Theba Watershed
Zone A Floodplain Delineation Study

Maricopa County, Arizona

Technical Data Notebook

Prepared for:

Flood Control District of Maricopa County

Prepared by:

Project Engineering Consultants, Ltd.
2310 W. Mission Lane, Suite 4
Phoenix, Arizona 85021

In Association With

LTM Engineering, Inc.
4727 E. Bell Road Suite 45-310
Phoenix, Arizona 85032

December 2009

Exp. 3-31-10

Registered Professional Engineer (Civil)
CERTIFICATE NO.
25972
MICHAEL D.
HEATON
Date Signed 12-23-09
ARIZONA, U.S.A.

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ARIZONA, U.S.A.

1.0 Introduction

1.1 Purpose of study

The goal of this project is to delineate approximately 30 miles of Zone A 100-year floodplains within the Theba Watershed (Figures 1-1).

1.2 Authority for the Study

The Flood Control District of Maricopa County (District) contracted with Project Engineering Consultants, Ltd., (PEC) to perform the study using existing 10-foot contour interval topographic mapping. The District's contract number is FCD 2007C018 and the Notice-to-Proceed date was August 1, 2008. The main contacts, addresses and other information for the County and PEC are:

Flood Control District of Maricopa County

Address:	2801 West Durango Street Phoenix, Arizona 85009
Phone:	(602)506-1501
Project Manager:	Mark Mayer, P.E., CFM

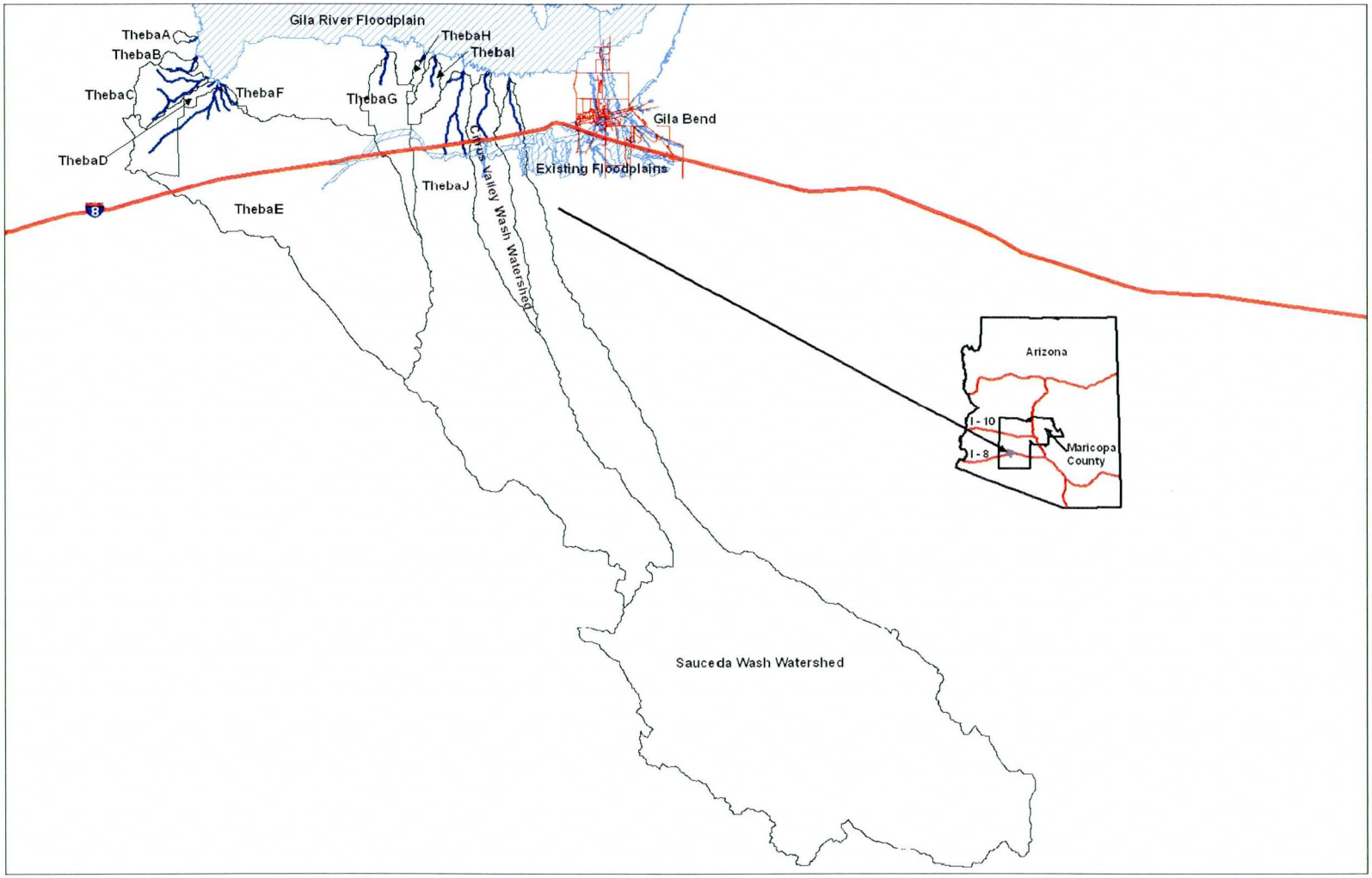
Project Engineering Consultants, Ltd.

Address:	2310 W. Mission Lane, Suite 4 Phoenix, AZ 85021
Phone:	(602)906-1901
Project Manager:	Mike Heaton, P.E., CFM

1.3 Site Location and Description

Theba Watershed is located in the southwestern part of Maricopa County, Arizona. The study area is bounded by the Painted Rock Mountains to the west, Gila River to the north, the Sauceda Wash watershed to the east, and Barry Goldwater Air Force Range to the south. All washes addressed in this study are ephemeral tributaries of the Gila River. The study area is divided into 12 distinct sub-watersheds for the purpose of modeling, and the washes are named per the District's requirements (Figure 1-2). Naming convention is described in Section 4.2.2.

Figure 1-1 Theba Watershed Floodplain Delineation Study Area Map



1.4 Methodology

1.4.1 Hydrology

The District provided PEC with aerial photos and topographic data. Additional USGS Digital Elevation Models (DEMs) were downloaded from the USGS website http://seamless.usgs.gov/website/Seamless/.

The watershed modeling software WMS (v7.1, distributed by Environmental Modeling Systems, Inc.) and ArcGIS (v9.3, distributed by ESRI) were used to develop watershed parameters. The built-in National Flood Frequency model Version 3 (USGS) was used to estimate peak discharges for the 100-year storm based on the watershed areas calculated by WMS.

The output of the hydrologic models was then compared to regional envelope curves. A more detailed explanation of the hydrologic methodology and results is provided in Section 4.

1.4.2 Hydraulics and Floodplain Delineation

WMS was used to develop cross sections from the existing elevation data provided by the District. Normal depth was calculated and was used as the downstream boundary condition for all of the reaches. Water surface elevations were computed using HEC-RAS version 3.1.3 and the preliminary floodplain was delineated using the WMS program.

