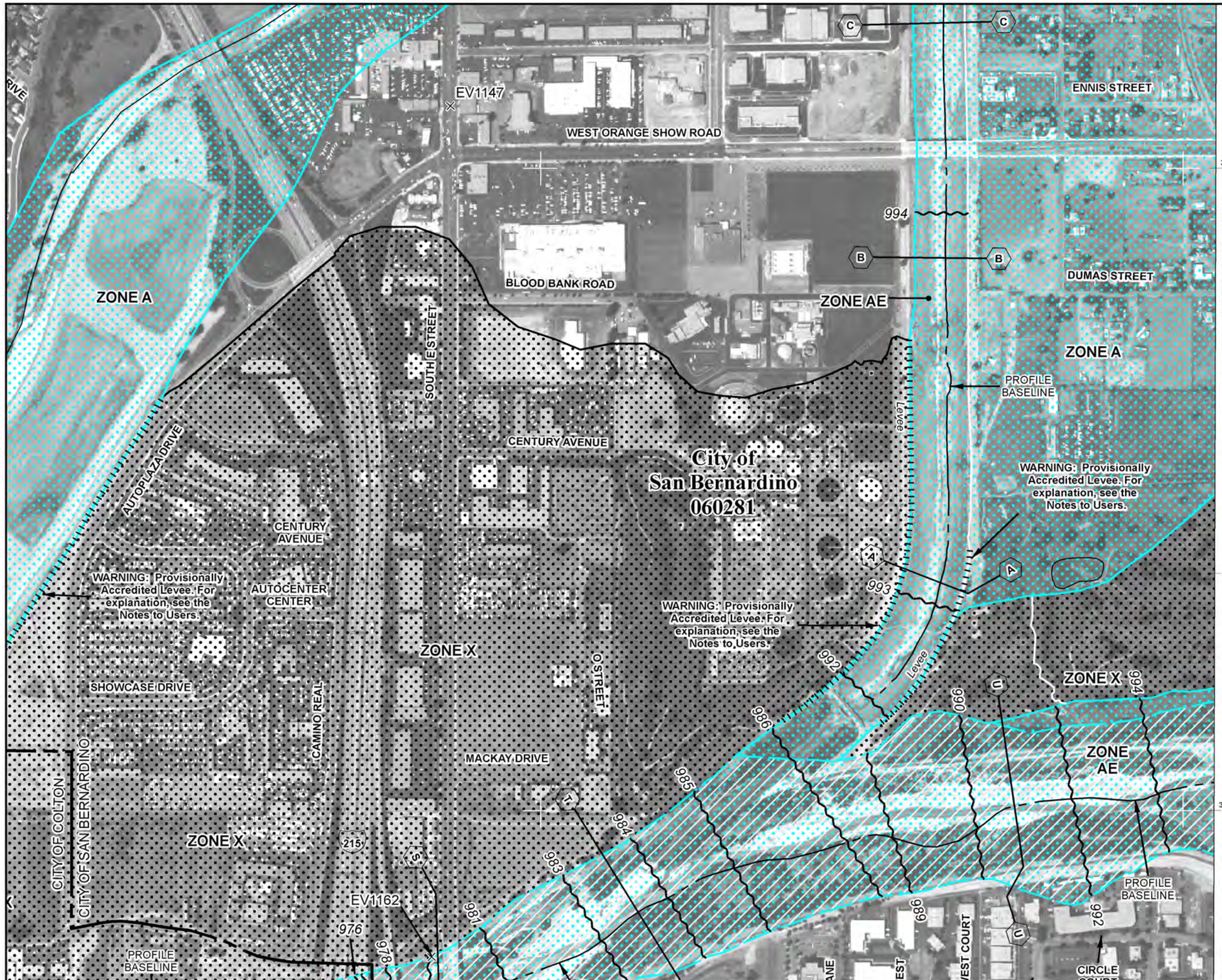

dional Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

50 0 500 1000 FEET

METERS

37°71'

JOINS PANEL 8684

37°70'