1.5 Summary of Results

Peak discharges were estimated for each of the 12 watersheds and are summarized in Section 4. Zone A floodplains were delineated for approximately 30 stream miles and are presented on work maps in Exhibit B, located at the end of this report.

2.0 ADWR/FEMA Forms

2.1 Study Documentation Abstract for FEMA Submittals

N/A

2.2 FEMA Forms

The following NFIP map panels affected for all impacted communities are:

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
040037	Maricopa County	AZ	04013C	3425D	4/15/1988
040037 040043	Maricopa County Town of Gila Bend	AZ	04013C	3450F	9/30/2005
040037 040043	Maricopa County Town of Gila Bend	AZ	04013C	3470F	9/30/2005
040037 040043	Maricopa County Town of Gila Bend	AZ	04013C	3475F	9/30/2005

Panel 3425D flooding source: ThebaB05, ThebaC10, ThebaC20, ThebaC25, ThebaC30

Panel 3450F flooding source: ThebaA05, ThebaB05, ThebaC05, ThebaC10, ThebaC15, ThebaC20, ThebaC25, ThebaC30, ThebaD05, ThebaE05, ThebaE10, ThebaE15, ThebaE20, ThebaE25, ThebaE30, ThebaF05

Panel 3470F flooding source: Citrus Valley Wash, Sauceda Wash

Panel 3475F flooding source: ThebaG05, ThebaH05, ThebaI05, ThebaJ05, Citrus Valley Wash, Sauceda Wash

Drainage areas and 100-year peak discharges of the flooding sources are listed below:

Flooding Source	Area (mi^2)	Peak flow 100yr (cfs)
ThebaA		
ThebaA05	0.27	482
ThebaB		
ThebaB05	0.77	1,049
ThebaB10	0.34	589
ThebaC		
ThebaC05	5.45	3,512
ThebaC10	1.35	1,533
ThebaC15	3.86	2,898
ThebaC20	0.59	875
ThebaC25	1.45	1,605
ThebaC30	4.24	3,056
ThebaD		
ThebaD05	0.36	609
ThebaE		
ThebaE05	62.13	11,107
ThebaE10	14.00	5,713
ThebaE15	13.86	5,685
ThebaE20	0.14	284
ThebaE25	48.13	9,993
ThebaF		
ThebaF05	0.30	529
ThebaG		
ThebaG05	6.31	3,800
ThebaH		
ThebaH05	0.56	840
ThebaI		
ThebaI05	1.80	1,840
ThebaJ		
ThebaJ05	67.65	9,000
Citrus Valley Wash	12.53	3,200
Sauceda	150.87	9,600

Flow rates were calculated using USGS Regional Regression Equation except for ThebaJ, Citrus Valley Wash and Sauceda Wash. The flow rates from the 2003 Gila Bend ADMP were used for these three washes.

HEC-RAS was used for hydraulic modeling. There is only one plan in each model. The model names are:

ThebaA_rev2, ThebaB_rev2, ThebaC_revtry, ThebaD_rev, ThebaE_rev, ThebaF_rev, ThebaG_rev_CL2, ThebaH_rev, ThebaI_rev, ThebaJ_trunc, ThebaK_CVW_rev, ThebaL_S_rev.

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

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

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

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

B. OVERVIEW

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

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301	City of Katy	TX	480301	0005D	02/08/83
480287	Harris County	TX	48201C	0220G	09/28/90
------	See attached sheet (page 2-1 of the TDN)				

2. a. Flooding Source: See attached flooding source list

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

   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Theba Watershed Zone A Floodplain Study

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

5. Basis for Request and Type of Revision:

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

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

   ☐ Coastal Analysis ☒ Hydraulic Analysis ☒ Hydrologic Analysis ☐ Corrections

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

   ☐ New Topographic Data ☐ Other (Attach Description)

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

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

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

   ☐ Dam ☐ Fill ☐ Other (Attach Description)

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☐ No, Attach Explanation

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

D. SIGNATURE

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

Name: Mark Mayer	Company: Flood Control District, Maricopa County	
Mailing Address: 2801 W Durango Street Phoenix, AZ 85009	Daytime Telephone No.: (602) 506 1501	Fax No.: (602) 506 4601
	E-Mail Address: mkm@mail.maricopa.gov	
Signature of Requester (required): Mark Mayer	Date: 5/20/10	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Timothy S. Phillips, General Manager, Flood Control District of Maricopa County	Community Name: Maricopa County	
Mailing Address: 2801 W Durango Street Phoenix, AZ 85009	Daytime Telephone No.: (602) 506 1501	Fax No.: (602) 506 4601
	E-Mail Address: tsp@mail.maricopa.gov	
Community Official's Signature (required):	Date: 5/20/10	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

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

Certifier's Name: Michael D. Heaton	License No.: 25972	Expiration Date: March 2010
Company Name: Project Engineering Consultants, Ltd.	Telephone No.: (602) 906 1901	Fax No.: (602) 906 3080
Signature:		Date: 12-23-09

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

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

Seal (Optional)

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

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

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3. Project Name/Identifier: Theba Watershed Zone A Floodplain Study

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

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

   ☐ New Topographic Data ☐ Other (Attach Description)

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

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

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   ☐ Dam ☐ Fill ☐ Other (Attach Description)

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☐ No, Attach Explanation

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

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Mailing Address: 2801 W Durango Street Phoenix, AZ 85009	Daytime Telephone No.: (602) 506 1501	Fax No.: (602) 506 4601
	E-Mail Address: mkm@mail.maricopa.gov	
Signature of Requester (required): Mark Mayer	Date: 5/20/10	

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Community Official's Name and Title: Rick Buss, Town Manager	Community Name: Town of Gila Bend	
Mailing Address: PO Box A Gila Bend, AZ 85337	Daytime Telephone No.: (928) 683-2255	Fax No.: (928) 683-6430
	E-Mail Address: fbuss@gilabendaz.org	
Community Official's Signature (required):	Date: 2/23/10	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

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

Certifier's Name: Michael D. Heaton	License No.: 25972	Expiration Date: March 2010
Company Name: Project Engineering Consultants, Ltd.	Telephone No.: (602) 906 1901	Fax No.: (602) 906 3080
Signature: Michael D. Heaton		Date: 12-30-09

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

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

Seal (Optional)

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

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: See page 2-2 of TDN
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

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

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

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

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

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

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model
☒ Regional Regression Equations ☒ Other (please attach description)

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

4. Review/Approval of Analysis

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

5. Impacts of Sediment Transport on Hydrology

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

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit				
Upstream Limit				

2. Hydraulic Method/Model Used

HEC-RAS

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs may help verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. **These tools do not replace engineering judgment.** CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. Review of your submittal and resolution of valid modeling discrepancies may result in reduced review time.

4.