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 8683H

FIRM

FLOOD INSURANCE RATE MAP

SAN BERNARDINO COUNTY, CALIFORNIA

AND INCORPORATED AREAS

PANEL 8683 OF 9400

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

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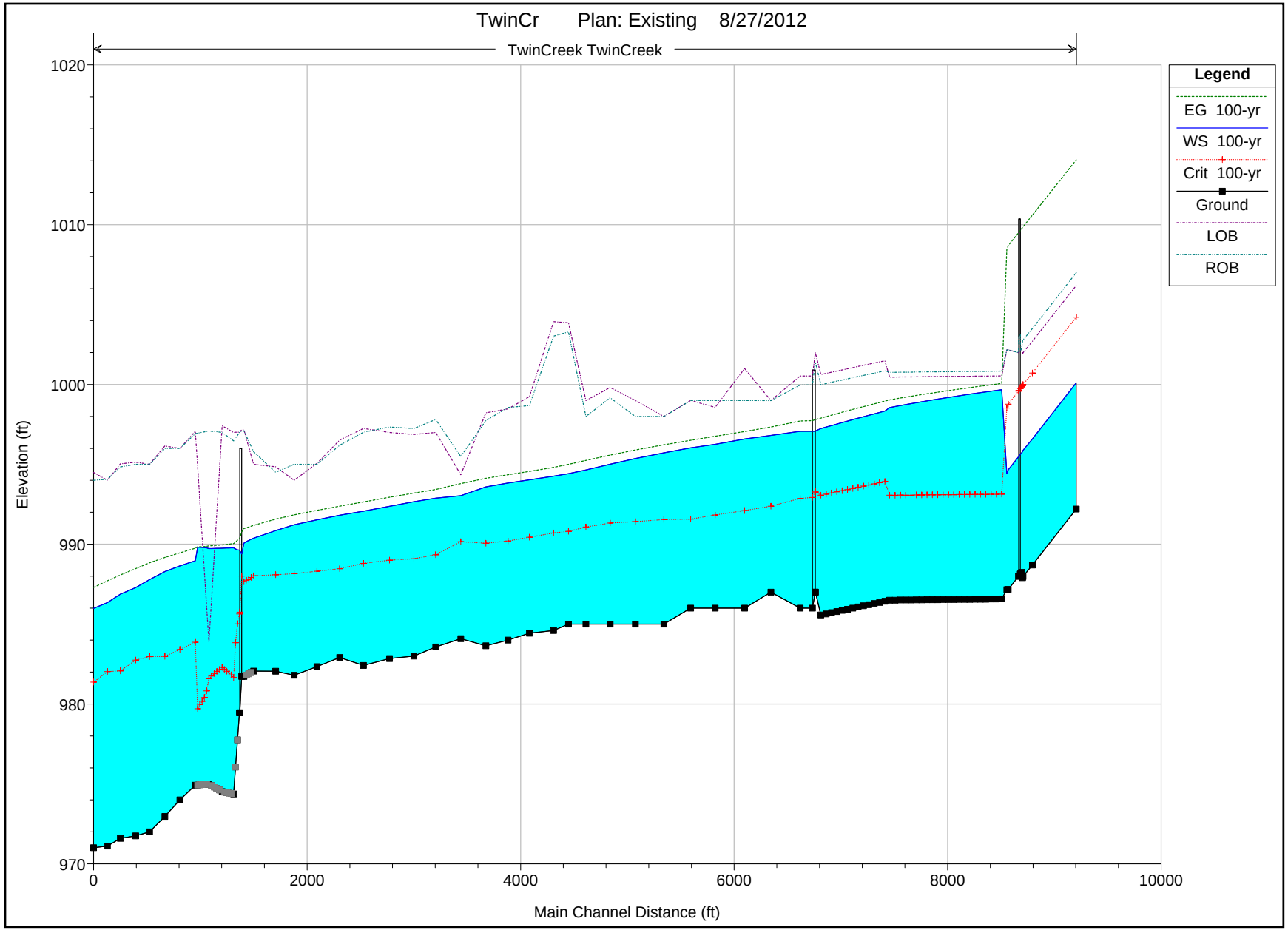
Attachment 1 - HEC-RAS Modeling Exhibits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TwinCreek TwinCreek
Legend
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WS 100-yr
Crit 100-yr
Ground
LOB
ROB
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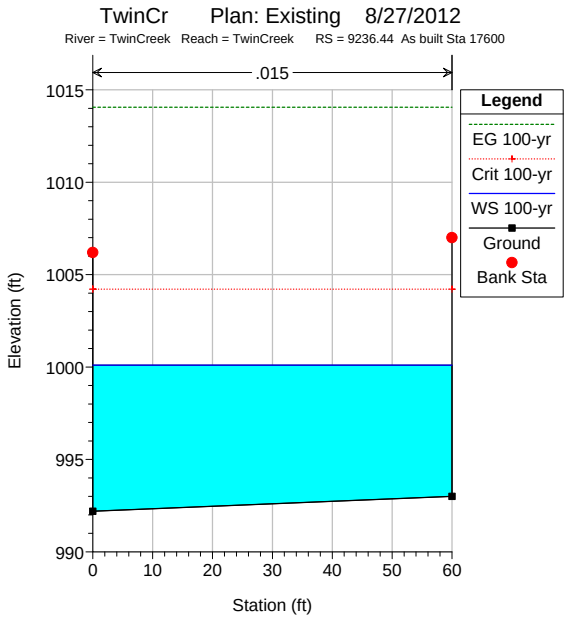
1010
1000
990
980
970
0
2000
4000
6000
8000
10000
Main Channel Distance (ft)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WS 100-yr
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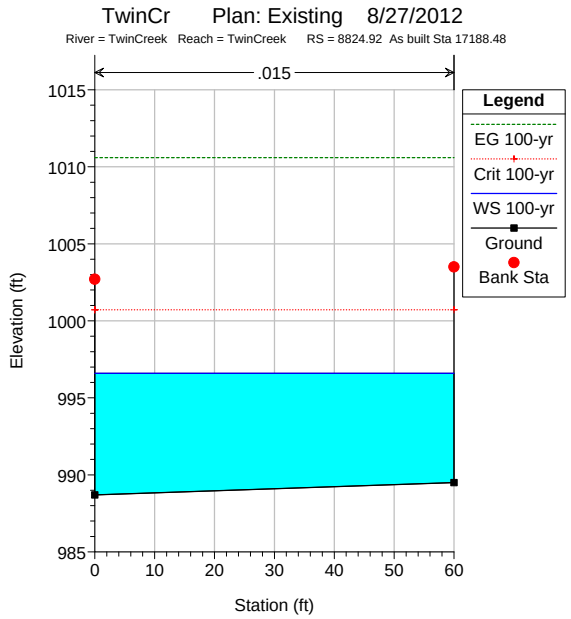
Bank Sta
Elevation (ft)
Station (ft)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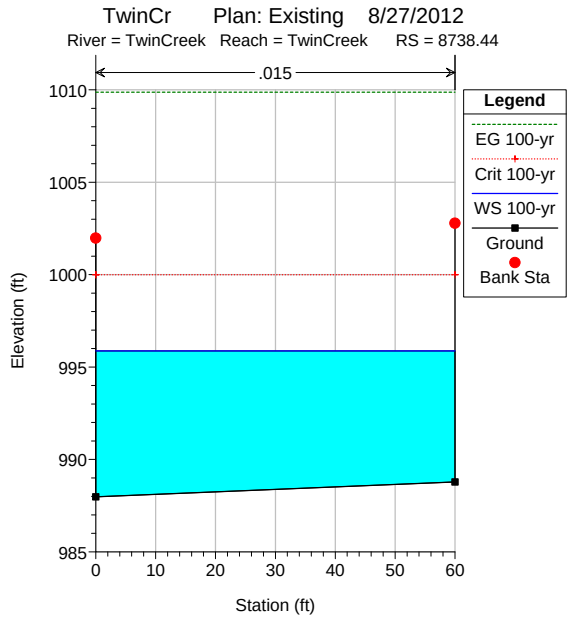
Ground
Bank Sta
Elevation (ft)
Station (ft)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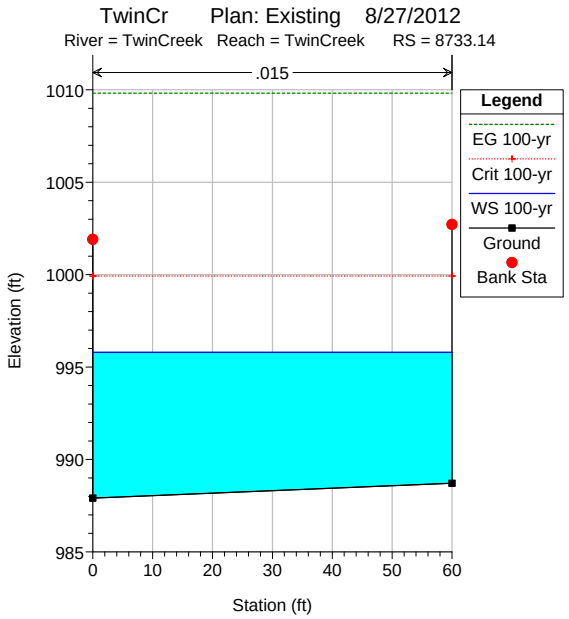
Station (ft)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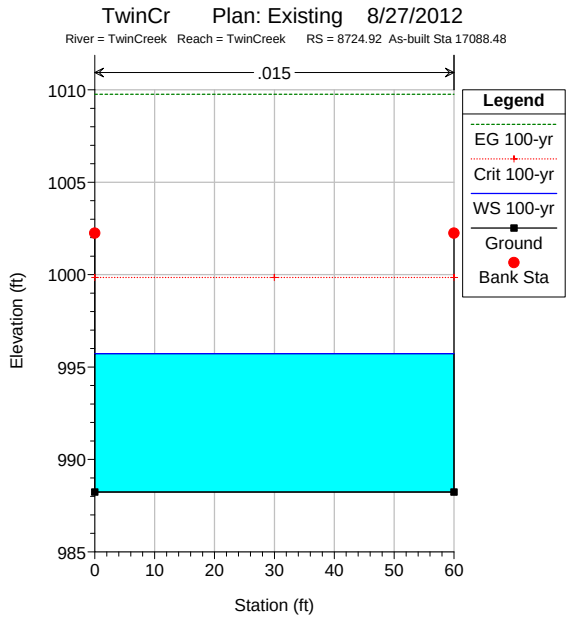
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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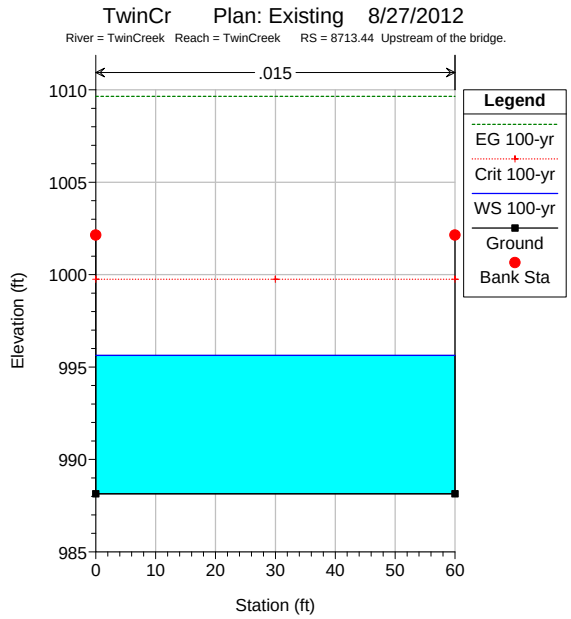
Ground
Bank Sta
Elevation (ft)
Station (ft)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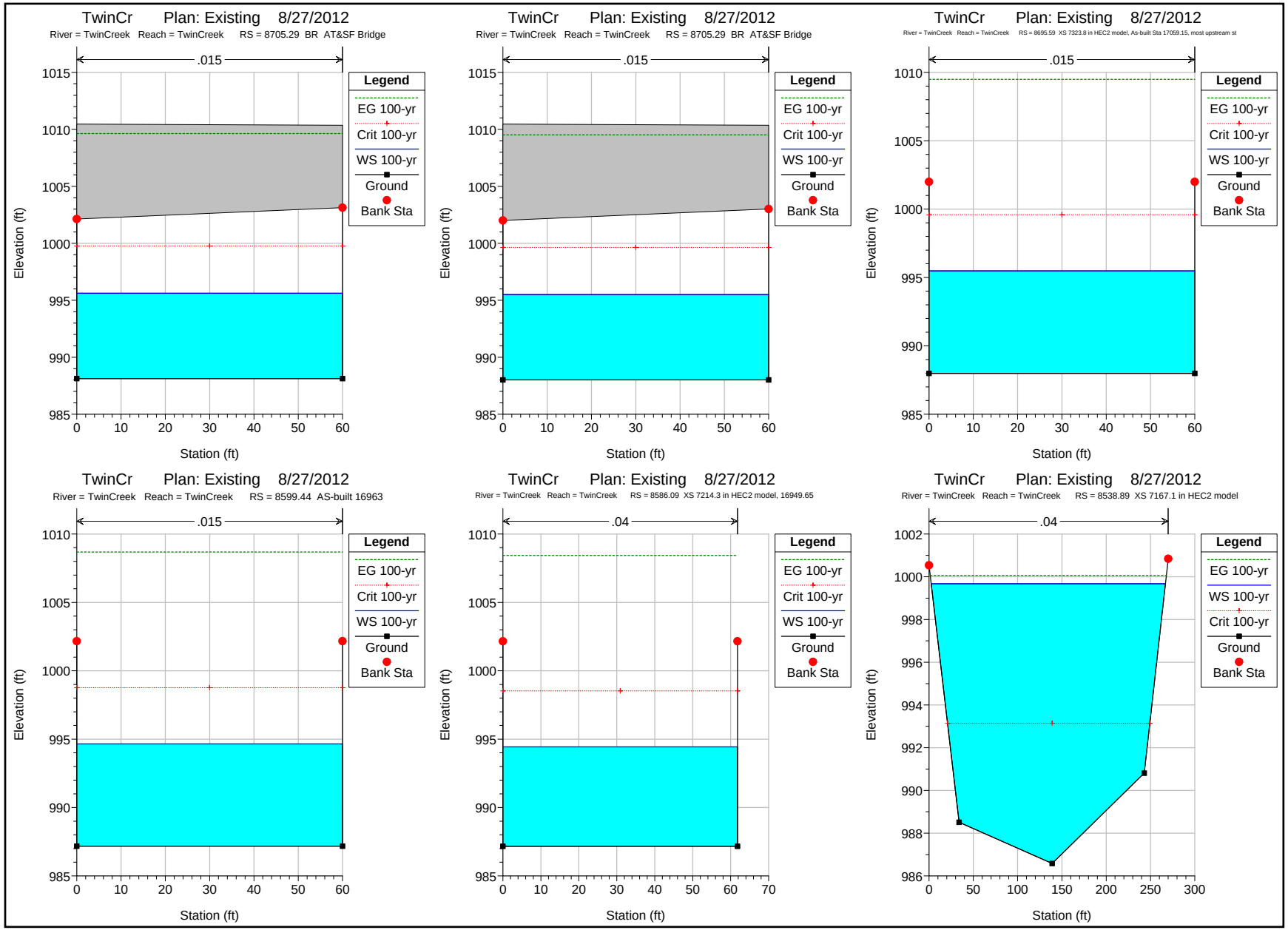
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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Legend
EG 100-yr
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8705.29 BR AT&SF Bridge
.015
Legend
EG 100-yr
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8695.59 XS 7323.8 in HEC2 model, As-built Sta 17059.15, most upstream st
.015
Legend
EG 100-yr
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8599.44 AS-built 16963
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EG 100-yr
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
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River = TwinCreek Reach = TwinCreek RS = 8586.09 XS 7214.3 in HEC2 model, 16949.65
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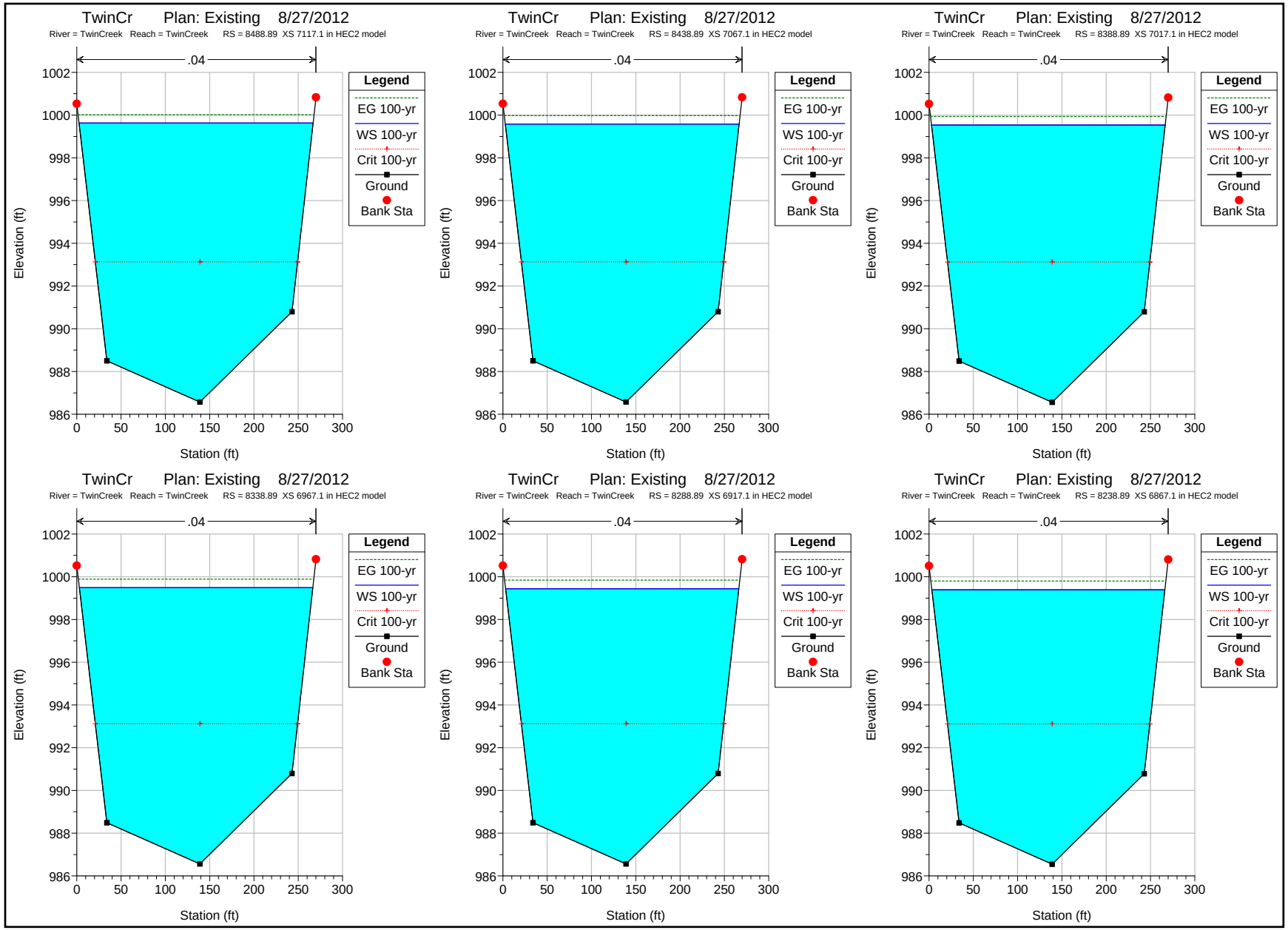
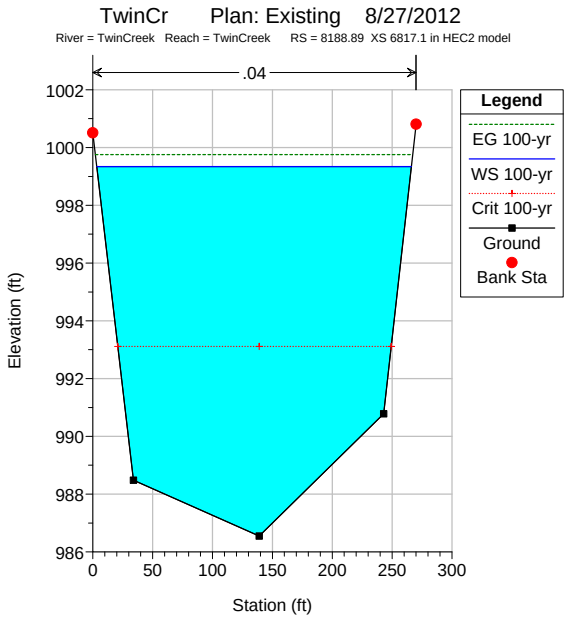
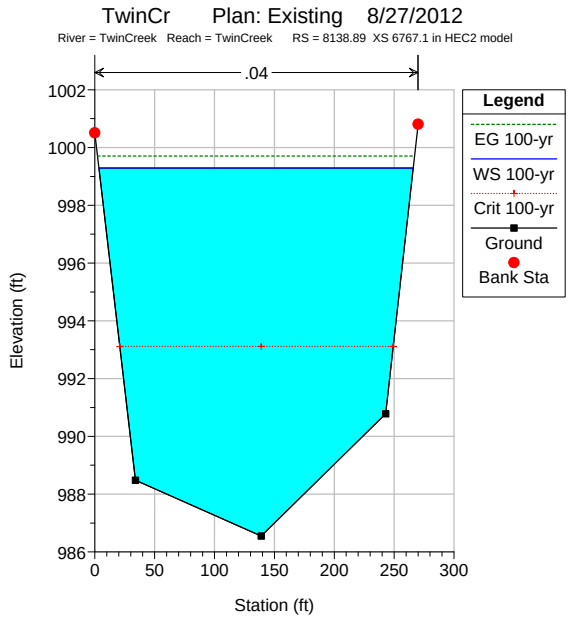
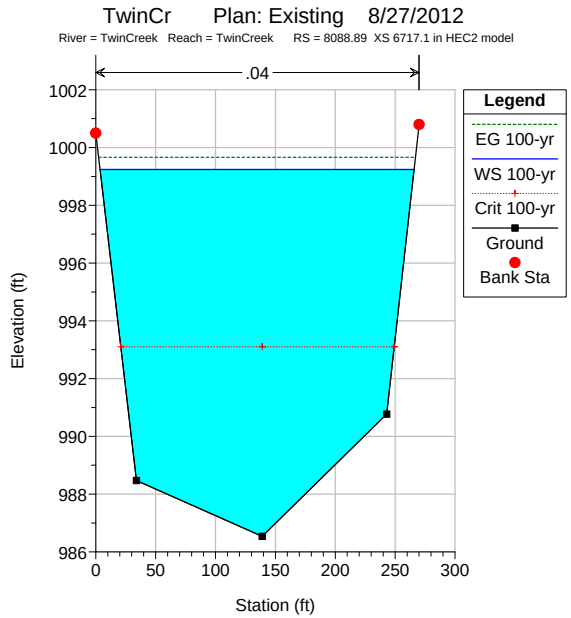
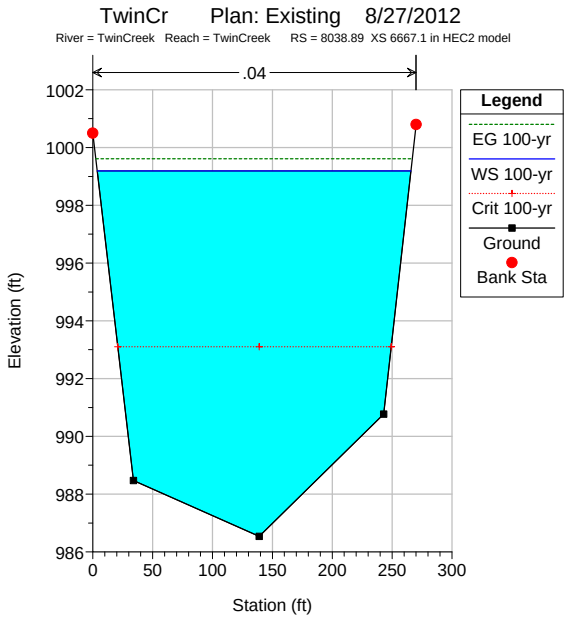
Legend
EG 100-yr
Crit 100-yr
WS 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8538.89 XS 7167.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

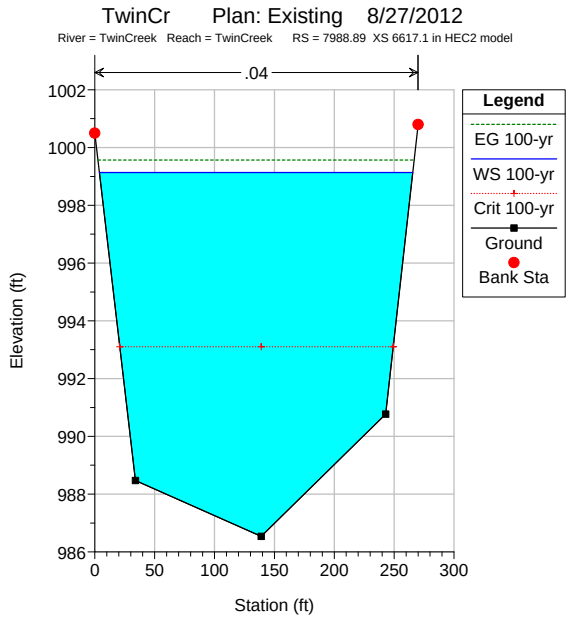

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8488.89 XS 7117.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8438.89 XS 7067.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8388.89 XS 7017.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8338.89 XS 6967.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8288.89 XS 6917.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8238.89 XS 6867.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1002
1000
998
996
994
992
990
988
986
0
50
100
150
200
250
300

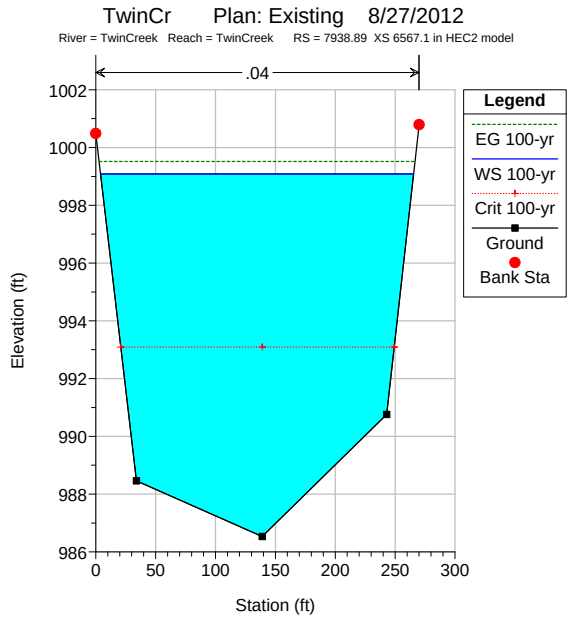

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8188.89 XS 6817.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

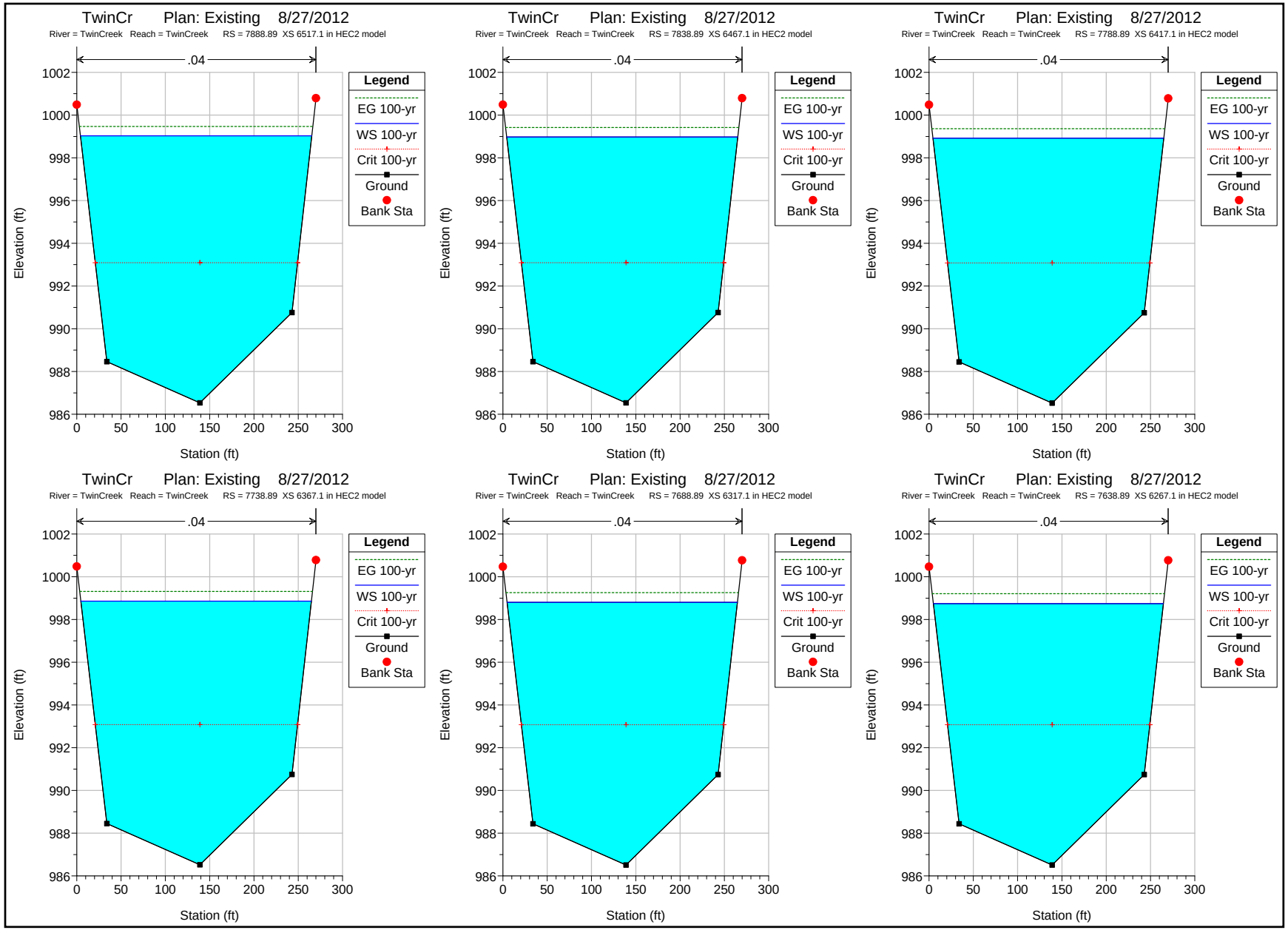

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8138.89 XS 6767.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

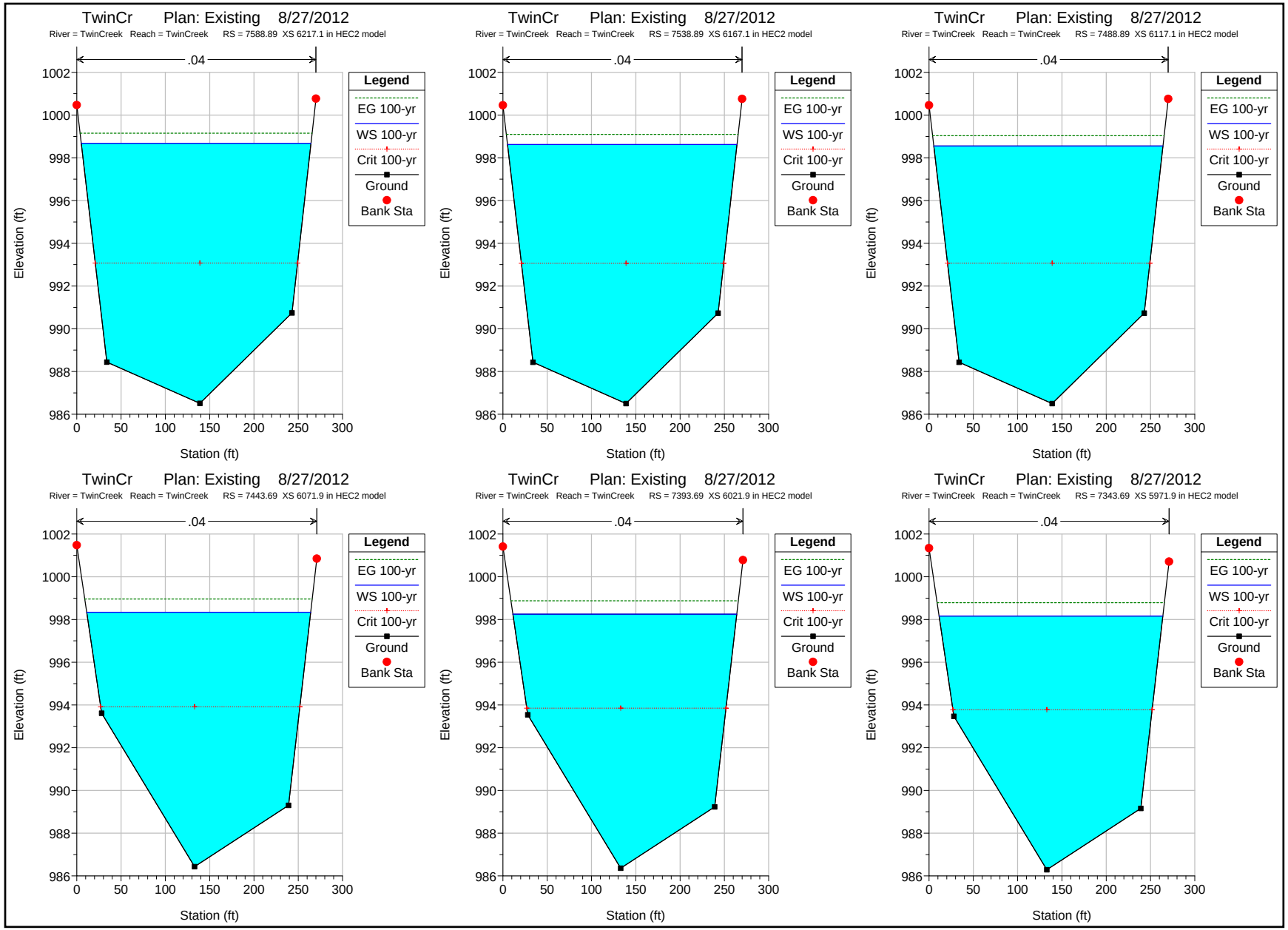

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8088.89 XS 6717.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