Models Submitted	Natural Run		Floodway Run		Datum
Duplicate Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	_____
Corrected Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	_____
Existing or Pre-Project Conditions Model	File Name: p 2-3	Plan Name: p 2-3	File Name:	Plan Name:	NAVD88
Revised or Post-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	_____
Other - (attach description)	File Name:	Plan Name:	File Name:	Plan Name:	_____

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

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

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

☒ Digital Mapping (GIS/CADD) Data Submitted

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

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

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

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:
      - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
      - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

   b. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☒ Yes ☐ No
      If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

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

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

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

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

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☒ No

   If Yes, please submit documentation to the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

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

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

3.0 Mapping and Survey Information

3.1 Field Survey Information

Field surveys related to this contract consisted of surveying structures that could impact the floodplains within this watershed. Field surveys were conducted under the supervision of Paul Miluski, RLS on January 22, 2009. Field notes for cross sections on ThebaC, ThebaJ and Sauceda Wash are provided in Appendix C.

3.2 Mapping

PEC used existing digital terrain models (DTMs) provided by the District for hydraulic modeling and floodplain delineation. The same data set together with some USGS digital elevation models (DEMs) was used for hydrologic modeling. The District's information shows that Stewart Geo Technologies, Inc. previously created the DTMs as part of Maricopa County orthophotography project in 2000 and 2001. The horizontal datum is the Arizona Coordinate System Central Zone 1983 North American Datum (NAD 83). The vertical datum is the North American Vertical Datum 1988 (NAVD 88). Topographic mapping is not a part of this Zone A floodplain delineation project. Technical details of the topographic mapping will be provided by the District upon request.

4.0 Hydrology

4.1 Method Description

The purpose of the hydrologic analysis is to develop peak flow data to be used for the delineation of approximately 30 miles of Zone A floodplain. Washes were identified by the District and confirmed by PEC. Peak flows for the 100-year storm were computed using the National Flood Frequency (NFF) model developed by the US Geological Survey (USGS 1999) as described in the Arizona Department of Water Resources State Standard 2-96, Delineation of Floodplain and Floodway in Riverine Environments (ADWR, 1996). The NFF Region is Southern Arizona Region 13. The recommended range of area for this model is 0.1 mi^2 to 1,780 mi^2. All of the areas used for hydrologic analysis are within this recommended range. The NFF equation which was used is:

$$\text{LOG } Q_{100} = 5.52\text{-}2.42\text{AREA}^{-0.12}$$

Where Q_{100} is the 100-year discharge and AREA is the area contributing to the concentration point of the model.

Drainage area for each concentration point was generated using WMS7.1 based on the County's topographic data and/or USGS Digital Elevation Models (DEMs). The delineation of sub-basins was based on the Topaz method. This method uses topographic data to generate flow direction for each modeling pixel and calculated flow accumulation for each pixel based on the flow direction grid. The pixels contributing to a common concentration point form the drainage area for the concentration point. For the areas with flat topo or man-made structures, aerial photos and field observations were used to help refine the watercourse alignments and drainage boundaries.

However, for ThebaJ, Citrus Valley Wash, and Sauceda Wash, a detailed study, the District's *Gila Bend Area Drainage Master Study & Floodplain Delineation Study 2003*, was available. The detailed hydrology was developed in the study, but no floodplain delineation was approved by FEMA for the downstream portion (north of I-8) of these washes. Discharges from the detailed study were used for the Zone A delineation for these washes.

4.2 Parameter Estimation

4.2.1 Drainage Area Boundaries

The major portion of the study watershed is undeveloped desert, although there are massive farms between Interstate 8 and the Gila River. For the purpose of this study, the Theba watershed was divided into 12 smaller independent modeling basins, i.e., Areas A through J alphabetically, Citrus Valley Wash watershed, and Sauceda Wash watershed (305 total square miles). All of the concentration points and most of the watersheds are located between the Gila River and the UPRR. However, ThebaE, ThebaG, ThebaJ, Citrus Valley Wash watershed and Sauceda Wash watershed extend beyond the UPRR to

the south. Exhibit A shows the sub-basin delineation for the Theba watershed with geographic feature backgrounds.

Several of the modeling areas were then sub-divided into multiple sub-basins for modeling purposes. The naming convention of the sub-basins and concentration points are presented in the next subsection.

Since different topographical data sets were used to generate the watershed boundaries, there were minor boundary gaps and overlaps among some watersheds directly out of the WMS models. The boundaries were later snapped together seamlessly using ArcGIS based on ortho photos and engineering judgment.

4.2.2 Watershed Work Maps

Drainage Area Boundary Map (Exhibit A) can be found in pockets at the back of this TDN.

Exhibit A shows the hydrologic modeling elements (modeling basins and concentration points). With the exception of the Citrus Valley Wash and Sauceda Wash most watercourses in the study area are currently unnamed. For the purpose of this study, the modeling basin for each unnamed wash, from west to east, is labeled as "Theba" and followed by a capital letter "A" to "J" ("ThebaA", "ThebaB", etc.). Each modeling reach is labeled with its basin label followed by a two digit reach number ("ThebaE_05", "ThebaE_10", etc.). The concentration point is labeled with the reach name followed by "C" (as Concentration point) and a lower case letter ("ThebaE_05Cz", "ThebaE_05Cy", etc.). The lower case letter is z for the most upstream concentration point in the reach, y for the next concentration point moving downstream, and so on.

4.2.3 Gage Data

District maintains a precipitation/stream gage on Sauceda Wash as a part of its county-wide flood warning system. The gage was installed in 1990 and is located approximately four miles upstream of the Sauceda Wash study reach.

4.2.4 Statistical Parameters

Statistical parameters were not directly used in this study.

4.2.5 Precipitation

Rainfall data were not directly used in this study.

4.2.6 Physical Parameters

The only hydrologic modeling parameter for the NFF method was drainage area.

4.3 Problems Encountered During the Study

4.3.1 Special Problems and Solutions

DEM Extents:

The District provided both raster and vector elevation data sets to PEC. Because of the extremely long time required for WMS to load and perform calculations on the vector data, the raster data (grid) was used for the hydrologic modeling. For watersheds ThebaE, ThebaJ, Citrus Valley Wash and Sauceda Wash, the USGS DEMs were used to supplement the District's topographic data. In this case, the resolution of the pixels was set to the USGS DEM resolution (10-m).

Local Depressions:

Before performing the hydrologic modeling, the grid data sets were filled to eliminate the local depressions (pits). After the filling process, the data sets differed slightly from the original. As a consequence, the flow network generated from the filled data was slightly different from the river network provided by the District, and some small basins disappeared. Because this is an approximate study, the slight differences were considered acceptable and no additional in-depth analysis was performed.

Lateral Weirs:

There is a high-rise earthen berm running south-north along the west edge of the farm lands in the study area (roughly along the west edge of the effective FIRM panel 04013C3450F). Storm water from the west will concentrate and flow northward along the berm, and drain into a shallow channel which continues running north toward the concentration point ThebaC_30Cz. After initial hydraulic modeling of the flow upstream of ThebaC_30Cz, it was found that the channel immediately north of the berm will not contain all of the 100 year flow. Because of this, lateral weirs were modeled along the east bank of the channel, which would allow the water to overflow. The flow remaining in the channel then contributes to ThebaC_30Cz, while the rest flows to the ThebaE watershed. Since using lateral weirs also changed all the downstream flows, once the new flows were calculated with the lateral weirs, the flows were inserted into the original model, and new floodplain boundaries were calculated.

4.3.2 Model Warning and Error Messages

No error messages are present in the NFF hydrology model results.