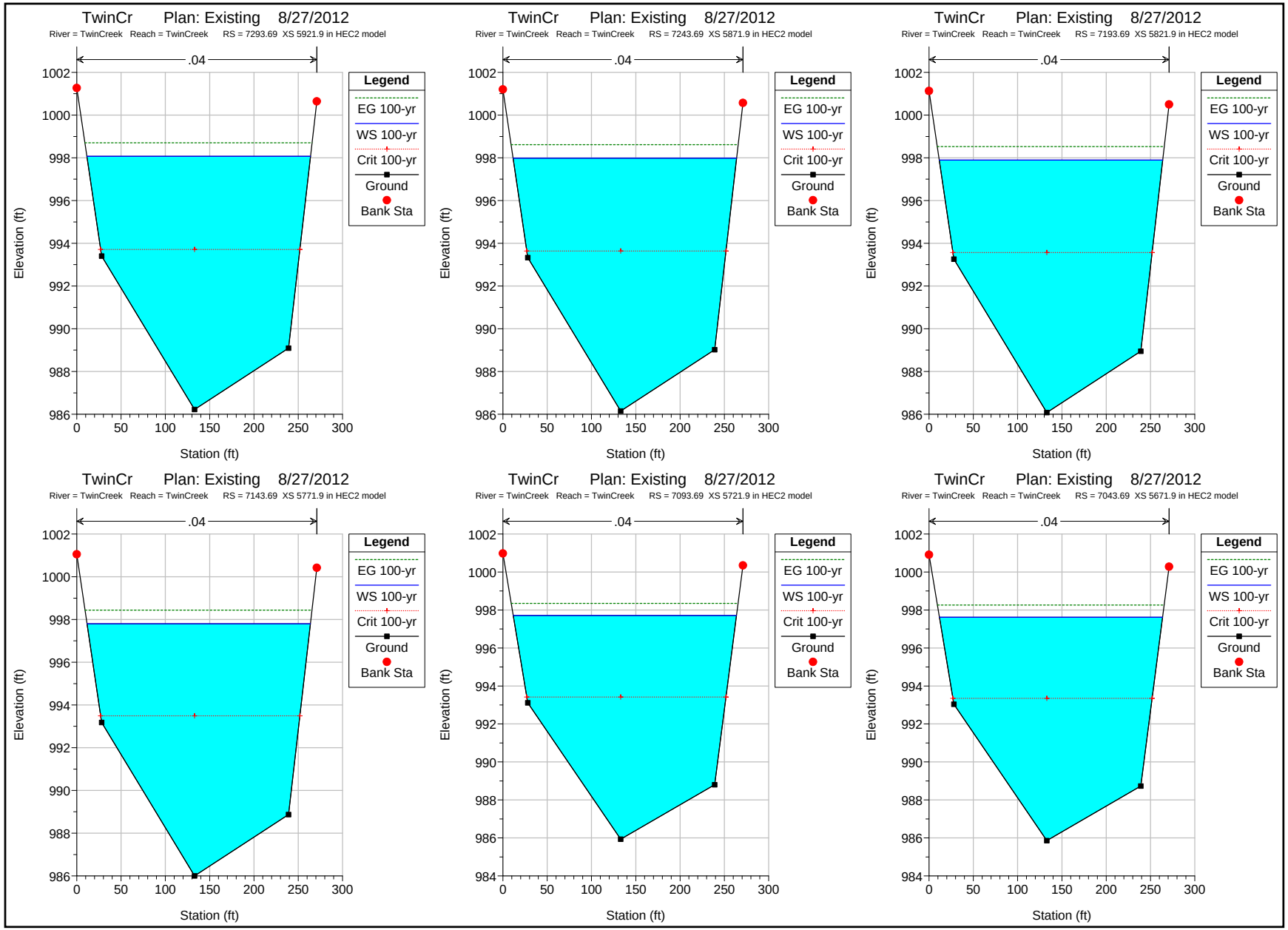

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 8038.89 XS 6667.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

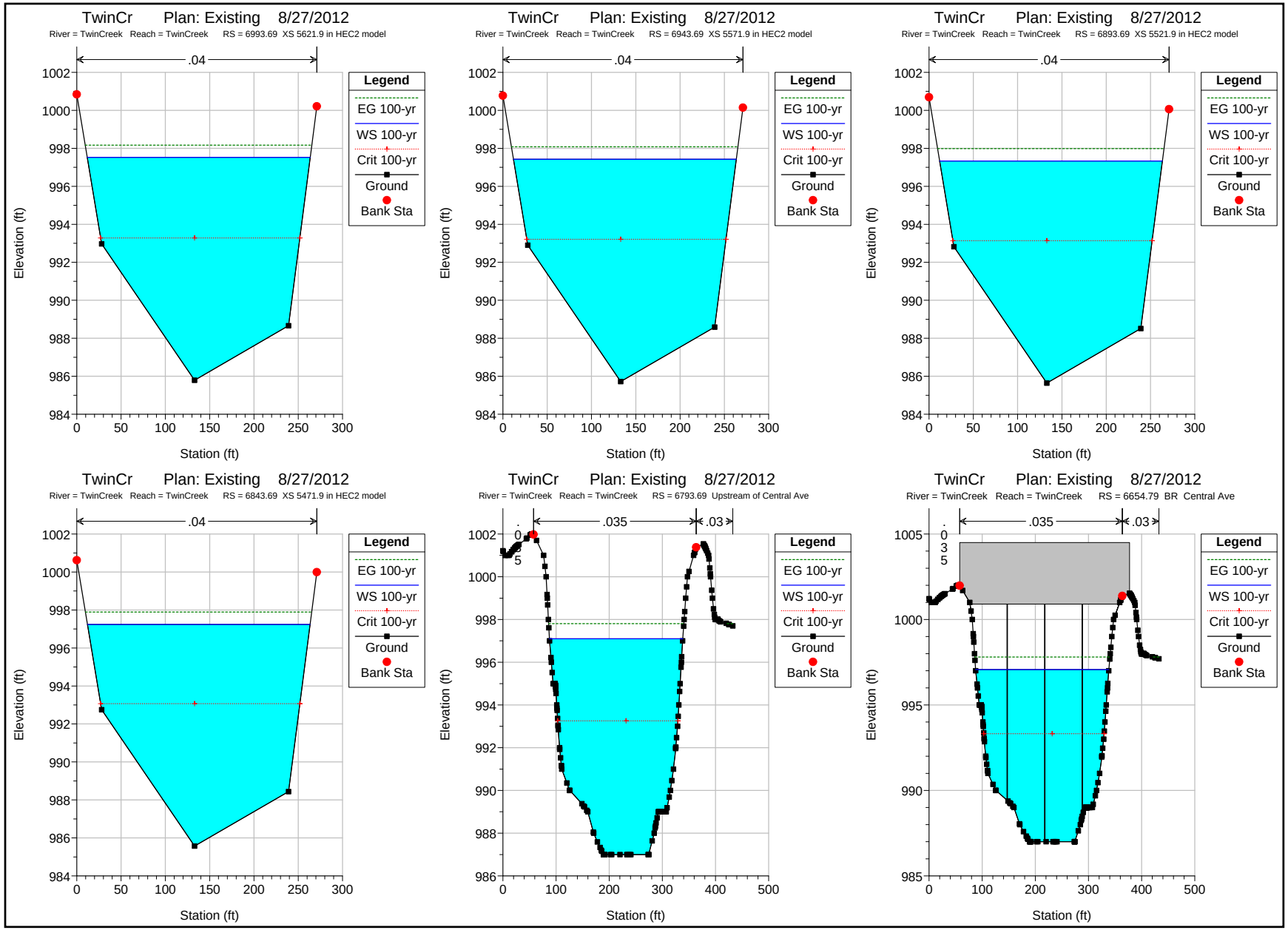

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7988.89 XS 6617.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

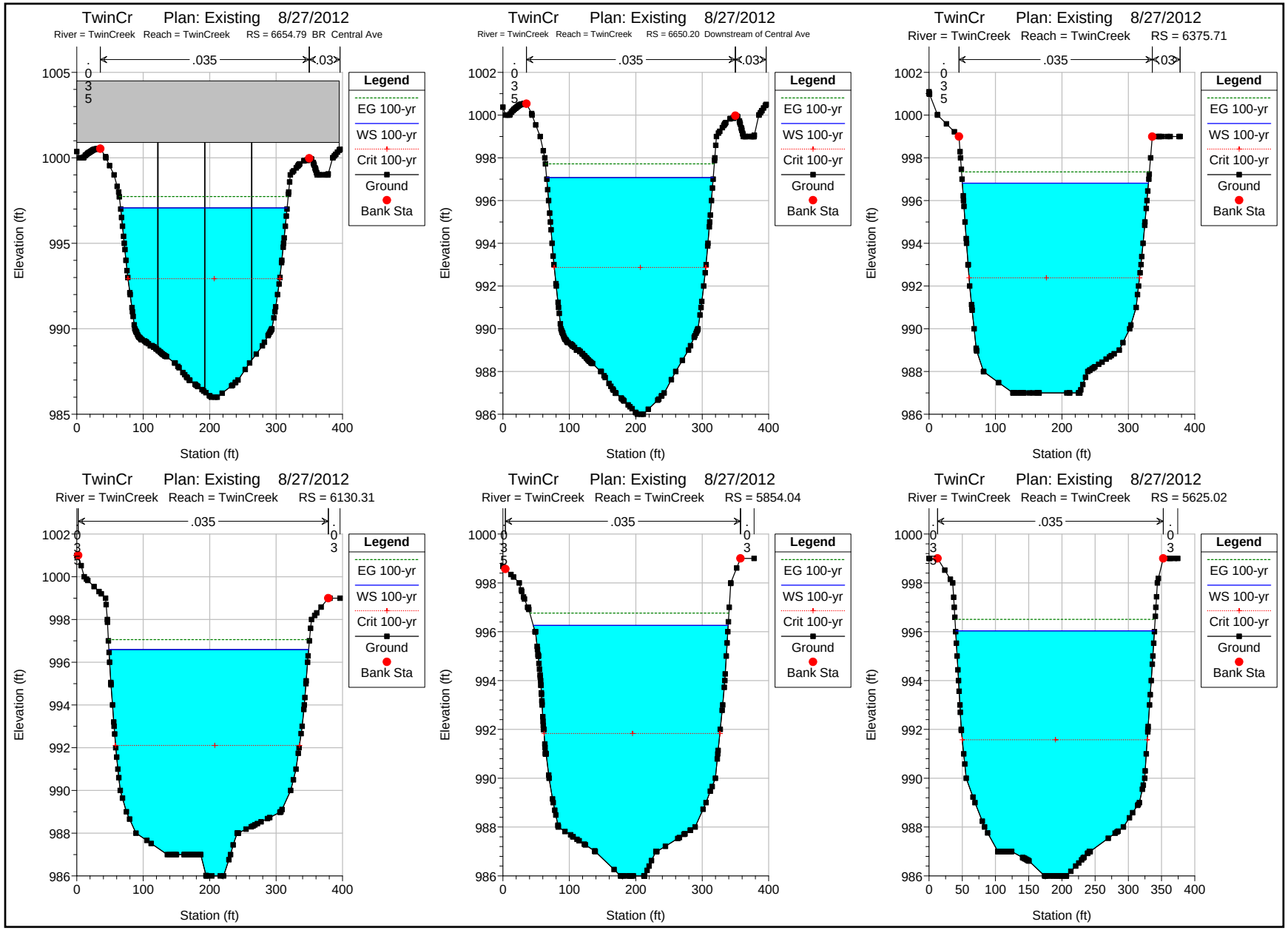

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7938.89 XS 6567.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

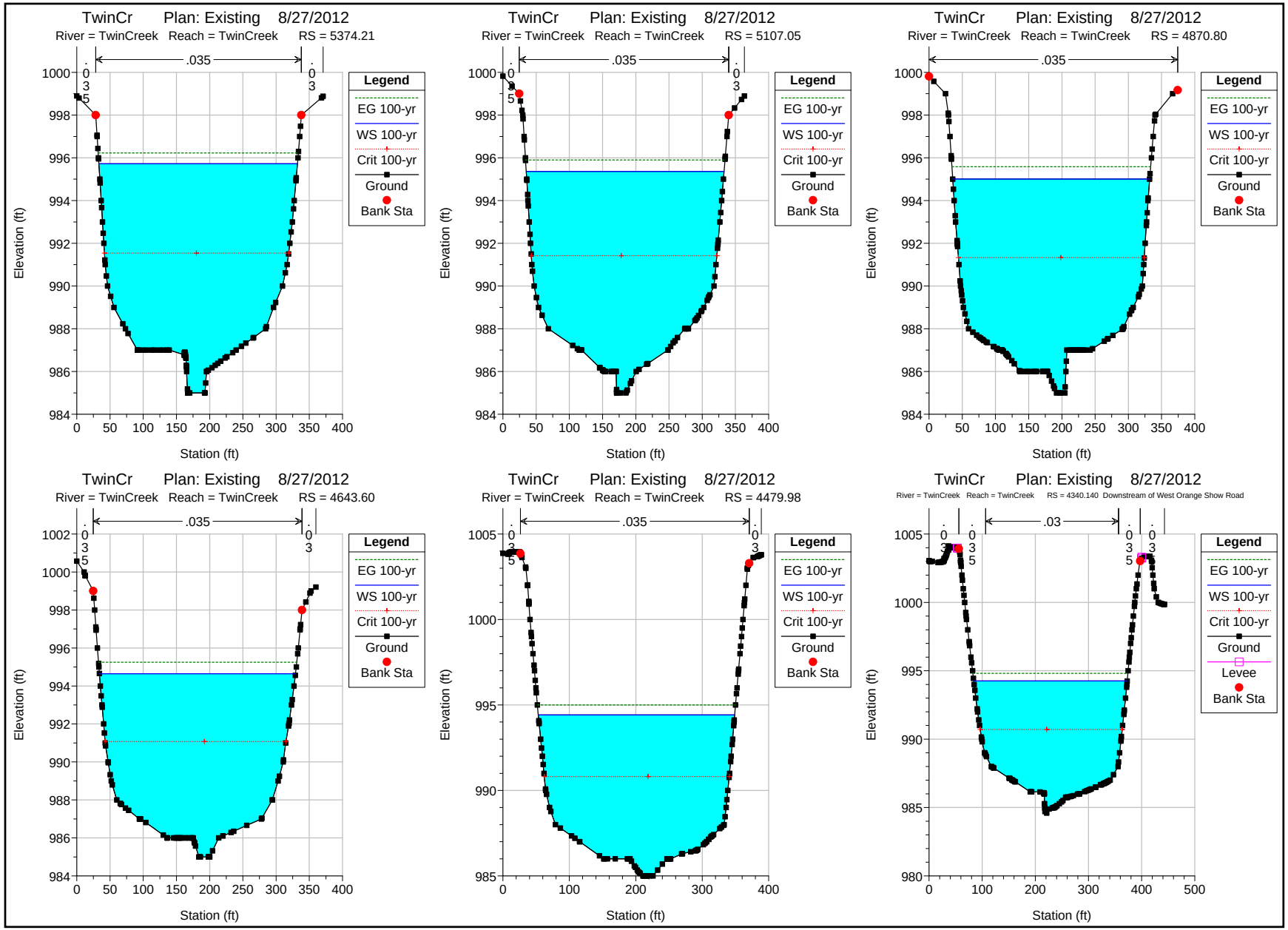

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7888.89 XS 6517.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7838.89 XS 6467.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7788.89 XS 6417.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7738.89 XS 6367.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7688.89 XS 6317.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7638.89 XS 6267.1 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1002
1000
998
996
994
992
990
988
986
0
50
100
150
200
250
300

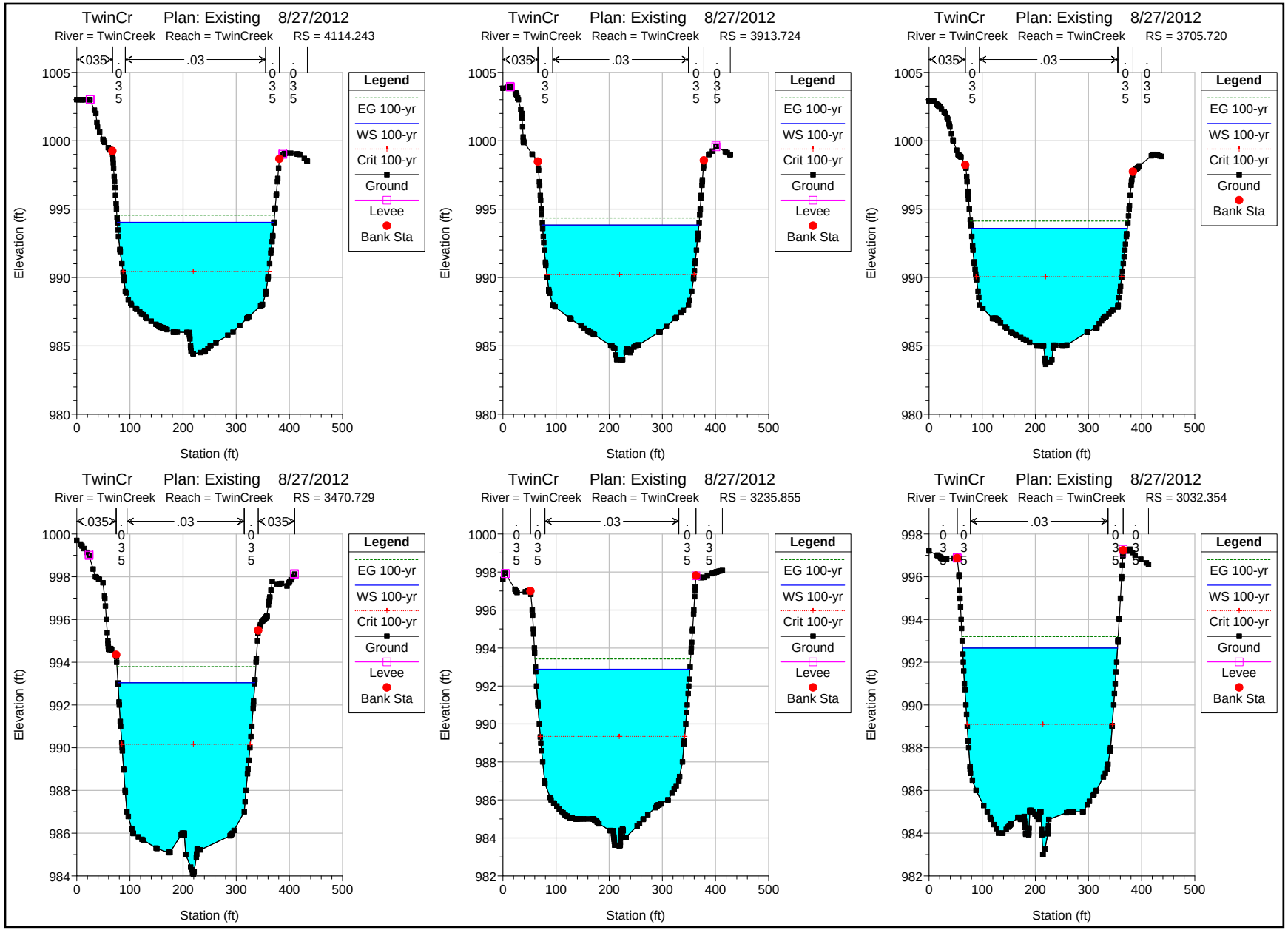

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7588.89 XS 6217.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7538.89 XS 6167.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7488.89 XS 6117.1 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7443.69 XS 6071.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7393.69 XS 6021.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7343.69 XS 5971.9 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1002
1000
998
996
994
992
990
988
986
0
50
100
150
200
250
300

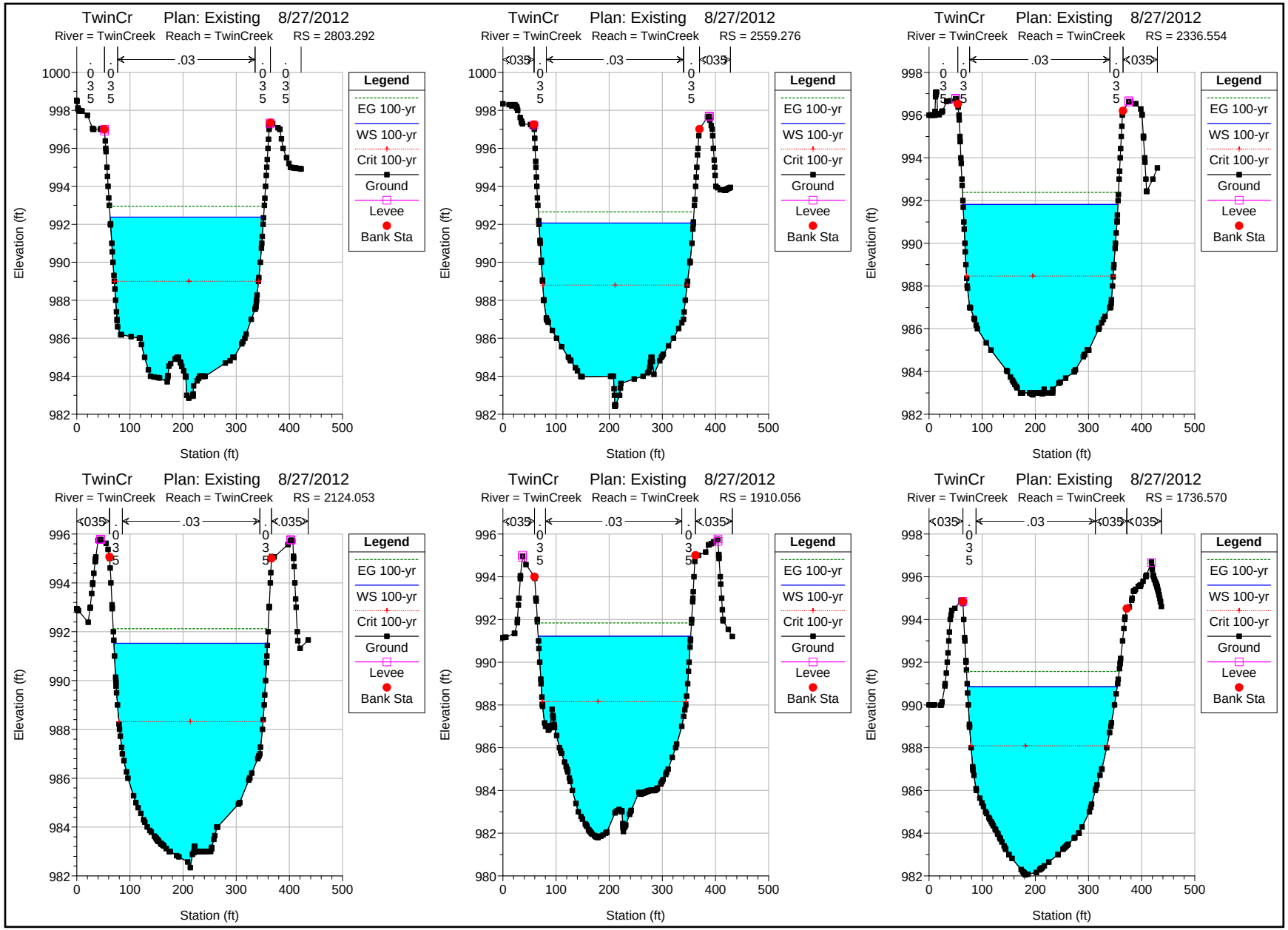

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7293.69 XS 5921.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7243.69 XS 5871.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7193.69 XS 5821.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7143.69 XS 5771.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7093.69 XS 5721.9 in HEC2 model
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 7043.69 XS 5671.9 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