4.4 Calibration

As previously noted, the Sauceda precipitation/stream gage is the only gage within the study area. Its period of record, 19 years, is not long enough for statistical calibration. Additionally, its stream gage data is only applicable to the Sauceda Wash reach. However, the Sauceda Wash peak discharges were taken directly from the more detailed

Gila Bend Area Drainage Master Study & Floodplain Delineation Study. Therefore, no additional calibration was performed for this study.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

The NFF input and output values and Gila Bend Area Drainage Master Plan HEC-1 Schematic are included in Appendix D. The weir diversion data are included in Appendix E. Peak discharges for individual concentration points used for delineating the 100-year event are shown in Table 4-1.

Table 4-1 Hydrologic Analysis Results

Drainage Area and Concentration Point Name	Peak flow 100yr (cfs)
ThebaA	
ThebaA_05Cz	482
ThebaB	
ThebaB_05Cy	1,049
ThebaB_05Cz	676
ThebaC	
ThebaC_05Cy	3,512
ThebaC_10Cy	1,533
ThebaC_15Cy	2,898
ThebaC_20Cz	875
ThebaC_25Cy	1,605
ThebaC_30Cz*	3,056
ThebaD	
ThebaD_05Cy	609
ThebaE	
ThebaE_05Cz	11,107
ThebaE_10Cz	5,713
ThebaE_15Cy	5,685
ThebaE_15Cz*	5,015
ThebaE_20Cz	284
ThebaE_25Cz	9,993
ThebaF	
ThebaF_05Cy	529
ThebaF_05Cz	474

Table 4-1 Hydrologic Analysis Results

Drainage Area and Concentration Point Name	Peak flow 100yr (cfs)	
ThebaG		
ThebaG_05Cy	3,752	
ThebaG_05Cx	3,800	
ThebaH		
ThebaH_05Cy	840	
ThebaH_05Cz	801	
ThebaI		
ThebaI_05Cy	1,477	
ThebaI_05Cx	1,840	
ThebaJ		
ThebaJ_05Cz	9,000	**
Citrus Valley Wash		
CVW_05Cw	3,200	**
Sauceda		
Sau_05Cw	9,600	**

* The area/accumulated flow from the area ThebaC/ThebaE is included in both ThebaC_30Cz and ThebaE_15Cz. This flow is included in ThebaE for the scenario where the berm is either removed, or breached. The flow is included in ThebaC for the scenario where the berm concentrates the flow from this area and water flows along the berm and into ThebaC. The percentage of flow that can be conveyed to ThebaC is discussed further above in the special problems section.
** The flow rate rates for ThebaJ, Citrus Valley Wash and Sauceda Wash were adopted from the Gila Bend Area Drainage Master Study & Floodplain Delineation Study 2003.

4.5.2 Verification of Results

This is an approximate study. The NFF is an approved hydrologic modeling method for this type of study. As a regression model, the NFF is based on historical sample data rather than the local physical conditions. The 100-year NFF model for Arizona Region 13 is reported to have 48% modeling error. While the NFF accuracy is acceptable, results from more reliable sources such as detailed studies will give greater confidence for hydraulic modeling and future data users. Fortunately, previous detailed FIS results were available for three eastern sub-watersheds (ThebaJ, Citrus Valley Wash, and Sauceda Wash) for this study. There has been no significant change in development

status within the study area since the detailed study (Gila Bend ADMP, 2003 was conducted. The results of the detailed study are still valid.

The detailed study shows that the peak discharges of the three washes at their Gila Bend Canal crossings are slightly higher than those at the downstream Gila River outlets. The downstream drainage areas do not contribute enough runoff to offset the flow attenuation in the washes. This is likely due to the long, narrow shape of the watersheds in conjunction with areal reduction of the rainfall. The comparison between the results of the NFF and FIS (Appendix D) shows that the NFF method is more conservative, i.e., estimates higher peak flows. Because the Gila Bend study was a more detailed study than this approximate study, it was assumed to be more accurate, so those lower values were used. In the Gila Bend study, flow transfer between drainage basins (inter-basin flow) was modeled as a possible scenario due to the existence of structures for the area south of I-8. The results from more conservative scenarios (neglecting the inter-basin flow) were adopted for this approximate study.

A comparison of the envelope curves is made in Figure 4-1. While Craeger Curve is a general curve, the Malvick and Boughton Curves are specified for the Arizona region. The NFF results (the black Regression line) lies below the Craeger Envelope Curve and between the Malvick and Boughton Curves for drainage areas smaller than 20 mi^2. For larger drainage areas (greater than 20 mi^2) the Regression line runs below the Malvick Curve. Since most of the watersheds are smaller than 20 mi^2, NFF is a reasonable approach for this study.

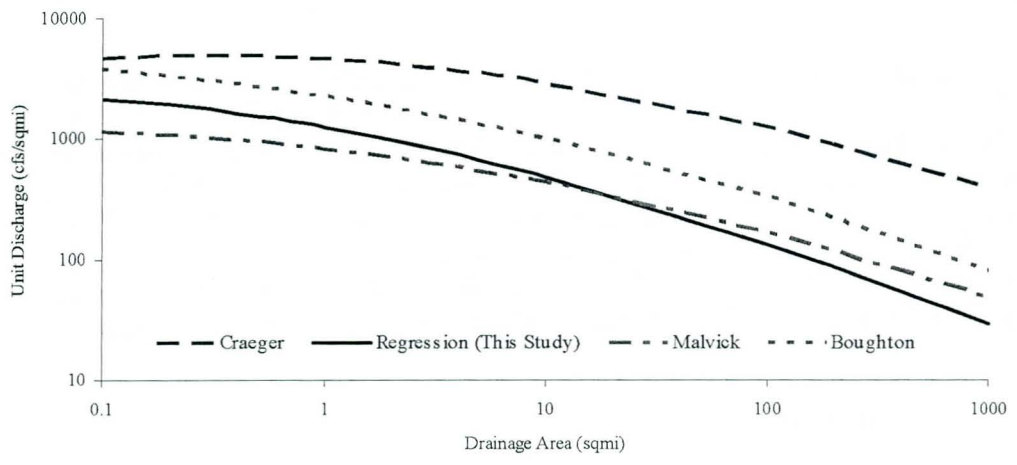


Figure 4-1 Envelope Curves

5.0 Hydraulics

5.1 Method description

The hydraulic analysis was performed using the U.S. Army Corps of Engineers HEC-RAS River Analysis System Version 3.1.3 (May 2005) incorporated in the WMS model version 7.1. The 100-year peak flows were used. The sub-critical steady state flow regime was used for the hydraulic modeling, and the downstream boundary conditions were set as normal depth.

It should be noted that the elevation grids used in the hydrologic analysis were not used in the hydraulic analysis. The topographic data used for the hydraulic analysis was Triangulated Irregular Networks (TINs) generated from the District's mass point and breakline data for better floodplain delineation accuracy.

The base point for each of the reaches was determined by drawing a line from the furthest downstream cross section to the north until the road 1 mile north of Sisson Rd. was reached. This distance was measured using ArcGIS, and this distance was used as the station of the downstream cross section of the reach.

5.2 Study Work Maps

Seven work maps, including a title sheet, are provided in this report to present the delineated floodplains as follows:

Drainage Area	Sheet Nos.
Sub-Watershed Theba A	2
Sub-Watershed Theba B	2
Sub-Watershed Theba C	3 & 4
Sub-Watershed Theba D	4
Sub-Watershed Theba E	3 & 4
Sub-Watershed Theba F	4
Sub-Watershed Theba G	5
Sub-Watershed Theba H	5
Sub-Watershed Theba I	5
Sub-Watershed Theba J	6
Sub-Watershed Citrus Valley Wash	6
Sub-Watershed Sauceda Wash	7

Full scale (1"=500') work maps are provided in Exhibit F

Details of the roughness estimation are presented in the n-value report which is included in this document as Appendix E.1.

5.3.2 Expansion and Contraction Coefficients

As indicated in Appendix E.3, all of the expansion and contraction coefficients in the channel reaches were set to the HEC-RAS default values of 0.1 for contraction and 0.3 for expansion to model gradual transitions.

5.4 Cross Section Description

Cross sections were cut using WMS. Cross section stationing is from left to right looking downstream with the thalweg as station 10,000. Cross section numbering is distance in miles above 1 mile north of Sisson Road. Cross section plots are included as Appendix E.2.

5.5 Modeling Considerations

5.5.1 Hydraulic Jump and Drop Analysis

The watercourses modeled in this study were mostly in their natural conditions without significant hydraulic structures to alter the flow regime. There was no hydraulic jump/drop analysis performed for this study.

5.5.2 Bridges and Culverts

N/A

5.5.3 Levees and Dikes

No certified levees exist within the study area. However, there is an earthen dike/berm running along the west edge of the farm lands in the study area. Because the dike is not certified, it was analyzed under two conditions; one using current conditions with the dike in place (with), and the other as if the dike did not exist (without). Hydraulic modeling was conducted for both "with" and "without" levee scenarios. The "with" levee scenario created a floodplain along the west side of the dike. In the "without" levee scenario, the storm water tends to flow northeasterly as shallow sheet flow over the farms. Downstream of the dike on the agricultural lands, a natural watercourse had existed before the lands were developed into farms. The old watercourse was utilized by this study to delineate a floodplain for the "without" scenario. The storm water runoff upstream of the dike would concentrate to this old wash and flow across the farms. Since there was no defined conveyance on the farm lands, the flood width was estimated by assuming 1 ft flow depth and using Manning's Equation.

Flooded Cross Sections:

Cross sections in the HEC-RAS models did not always contain the flow, and this was especially true for the cross sections upstream of the confluent points. To solve this problem, the flows were redistributed between the two reaches to balance the water surface elevations.

Overlapped Floodplain Boundaries:

At the downstream of the sub-watersheds, the storm water tends to overtop the basin boundaries. Since the downstream part of the sub-watersheds i.e. the area adjacent to the existing Gila River floodplain is very flat, the flow path in this region is not clearly defined, although the 10-ft topographic data does provide an indication. The storm water from different sub-watersheds might join at the surface, yet might not be able to form a uniform flow. The flow redistribution technique was not applied to the inter-basin flow. Some floodplains for individual sub-watersheds overlapped at the downstream. In this case, the overlapped floodplains were merged together.

5.7.2 Modeling Warnings and Error Messages

No modeling errors were noted in the WMS model results. There were warning about the reach length between adjacent cross sections (i.e., the density of the cross sections), and critical depth which might have little or no effects on this approximate study.

5.8 Calibration

As previously noted, no stage gages exist for the Theba Watershed. Therefore, calibration could not be performed.

5.9 Hydraulic Analysis Results

HEC-RAS models were created for all 12 sub-watersheds. Table 5-1 presents the summary of the hydraulic modeling.

Table 5-2 Hydraulic Modeling Summary

Reach	River Sta	Q Total (cfs)	W.S. Elev (ft)	Crit W.S. (ft)	Vel Avg (ft/s)	Top Width (ft)	Max Chl Dpth (ft)	Froude # Chl	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)
ThebaA_05	1.032	482	685.41	685.41	8.15	58.22	2.31	0.96	9981.78	10040.00
ThebaA_05	0.909	482	677.42	677.30	5.76	91.06	2.32	0.80	9968.03	10059.09
ThebaA_05	0.830	482	672.41	672.41	4.60	207.92	1.58	0.90	9876.82	10118.74
ThebaA_05	0.752	482	667.63	667.63	6.25	170.56	2.27	0.77	9984.19	10183.68

Table 5-2 Hydraulic Modeling Summary

Reach	River Sta	Q Total (cfs)	W.S. Elev (ft)	Crit W.S. (ft)	Vel Avg (ft/s)	Top Width (ft)	Max Chl Dpth (ft)	Froude # Chl	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)
ThebaC_20	3.658	875	710.48	710.48	7.14	89.10	2.95	0.96	9960.77	10049.87
ThebaC_20	3.557	875	705.45		4.64	83.19	4.35	0.48	9958.25	10041.44
ThebaC_15	3.391	2898	701.86	700.70	4.13	370.96	4.31	0.40	9817.41	10188.37
ThebaC_15	3.159	2898	697.03		4.02	434.44	5.43	0.35	9504.16	10074.06
ThebaC_15	3.023	2898	691.45	691.45	7.96	281.98	5.45	0.81	9967.30	10249.28
ThebaC_15	2.860	2898	685.91		3.36	485.14	4.07	0.33	9843.96	10379.42
ThebaC_15	2.707	2898	681.83		5.28	394.24	4.60	0.50	9782.16	10176.40
ThebaC_10	4.649	1533	813.91	813.91	9.51	62.55	4.80	0.98	9973.66	10036.21
ThebaC_10	4.392	1533	783.14	783.14	8.79	72.69	4.50	1.00	9964.57	10037.26
ThebaC_10	4.106	1533	756.10	756.10	8.72	76.70	4.32	1.01	9952.30	10029.00
ThebaC_10	3.934	1533	739.68	739.68	8.47	81.43	4.19	1.00	9966.23	10047.66
ThebaC_10	3.764	1533	726.56	726.56	8.21	91.10	4.12	1.01	9969.33	10060.42
ThebaC_10	3.622	1533	715.83	715.83	7.50	146.29	2.93	0.92	9937.24	10083.53
ThebaC_10	3.436	1533	705.42	704.81	6.07	136.54	3.36	0.63	9970.78	10107.32
ThebaC_10	3.179	1533	695.24	695.24	8.11	122.65	3.56	0.91	9941.00	10063.65
ThebaC_10	2.909	1533	687.47	686.78	5.29	209.84	4.21	0.55	9880.80	10090.64
ThebaC_10	2.701	1533	681.15	681.03	6.25	238.12	3.47	0.79	9940.13	10178.24
ThebaC_05	2.520	3512	677.50	675.65	3.65	556.50	4.37	0.33	9662.62	10223.09
ThebaC_05	2.370	3512	672.97	672.47	5.12	558.06	2.72	0.60	9700.20	10258.26
ThebaC_05	2.238	3512	666.51	665.51	4.76	420.43	3.85	0.47	9865.04	10285.47
ThebaD_05	2.710	609	673.21	672.54	3.13	283.42	3.13	0.43	9772.96	10056.38
ThebaD_05	2.530	609	668.83	668.43	1.33	784.10	1.53	0.26	9732.28	10530.53
ThebaD_05	2.383	609	664.38	664.08	3.33	287.51	2.17	0.53	9933.98	10221.49
ThebaE_25	3.674	9993	700.01	700.01	12.33	397.17	6.01	0.95	9823.38	10220.54
ThebaE_25	3.468	9993	692.34		10.44	481.41	8.81	0.69	9688.14	10209.49
ThebaE_25	3.276	9993	685.84	685.84	9.79	678.21	5.88	0.98	9558.85	10294.50
ThebaE_25	3.083	9993	679.58		7.68	998.74	5.23	0.64	9750.60	10749.34
ThebaE_25	2.941	9993	674.29	674.29	8.68	917.75	4.67	0.94	9630.90	10548.66
ThebaE_25	2.710	9993	669.76		5.20	993.22	7.63	0.41	9546.00	10539.22
ThebaE_20	3.564	284	693.93	693.56	4.49	49.29	2.22	0.65	9979.32	10028.60
ThebaE_20	3.335	284	681.19	681.19	4.07	224.75	0.81	0.94	9802.75	10027.50
ThebaE_20	3.171	284	675.45	675.13	2.16	324.81	1.69	0.34	9950.98	10325.27
ThebaE_20	3.049	284	672.86		4.42	65.08	2.00	0.72	9975.06	10040.14
ThebaE_15	3.931	5685	690.40		3.19	1023.01	6.27	0.27	9233.09	10256.10
ThebaE_15	3.719	5685	688.33	688.07	6.03	1170.61	3.54	0.68	9529.61	10700.21
ThebaE_15	3.548	5685	682.81	682.53	6.40	779.51	3.89	0.68	9464.27	10243.77
ThebaE_15	3.300	5685	679.37		4.01	820.70	3.94	0.39	9461.36	10282.06
ThebaE_15	3.065	5685	674.20	674.20	9.42	528.24	3.24	1.04	9555.95	10084.19
ThebaE_10	2.909	5713	672.09		3.86	1000.58	6.03	0.30	9666.82	10749.03
ThebaE_10	2.753	5713	670.98		2.83	1445.19	5.40	0.34	9311.58	10756.77
ThebaE_05	2.544	11107	667.91		3.53	2346.60	6.14	0.42	9232.25	11578.85
ThebaE_05	2.516	11107	667.24	666.61	4.29	2093.98	6.66	0.51	9252.04	11423.43