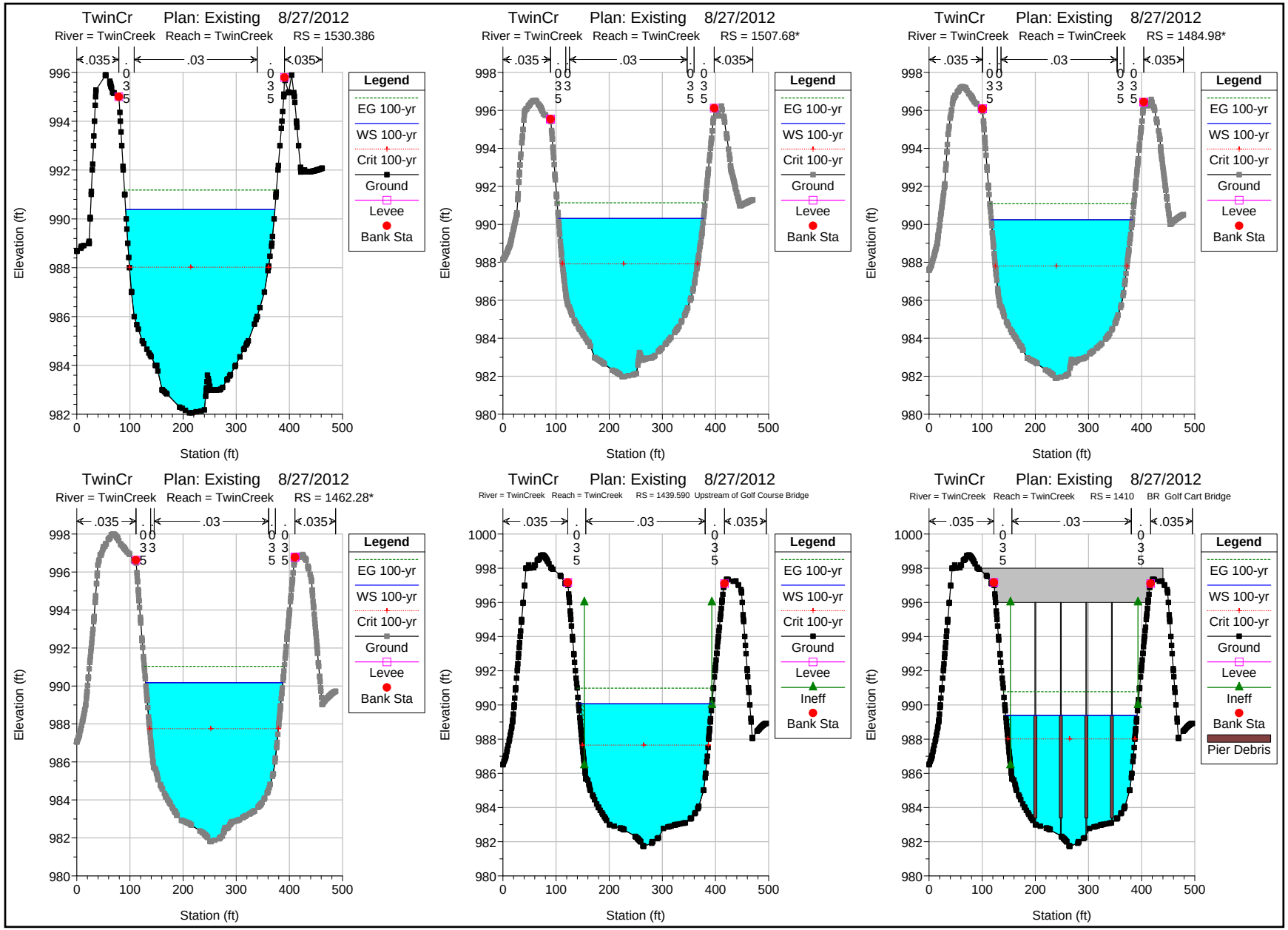

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6993.69 XS 5621.9 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6943.69 XS 5571.9 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6893.69 XS 5521.9 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6843.69 XS 5471.9 in HEC2 model
.04
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6793.69 Upstream of Central Ave
.035
.03
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6654.79 BR Central Ave
.035
.03
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

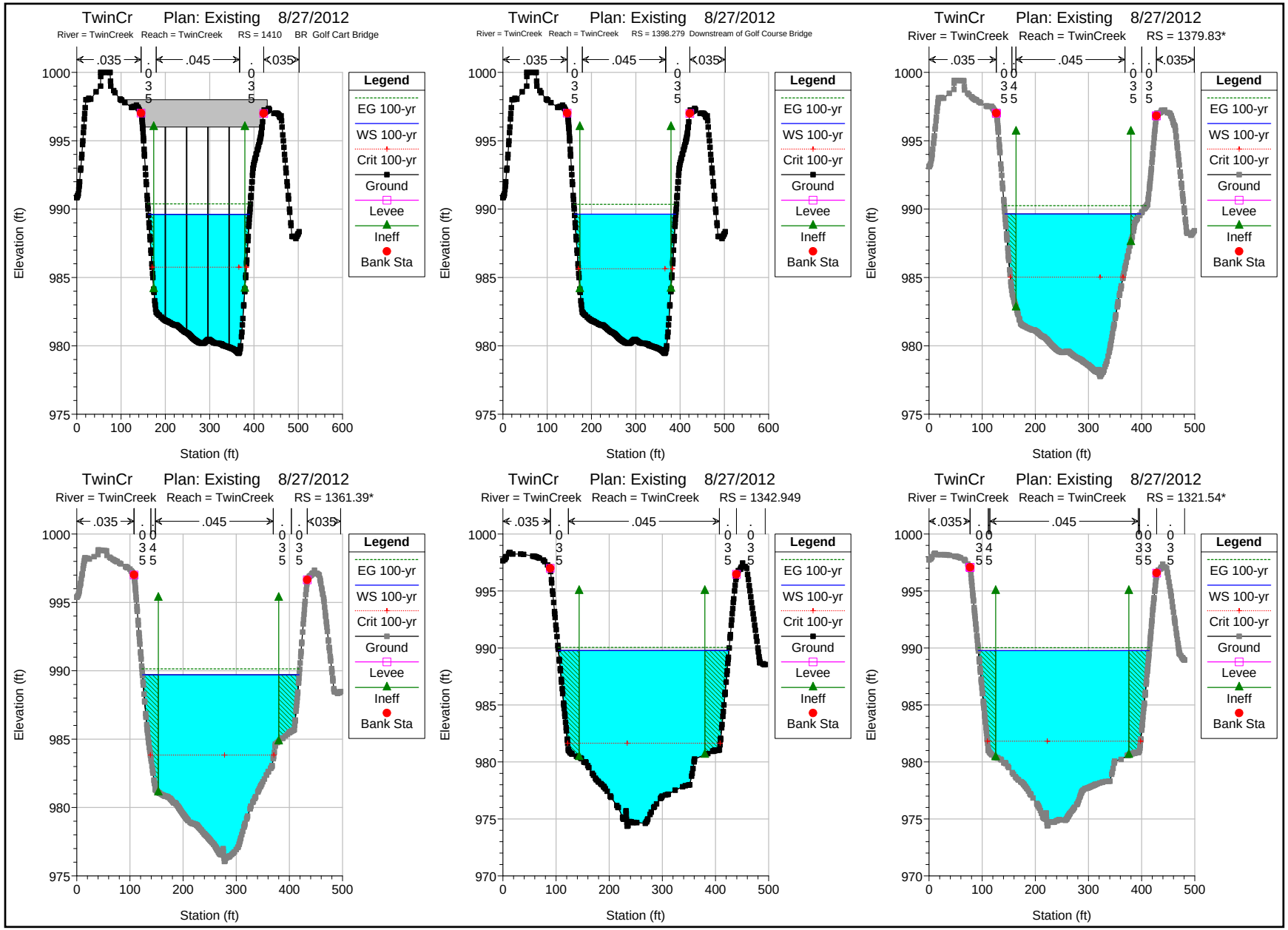

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6654.79 BR Central Ave
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6650.20 Downstream of Central Ave
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6375.71
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 6130.31
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 5854.04
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 5625.02
.035
.03
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

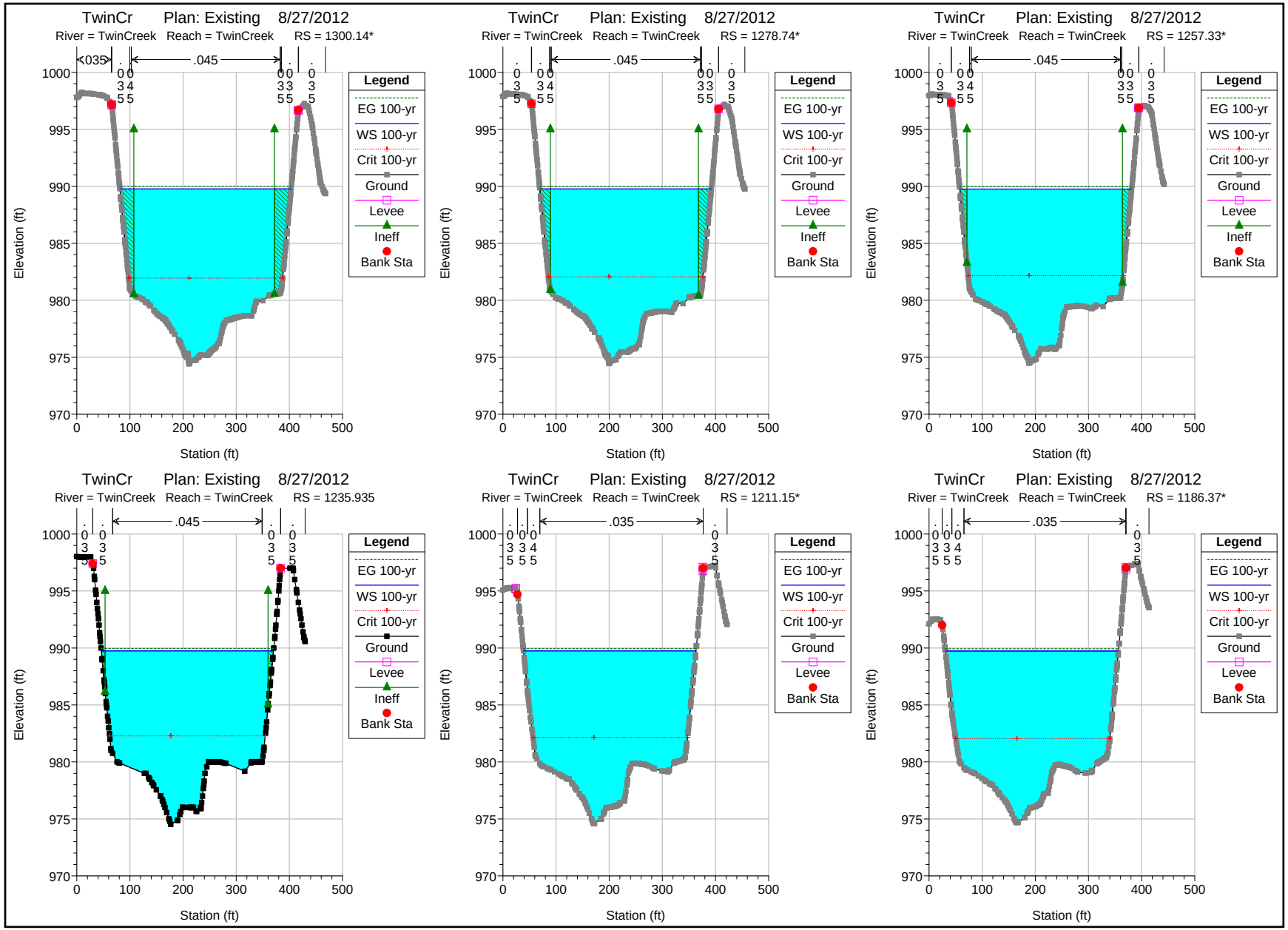

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 5374.21
.035
.035
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 5107.05
.035
.035
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 4870.80
.035
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 4643.60
.035
.035
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 4479.98
.035
.035
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 4340.140 Downstream of West Orange Show Road
.03
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

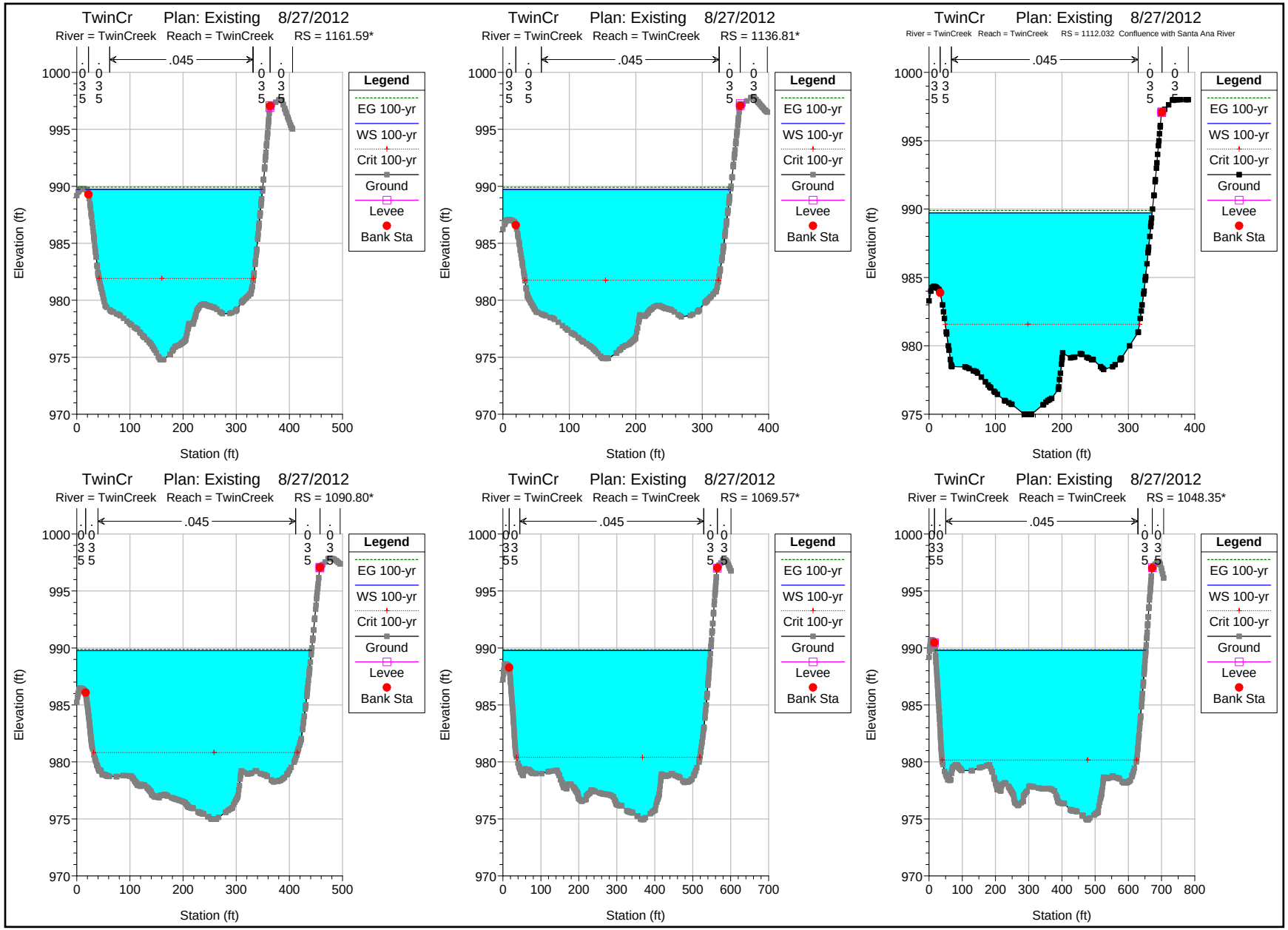

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 4114.243
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 3913.724
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 3705.720
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 3470.729
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 3235.855
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 3032.354
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