Table 5-2 Hydraulic Modeling Summary

Reach	River Sta	Q Total (cfs)	W.S. Elev (ft)	Crit W.S. (ft)	Vel Avg (ft/s)	Top Width (ft)	Max Chl Dpth (ft)	Froude # Chl	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)
CVW_05	3.397	3200	690.00		5.29	610.54	6.70	0.46	9566.88	10177.42
CVW_05	3.143	3200	684.56	684.56	7.83	439.06	6.37	0.69	9752.95	10192.01
CVW_05	2.932	3200	680.27	679.68	5.20	539.01	6.46	0.48	9667.21	10206.22
CVW_05	2.717	3200	676.56		6.34	445.16	4.84	0.58	9813.45	10258.61
CVW_05	2.563	3200	673.09	672.93	5.68	746.63	4.45	0.60	9494.33	10240.96
CVW_05	2.391	3200	671.42	669.92	2.89	525.74	3.73	0.30	9639.73	10165.47
CVW_05	2.168	3200	671.43		0.87	890.29	11.55	0.05	9684.27	10607.12
CVW_05	2.015	3200	671.10	670.86	4.52	750.85	10.03	0.76	9526.30	10277.14
ThebaL_Sau_05	4.478	9600	722.55	721.35	8.71	491.65	8.61	0.58	9794.68	10286.33
ThebaL_Sau_05	4.294	9600	718.31	718.31	10.47	541.91	8.31	0.74	9845.63	10387.54
ThebaL_Sau_05	3.988	9600	710.03		5.77	1207.83	6.63	0.51	8929.70	10168.99
ThebaL_Sau_05	3.642	9600	701.47	701.47	9.38	1078.87	5.39	0.85	9157.01	10293.01
ThebaL_Sau_05	3.328	9600	694.07		7.22	786.62	7.22	0.54	9567.29	10353.91
ThebaL_Sau_05	3.030	9600	686.66	686.51	10.33	417.69	5.63	0.82	9721.73	10139.42
ThebaL_Sau_05	2.778	9600	680.80	679.97	8.73	515.62	8.56	0.59	9673.44	10189.06
ThebaL_Sau_05	2.438	9600	673.96	673.33	10.04	360.72	9.36	0.66	9851.58	10212.30
ThebaL_Sau_05	2.257	9600	668.86	668.86	11.32	415.12	8.86	0.77	9651.18	10066.30

5.9.1 Verification of Results

The Gila Bend study provided approximate delineation for Sauceda Wash and Citrus Valley Wash. The flow rate used for hydraulic modeling in the Gila Bend study was lower for Sauceda Wash since the UPRR and I-8 was considered as flow attenuation structures. Since more cross sections were modeled in this study, floodplain boundaries were better defined. With all the differences in data and approach, the delineations between this study and the Gila Bend study are comparable. For the rest of the study area, there is no previous study to compare.

6.0 Erosion and Sediment Transport

No erosion or sediment transport analysis was performed for this study.

7.0 Draft FIS Report Data

7.1 Summary of Discharges

N/A

7.2 Floodway Data

N/A

7.3 Annotated FIRM Panels

Annotated FIRM panels are included in the pocket at the back of this TDN.

7.4 Flood Profiles

N/A

Appendix A
References

A.1 Data Collection Summary

Flood Control District of Maricopa County (Digital Files)

- 10 foot DTM contour data in ArcInfo, AutoCAD, ASCII grid, and Microstation formats
- DXF, E00, shape files for the streams, bridges, canal, control points, culverts, drainage basins, drainage depths, drainage path lines, elevations, elevation points, FEMA flood zone, flood elevations, structures, lakes, rivers, rail roads, landuse, and soils.
- Orthographic projection satellite imagery in MrSID format.
- Gila Bend Area Floodplain Delineation Study Technical Data Notebook, FCD 90-67, Burgess & Niple, Inc., 1992
- Gila Bend Area Drainage Master Plan Floodplain Delineation Study Technical Note Book, FCD 99-18, Engineering and Environmental Consultants, Inc., 2003

USGS Seamless Data Distribution System

- 10 meter (1/3 arc second) data for the portions of the study area to the south of the 10 ft contour data provided by the Flood Control District.

Arizona Department of Transportation

- Interstate 8 as-built from Yuma to Gila Bend, Updated 1973

USGS 1999, The National Flood-Frequency Program—Methods for Estimating Flood Magnitude and Frequency in Arizona, U.S. Geological Survey Fact Sheet 111-98

A.2 Referenced Documents

Boughton, W., K. Renard, and J. Stone, 1987. Flood Frequency Estimates in Southern Arizona. Journal of Irrigation and Drainage Engineering. Vol. 113. 469-478.

Malvick, A., 1980. A Magnitude-Frequency-Area Relation for Floods in Arizona. Research Report No. 2, University of Arizona, Tucson, AZ.

Phillips, J. and S. Tadayon, 2006. Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan guidelines for Vegetated Channels in Central Arizona.

Sabol, G. et al, 1995. Drainage Design Manual for Maricopa County, Arizona, Volume 1. Flood Control District of Maricopa County, AZ.

Sabol, G. et al, 1995. Drainage Design Manual for Maricopa County, Arizona, Volume 2. Flood Control District of Maricopa County, AZ.

U.S Geological Survey, Water Resources Division, 1991. Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa, County, Arizona

Appendix B
General Documentation and Correspondence

B.1 Special Problem Reports

Special problems are discussed in Chapters 4 and 5 of the TDN.

B.2 Contact Reports

N/A

B.3. Meeting Minutes or Reports

Meeting minutes are available from the District upon request.

B.4 General Correspondence

AFFIDAVIT OF PUBLICATION
GILA BEND FLOODPLAINS

01

Arizona Business Gazette
The business resource

PO BOX 194
Phoenix, Arizona 85001-0194
(602) 444-7315 FAX (602) 444-7364

STATE OF ARIZONA
COUNTY OF MARICOPA } SS.

Mark Gilmore, being first duly sworn, upon oath deposes and says: That of the Arizona Business Gazette, a newspaper of general circulation in the county of Maricopa, State of Arizona, published weekly at Phoenix, Arizona, and that the copy hereto attached is a true copy of the advertisement published in the said paper on the dates indicated.

9/11/2008

Sworn to before me this
11TH day of
SEPTEMBER 2008

Marilyn Greenwood
Notary Public

Study Notification Mailing List

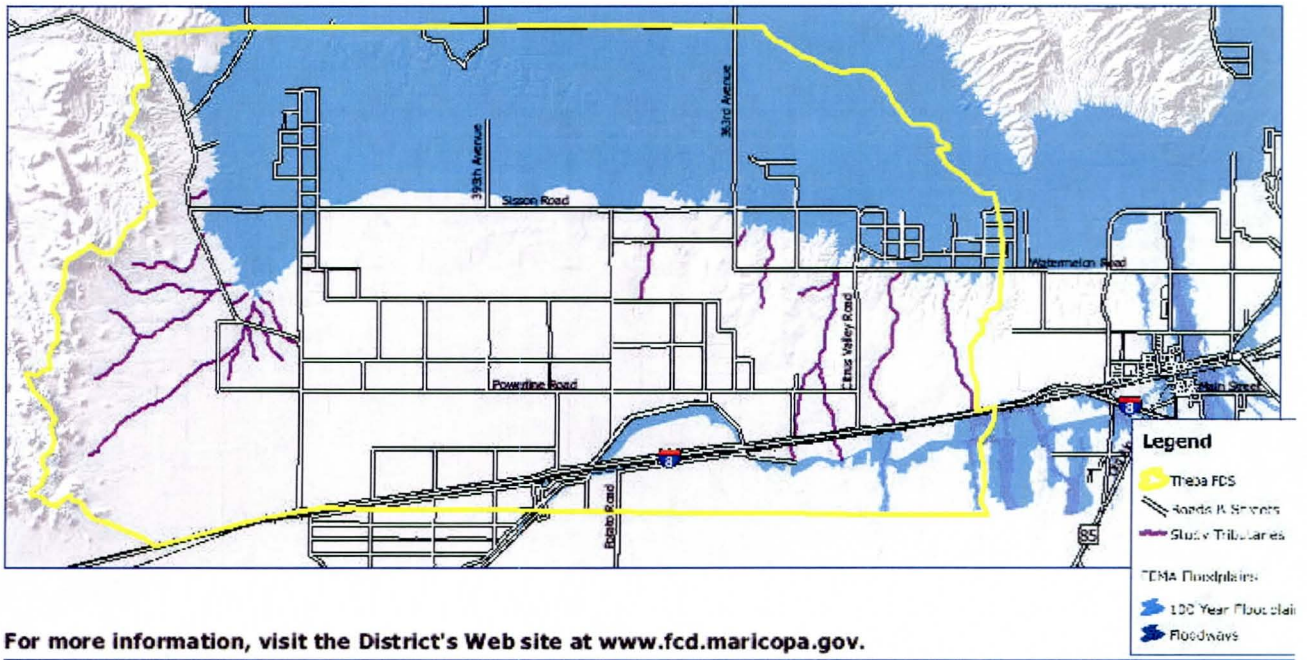
TAX_OWNER & PARCELS	TAX_ADDR1	TAX_ADDR2	TAX_CITY	TAX_STATE	TAX_ZIP
AA AMERICAN DEVELOPMENT CORPORATION	3001 W INDIAN SCHOOL RD STE 140		PHOENIX	AZ	850174142
40345015G					
40345015E					
BPR FARMS NO 1 LLC/BANNING LLOYD E/CHERY					
40320008					
DOBSON RIGGS FARM LLLP	2820 S ALMA SCHOOL RD STE 2	PMB B2	CHANDLER	AZ	85248
40320013C					
40320012C					
40320014A					
40320007H					
40320014B					
40320011E	PMB B2	2820 S ALMA SCHOOL RD STE 2	CHANDLER	AZ	85248
FIX GERALDINE/MURPHY ELMO D TR	161 SHANNON RD		COTOPAXI	CO	812239601
40316021D					
GILA BEND POWER PARTNERS LLC	5949 SHERRY LN STE 1900		DALLAS	TX	752258015
40315049H					
GILRIGGS LLC/ETAL	7091 BALFOUR RD		PARADISE VALLEY	AZ	85253
40320007E					
HEIDEN W BRUCE TR/HA PROPERTIES LP/	PO BOX 428		BUCKEYE	AZ	853260033
40316021J					
40316021G					
KIMBLEWICK LAND INC	PO BOX 887		GILA BEND	AZ	853370887
40318033					
40319016C					
40319015B					
PALOMA IRRIGATION & DRAINAGE DISTRI	JEFFREY C ZIMMERMAN	3003 N CENTRAL AVE STE 1260	PHOENIX	AZ	850122902
40320014D					
40345005B					
40316021L					
40316021H					
40316021K					
PERRY WILLIAM K	2122 E HIGHLAND AVE STE 450		PHOENIX	AZ	850164719
40320007J					
SECTION 25 LLC	3340 PEACHTREE RD NE STE 2200		ATLANTA	GA	303261088
40345005A					
STUHR TYSON S/STACEY E	HC 1 BOX 270		GILA BEND	AZ	853373064
40315050C					
TRI POINT DEVELOPMENT LLC	3340 PEACHTREE RD NE STE 2200		ATLANTA	GA	303261088
40316012B					
40316019					
40316021C					
40316013D					
40316013C					
UNITED STATES OF AMERICA IN TRUST	PO BOX 830		SELLS	AZ	856340830
40320011C					
40320007A					
40320006A					
40320011A					
40320011D					
40319015A					
40320006C					
40319016A					
40320012B					
40320012A					
40320013B					
40320013A					
40319016B					
WHM PALOMA INVESTMENTS LLC	3340 PEACHTREE RD NE STE 2200		ATLANTA	GA	303261088
40315052					
40345016B					
40345014A					
40345007A					
40345004B					
40345004A					
40315051B					
40345016A					
40316004B					
40345007D					
40315051D					
40345006					
40345017B					
40316010A					
40318032					
40316004A					
40345001A					
40345017A					

Theba Watershed Zone A Floodplain Delineation Study

Introduction and Project Overview

The Flood Control District of Maricopa County has contracted with Project Engineering Consultants, Inc. (PEC) to provide approximate delineations of floodplains along approximately 30 linear miles of tributaries to the Gila River. The study area is immediately west of Gila Bend, between Interstate 8 and the Painted Rock Reservoir. Based on property ownership records, you have property that may contain some newly delineated floodplain.