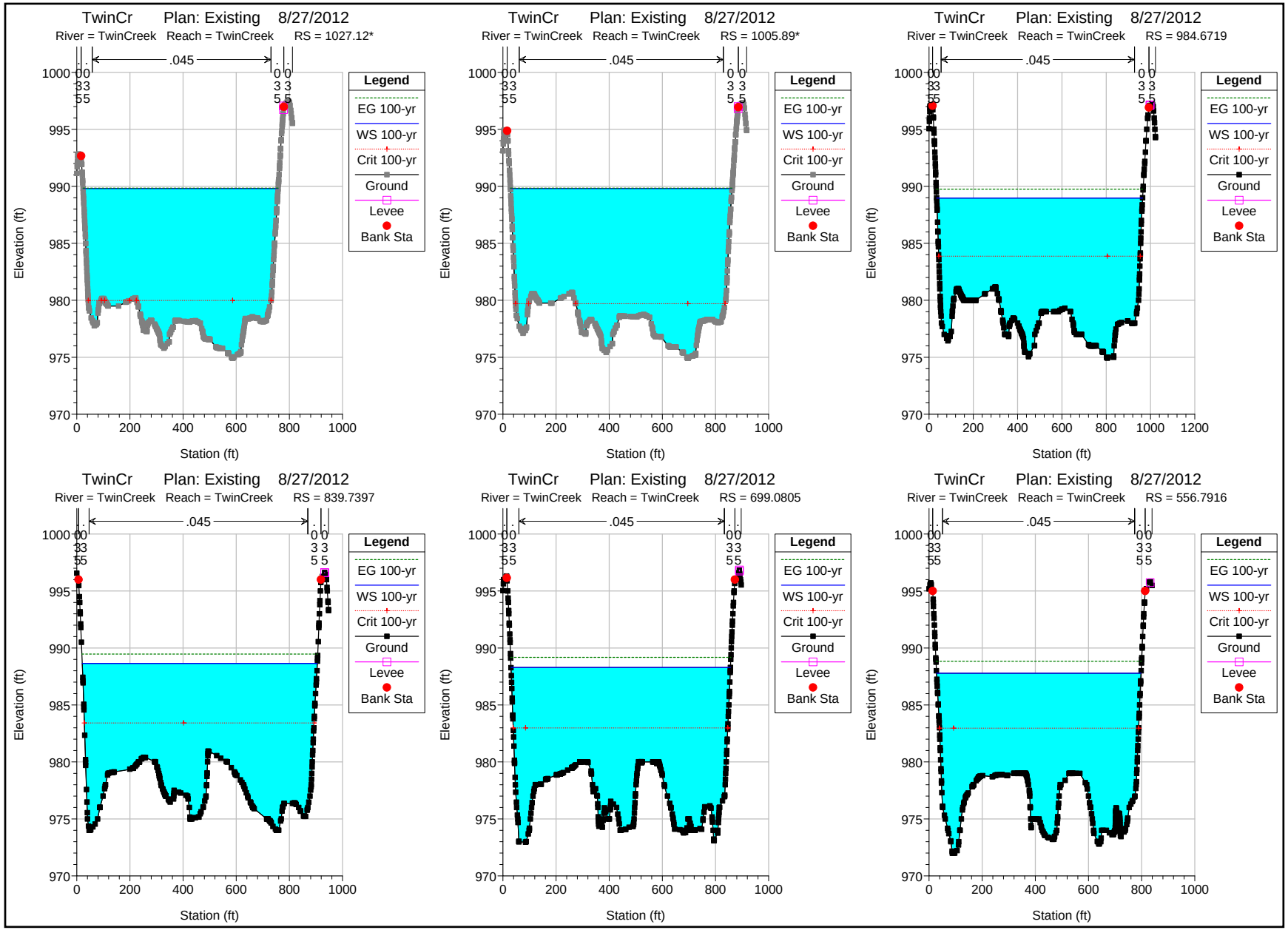

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 2803.292
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 2559.276
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 2336.554
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 2124.053
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1910.056
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1736.570
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
.035
.03

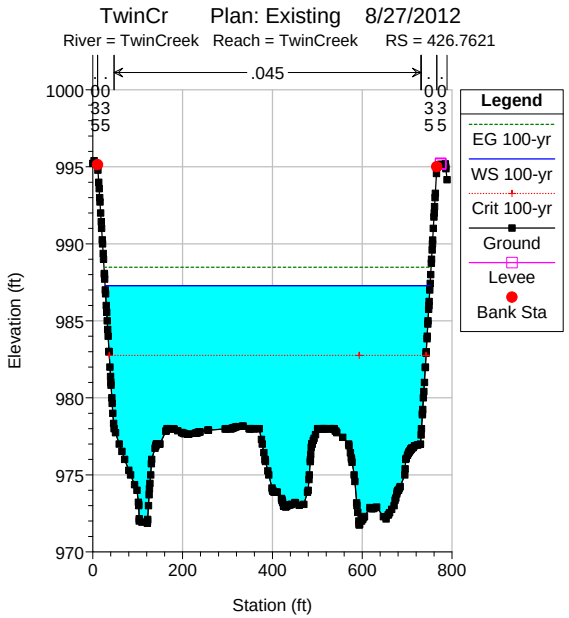

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1530.386
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1507.68*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1484.98*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1462.28*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1439.590 Upstream of Golf Course Bridge
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1410 BR Golf Cart Bridge
.035
.03
Elevation (ft)
Station (ft)
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Ineff
Bank Sta
Pier Debris

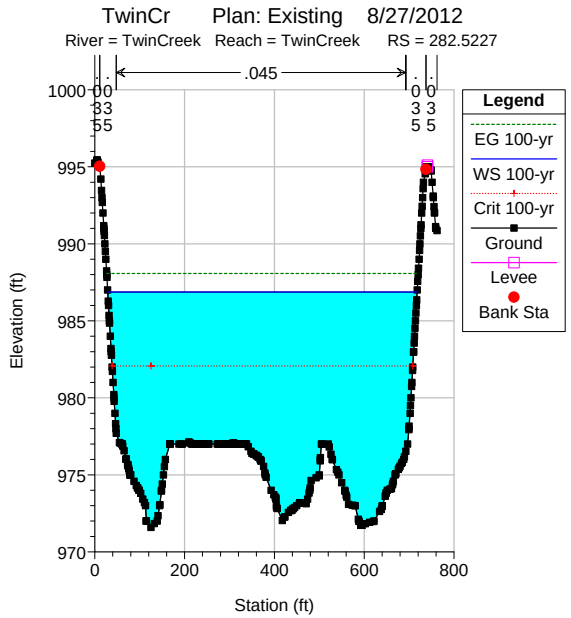

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1410 BR Golf Cart Bridge
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1398.279 Downstream of Golf Course Bridge
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1379.83*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1361.39*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1342.949
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1321.54*
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

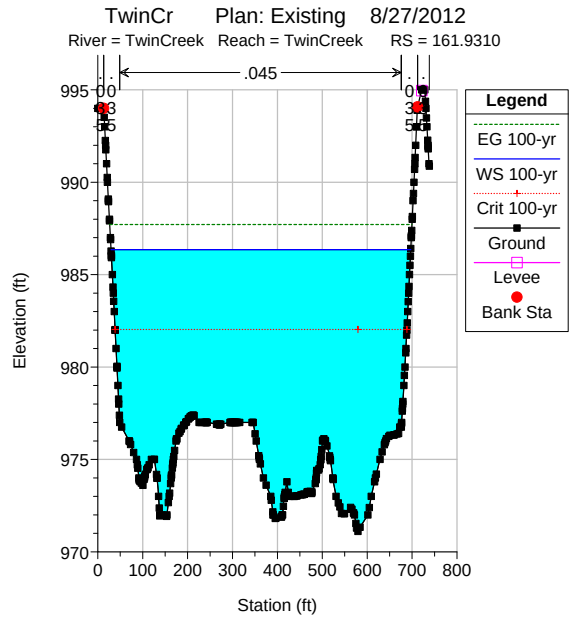

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1300.14*
.045
.035
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1278.74*
.045
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1257.33*
.045
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1235.935
.045
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1211.15*
.035
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1186.37*
.035
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
970
975
980
985
990
995
1000
0
100
200
300
400
500

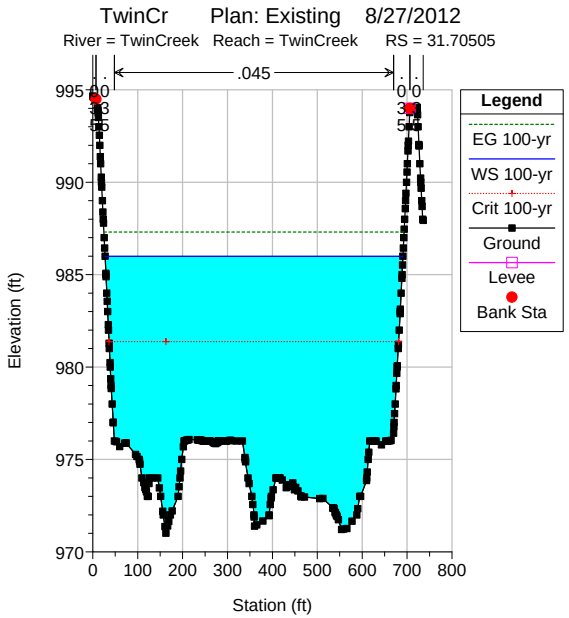

TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1161.59*
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1136.81*
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1112.032 Confluence with Santa Ana River
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1090.80*
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1069.57*
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1048.35*
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1027.12*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 1005.89*
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 984.6719
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 839.7397
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 699.0805
TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 556.7916
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 426.7621
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 282.5227
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 161.9310
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


TwinCr Plan: Existing 8/27/2012
River = TwinCreek Reach = TwinCreek RS = 31.70505
.045
Legend
EG 100-yr
WS 100-yr
Crit 100-yr
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

Attachment 2 – Hydraulic Analysis Results

HEC-RAS Plan: Existing River: TwinCreek Reach: TwinCreek Profile: 100-yr

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)	
TwinCreek	9236.44	100-yr	13500.00	992.20	1000.11	1004.21	1014.06	0.008393	29.98	450.34	60.00	1.93
TwinCreek	8824.92	100-yr	13500.00	988.70	996.59	1000.71	1010.60	0.008442	30.03	449.50	60.00	1.93
TwinCreek	8738.44	100-yr	13500.00	987.98	995.87	999.99	1009.87	0.008429	30.02	449.71	60.00	1.93
TwinCreek	8733.14	100-yr	13500.00	987.91	995.80	999.92	1009.82	0.008459	30.05	449.19	60.00	1.94
TwinCreek	8724.92	100-yr	13500.00	988.24	995.73	999.85	1009.75	0.008461	30.06	449.14	60.00	1.94
TwinCreek	8713.44	100-yr	13500.00	988.14	995.63	999.75	1009.65	0.008451	30.05	449.32	60.00	1.93
TwinCreek	8705.29		Bridge									
TwinCreek	8695.59	100-yr	13500.00	987.99	995.48	999.58	1009.49	0.008446	30.04	449.41	60.00	1.93
TwinCreek	8599.44	100-yr	13500.00	987.17	994.66	998.76	1008.69	0.008462	30.06	449.13	60.00	1.94
TwinCreek	8586.09	100-yr	13500.00	987.16	994.43	998.53	1008.44	0.061477	30.03	449.53	61.81	1.96
TwinCreek	8538.89	100-yr	13500.00	986.58	999.67	993.14	1000.06	0.000836	5.01	2696.81	264.40	0.28
TwinCreek	8488.89	100-yr	13500.00	986.57	999.63	993.13	1000.02	0.000845	5.02	2687.61	264.21	0.28
TwinCreek	8438.89	100-yr	13500.00	986.57	999.58	993.13	999.98	0.000856	5.05	2675.39	263.96	0.28
TwinCreek	8388.89	100-yr	13500.00	986.56	999.54	993.12	999.93	0.000866	5.06	2665.91	263.76	0.28
TwinCreek	8338.89	100-yr	13500.00	986.56	999.49	993.12	999.89	0.000878	5.09	2653.39	263.50	0.28
TwinCreek	8288.89	100-yr	13500.00	986.56	999.44	993.12	999.85	0.000891	5.11	2640.69	263.23	0.28
TwinCreek	8238.89	100-yr	13500.00	986.55	999.39	993.11	999.80	0.000901	5.13	2630.70	263.02	0.29
TwinCreek	8188.89	100-yr	13500.00	986.55	999.34	993.11	999.76	0.000915	5.16	2617.65	262.75	0.29
TwinCreek	8138.89	100-yr	13500.00	986.55	999.29	993.11	999.71	0.000929	5.18	2604.41	262.47	0.29
TwinCreek	8088.89	100-yr	13500.00	986.54	999.24	993.10	999.66	0.000941	5.20	2593.84	262.25	0.29
TwinCreek	8038.89	100-yr	13500.00	986.54	999.19	993.10	999.61	0.000956	5.23	2580.23	261.96	0.29
TwinCreek	7988.89	100-yr	13500.00	986.54	999.14	993.10	999.57	0.000972	5.26	2566.37	261.67	0.30
TwinCreek	7938.89	100-yr	13500.00	986.53	999.08	993.09	999.52	0.000985	5.28	2555.16	261.43	0.30
TwinCreek	7888.89	100-yr	13500.00	986.53	999.03	993.09	999.47	0.001002	5.31	2540.87	261.13	0.30
TwinCreek	7838.89	100-yr	13500.00	986.53	998.97	993.09	999.42	0.001020	5.34	2526.33	260.82	0.30
TwinCreek	7788.89	100-yr	13500.00	986.52	998.92	993.08	999.37	0.001034	5.37	2514.42	260.57	0.30
TwinCreek	7738.89	100-yr	13500.00	986.52	998.86	993.08	999.31	0.001053	5.40	2499.40	260.25	0.31
TwinCreek	7688.89	100-yr	13500.00	986.51	998.80	993.07	999.26	0.001070	5.43	2487.00	259.99	0.31
TwinCreek	7638.89	100-yr	13500.00	986.51	998.74	993.07	999.21	0.001090	5.46	2471.45	259.66	0.31
TwinCreek	7588.89	100-yr	13500.00	986.51	998.68	993.07	999.15	0.001112	5.50	2455.56	259.32	0.31
TwinCreek	7538.89	100-yr	13500.00	986.50	998.62	993.07	999.09	0.001130	5.53	2442.26	259.04	0.32
TwinCreek	7488.89	100-yr	13500.00	986.50	998.55	993.07	999.04	0.001154	5.57	2425.46	258.68	0.32
TwinCreek	7443.69	100-yr	13500.00	986.43	998.34	993.92	998.96	0.001703	6.32	2136.81	252.87	0.38
TwinCreek	7393.69	100-yr	13500.00	986.36	998.25	993.85	998.87	0.001714	6.33	2132.26	252.76	0.38
TwinCreek	7343.69	100-yr	13500.00	986.29	998.16	993.78	998.79	0.001726	6.35	2127.54	252.64	0.39
TwinCreek	7293.69	100-yr	13500.00	986.22	998.07	993.71	998.70	0.001738	6.36	2122.63	252.52	0.39
TwinCreek	7243.69	100-yr	13500.00	986.15	997.98	993.64	998.61	0.001750	6.38	2117.54	252.39	0.39
TwinCreek	7193.69	100-yr	13500.00	986.08	997.89	993.57	998.53	0.001764	6.39	2112.26	252.26	0.39
TwinCreek	7143.69	100-yr	13500.00	986.00	997.80	993.49	998.44	0.001770	6.40	2109.78	252.19	0.39
TwinCreek	7093.69	100-yr	13500.00	985.93	997.71	993.42	998.35	0.001784	6.42	2104.19	252.05	0.39
TwinCreek	7043.69	100-yr	13500.00	985.86	997.62	993.35	998.26	0.001800	6.43	2098.38	251.91	0.39
TwinCreek	6993.69	100-yr	13500.00	985.79	997.52	993.28	998.17	0.001815	6.45	2092.32	251.75	0.39
TwinCreek	6943.69	100-yr	13500.00	985.72	997.43	993.21	998.08	0.001832	6.47	2086.02	251.60	0.40
TwinCreek	6893.69	100-yr	13500.00	985.64	997.33	993.13	997.99	0.001842	6.48	2082.49	251.51	0.40
TwinCreek	6843.69	100-yr	13500.00	985.57	997.24	993.07	997.90	0.001859	6.50	2076.06	251.35	0.40
TwinCreek	6793.69	100-yr	13500.00	987.00	997.10	993.26	997.80	0.001609	6.75	1999.73	250.90	0.42
TwinCreek	6654.79		Bridge									
TwinCreek	6650.20	100-yr	13500.00	986.00	997.07	992.87	997.72	0.001376	6.44	2095.49	250.84	0.39
TwinCreek	6375.71	100-yr	13500.00	987.00	996.81	992.38	997.34	0.001136	5.82	2319.66	280.21	0.36
TwinCreek	6130.31	100-yr	13500.00	986.00	996.59	992.11	997.06	0.001023	5.49	2460.83	300.61	0.34
TwinCreek	5854.04	100-yr	13500.00	986.00	996.26	991.83	996.76	0.001117	5.69	2373.17	293.30	0.35
TwinCreek	5625.02	100-yr	13500.00	986.00	996.03	991.58	996.50	0.001029	5.51	2452.19	299.20	0.34
TwinCreek	5374.21	100-yr	13500.00	985.00	995.72	991.54	996.23	0.001162	5.71	2365.05	298.97	0.36
TwinCreek	5107.05	100-yr	13500.00	985.00	995.36	991.42	995.90	0.001268	5.87	2299.90	297.72	0.37
TwinCreek	4870.80	100-yr	13500.00	985.00	995.01	991.33	995.58	0.001407	6.07	2225.77	296.33	0.39
TwinCreek	4643.60	100-yr	13500.00	985.00	994.65	991.07	995.25	0.001514	6.22	2170.21	295.15	0.40
TwinCreek	4479.98	100-yr	13500.00	985.00	994.41	990.81	995.00	0.001459	6.14	2197.32	295.61	0.40
TwinCreek	4340.140	100-yr	12300.00	984.60	994.26	990.71	994.81	0.001112	5.96	2065.38	288.66	0.39
TwinCreek	4114.243	100-yr	12300.00	984.43	994.04	990.44	994.56	0.001043	5.81	2115.23	294.56	0.38
TwinCreek	3913.724	100-yr	12300.00	984.00	993.83	990.20	994.35	0.001024	5.77	2132.30	294.36	0.38
TwinCreek	3705.720	100-yr	12300.00	983.65	993.59	990.06	994.13	0.001098	5.90	2083.97	293.86	0.39
TwinCreek	3470.729	100-yr	12300.00	984.09	993.04	990.16	993.80	0.001620	6.97	1765.07	257.56	0.47
TwinCreek	3235.855	100-yr	12300.00	983.57	992.88	989.34	993.42	0.001090	5.91	2082.45	290.50	0.39
TwinCreek	3032.354	100-yr	12300.00	983.00	992.66	989.09	993.20	0.001077	5.88	2091.31	291.59	0.39
TwinCreek	2803.292	100-yr	12300.00	982.85	992.37	989.00	992.94	0.001162	6.05	2033.20	288.79	0.40
TwinCreek	2559.276	100-yr	12300.00	982.42	992.07	988.80	992.65	0.001225	6.13	2006.66	290.48	0.41
TwinCreek	2336.554	100-yr	12300.00	982.91	991.82	988.47	992.38	0.001148	6.02	2044.29	291.33	0.40
TwinCreek	2124.053	100-yr	12300.00	982.34	991.53	988.31	992.12	0.001248	6.19	1987.60	288.91	0.42
TwinCreek	1910.056	100-yr	12300.00	981.80	991.22	988.16	991.84	0.001343	6.34	1940.28	286.96	0.43
TwinCreek	1736.570	100-yr	12300.00	982.05	990.85	988.09	991.57	0.001710	6.80	1807.66	282.02	0.47
TwinCreek	1530.386	100-yr	12300.00	982.06	990.38	988.02	991.18	0.002007	7.17	1715.05	280.74	0.51
TwinCreek	1507.68*	100-yr	12300.00	981.98	990.31	987.92	991.13	0.002014	7.27	1692.32	273.04	0.51
TwinCreek	1484.98*	100-yr	12300.00	981.90	990.24	987.80	991.08	0.002015	7.36	1671.24	265.41	0.52
TwinCreek	1462.28*	100-yr	12300.00	981.81	990.17	987.75	991.03	0.002016	7.45	1651.05	258.11	0.52
TwinCreek	1439.590	100-yr	12300.00	981.73	990.07	987.65	990.98	0.001958	7.67	1603.97	251.06	0.52

HEC-RAS Plan: Existing River: TwinCreek Reach: TwinCreek Profile: 100-yr (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)	
TwinCreek	1410		Bridge									
TwinCreek	1398.279	100-yr	12300.00	979.45	989.63	985.64	990.35	0.002268	6.80	1808.90	228.61	0.40
TwinCreek	1379.83*	100-yr	12300.00	977.76	989.65	985.02	990.25	0.001870	6.26	1963.37	255.64	0.37
TwinCreek	1361.39*	100-yr	12300.00	976.06	989.71	983.84	990.14	0.001126	5.28	2329.91	295.06	0.29
TwinCreek	1342.949	100-yr	12300.00	974.37	989.77	981.65	990.04	0.000551	4.16	2957.14	321.02	0.21
TwinCreek	1321.54*	100-yr	12300.00	974.40	989.77	981.82	990.02	0.000535	4.03	3050.41	321.58	0.20
TwinCreek	1300.14*	100-yr	12300.00	974.43	989.77	981.94	990.00	0.000519	3.91	3145.33	322.16	0.20
TwinCreek	1278.74*	100-yr	12300.00	974.46	989.76	982.06	989.99	0.000503	3.80	3240.72	322.74	0.20
TwinCreek	1257.33*	100-yr	12300.00	974.49	989.76	982.16	989.97	0.000486	3.69	3328.96	323.33	0.19
TwinCreek	1235.935	100-yr	12300.00	974.52	989.75	982.29	989.96	0.000483	3.64	3380.84	323.92	0.19
TwinCreek	1211.15*	100-yr	12300.00	974.62	989.75	982.16	989.94	0.000322	3.57	3448.76	324.49	0.19
TwinCreek	1186.37*	100-yr	12300.00	974.71	989.74	982.04	989.93	0.000311	3.53	3486.48	325.75	0.19
TwinCreek	1161.59*	100-yr	12300.00	974.81	989.73	981.91	989.92	0.000438	3.48	3535.71	339.05	0.19
TwinCreek	1136.81*	100-yr	12300.00	974.90	989.73	981.76	989.91	0.000405	3.41	3637.82	342.71	0.18
TwinCreek	1112.032	100-yr	12300.00	975.00	989.73	981.58	989.90	0.000384	3.34	3720.00	335.86	0.17
TwinCreek	1090.80*	100-yr	12300.00	974.99	989.77	980.82	989.87	0.000211	2.50	4947.05	441.68	0.13
TwinCreek	1069.57*	100-yr	12300.00	974.97	989.79	980.41	989.86	0.000139	2.01	6131.31	547.28	0.10
TwinCreek	1048.35*	100-yr	12300.00	974.96	989.80	980.17	989.85	0.000098	1.69	7286.33	634.22	0.09
TwinCreek	1027.12*	100-yr	12300.00	974.95	989.81	979.98	989.84	0.000073	1.46	8435.77	734.17	0.08
TwinCreek	1005.89*	100-yr	12300.00	974.93	989.81	979.71	989.84	0.000057	1.29	9556.63	834.14	0.07
TwinCreek	984.6719	100-yr	70000.00	974.92	988.97	983.87	989.75	0.001951	7.10	9858.95	930.13	0.38
TwinCreek	839.7397	100-yr	70000.00	974.00	988.65	983.42	989.46	0.001955	7.25	9652.98	884.50	0.39
TwinCreek	699.0805	100-yr	70000.00	972.96	988.29	982.99	989.17	0.002041	7.53	9290.01	825.78	0.40
TwinCreek	556.7916	100-yr	70000.00	972.00	987.79	982.97	988.84	0.002483	8.22	8516.67	769.54	0.44
TwinCreek	426.7621	100-yr	70000.00	971.75	987.29	982.75	988.48	0.002826	8.75	7995.85	723.74	0.46
TwinCreek	282.5227	100-yr	70000.00	971.59	986.87	982.07	988.08	0.002691	8.81	7942.37	689.00	0.46
TwinCreek	161.9310	100-yr	70000.00	971.11	986.35	982.03	987.71	0.003160	9.36	7477.97	667.45	0.49
TwinCreek	31.70505	100-yr	70000.00	971.01	985.99	981.37	987.30	0.002943	9.19	7616.46	663.36	0.48

Attachment 3 – Digital Information (CD)