The study and resulting maps will be used floodplain management purposes a submitted to the Federal Emerger Management Agency (FEMA) for flc insurance information and revisions of Flc Insurance Rate Maps. This study should available to the public for review and comm in approximately 9 months.



For more information, visit the District's Web site at www.fcd.maricopa.gov.

Next Steps

This announcement is intended to inform you of the commencement of this study, and to advise you that it may be necessary to briefly enter or cross your property to perform surveying and reconnaissance activities in support of the study. This activity should not result in any inconvenience to you or damage to your property. If you have any objection to the entry onto your property, please notify Mark Mayer at (602)-506-6726. Otherwise, it will be assumed that you consent to the entry onto your property.

The parcel number(s) for your property within the study area is (are) located on the mailing label above your name. If you have any questions regarding this study or the right of entry, or if you have information regarding flooding in the area, please contact Mark Mayer. The study team is interested in receiving any historical flooding information including pictures or news clippings you may have regarding past flooding in the area, and any related problems.

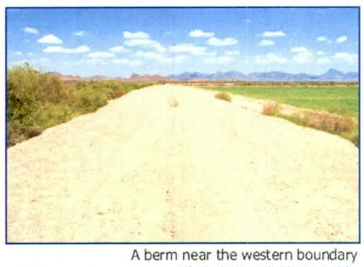
For More information:

Mark Mayer, P.E., CFM
Project Manager
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009
602-506-6726
mkm@mail.maricopa.gov

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix Arizona 85009

October 2008

Theba Watershed Zone A Floodplain Delineation Study



A berm near the western boundary of study area looking north.

Study Notification/
Right of Entry
for Surveying and
Reconnaissance Purposes

Maricopa County Supervisor:
Mary Rose Wilcox, District 5

www.fcd.maricopa.gov

Notification of Establishment of 1% Annual Chance Floodplain Mailing List

TAX_OWNER & PARCELS	TAX_ADDR1	TAX_ADDR2	TAX_CITY	TAX_STATE	TAX_ZIP
ABENGOA SOLAR INC	11500 W 13TH AVE		LAKEWOOD	CO	80215
40320016B					
40320016A					
40320017A					
ASSOCIATES - AA AMERICAN DEVELOPMENT LLC	3001 W INDIAN SCHOOL RD STE 140		PHOENIX	AZ	850174142
40345015G					
40345015E					
BIG BEND INVESTMENTS LLC	3575 PIEDMONT RD NE	BLDG 15 STE L120	ATLANTA	GA	30305
40345016B					
40345016A					
40345017B					
40345017A					
40345006					
40345004A					
40316010A					
40315052					
40318032					
40315051B					
WHM PALOMA INVESTMENTS LLC	3340 PEACHTREE RD NE STE 2200		ATLANTA	GA	303261088
40316006C					
40316005E					
40345007A					
BIG BEND INVESTMENTS LLC	PO BOX 19056		ATLANTA	GA	311261056
40316004A					
40316004B					
DOBSON RIGGS FARM LLLP	PMB 498	2040 S ALMA SCHOOL RD SUITE 1	CHANDLER	AZ	852867076
40320012C					
40320011E					
40320013C					
40320014A					
40320014B					
FIRST INTERNATIONAL BANK & TRUST	6840 E INDIAN SCHOOL RD		SCOTTSDALE	AZ	852513818
40345014A					
HETTINGA HEIN/ELLEN	2751 E PALO VERDE ST		YUMA	AZ	853653713
40316011E					
40316011C					
40316005H					
40316005J					
PALOMA IRRIGATION & DRAINAGE DISTRI	JEFFREY C ZIMMERMAN	3003 N CENTRAL AVE STE 1260	PHOENIX	AZ	850122902
40316006D					
40320006F					
40320006E					
40320017B					
40316005F					
40316005K					
UNITED STATES OF AMERICA IN TRUST	PO BOX 830		SELLS	AZ	856340830
40319016B					
40319016A					
40319015A					
40320011C					
40320012A					
40320012B					
40320013B					
40320013A					
40320011D					
40320007A					
40320006A					
40320011A					
40320006C					

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Theba Watershed Zone A Floodplain Delineation Study

Notification of Establishment
of One Percent Annual Chance Floodplain

Supervisor Mary Rose Wilcox, District 5

www.fcd.maricopa.gov

Theba Watershed Zone A Floodplain Delineation Study

Notification of Establishment of One Percent Annual Chance Floodplain

The Flood Control District of Maricopa County has recently completed the Theba Watershed Zone A Floodplain Delineation Study. Based on property ownership records, you have property that will be impacted by floodplains established by the study that are proposed to be incorporated onto the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM).

The FIRM for a community depicts land which has been determined to be subject to a one percent (100-year) or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The Flood Control District of Maricopa County (District) is applying for a Letter of Map Revision (LOMR) to revise FIRM 04013C, panel numbers 3425D, 3450F, 3470F and 3475F for unincorporated Maricopa County and the Town of Gila Bend, along Sauceda and Citrus Valley washes, and other tributaries to the Gila River. The District is proposing to revise the FIRM to reflect the results of the Theba Watershed Zone A Floodplain Delineation Study.

The revision to the FIRM will result in the establishment of one percent annual chance (Zone A) floodplains for Sauceda and Citrus Valley washes, and other tributaries to the Gila River. Zone A floodplains will be delineated for the first time along approximately 30 linear miles of washes immediately west of Gila Bend, north of Interstate 8.

This letter is to inform you of the proposed addition of the Zone A floodplain on your property identified by the parcel number(s) located on the mailing label above your name. If you have any questions or concerns about the proposed changes to the FIRM or its effects on your property, please contact me.

Mark Mayer
Senior Engineer - Civil
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009
602-506-6726
mkm@mail.maricopa.gov

B.5 Contract Documents

EXHIBIT A

SCOPE OF WORK

CONTRACT FCD 2007C018

THEBA WATERSHED
ZONE A FLOODPLAIN DELINEATION STUDY

EXHIBIT A

GENERAL SCOPE OF WORK

CONTRACT FCD 2007C018

THEBA WATERSHED ZONE A FLOODPLAIN DELINEATION STUDY

GENERAL

Project Goal

The goal of this project is to delineate an estimated 30 miles of approximate Zone A 100-year floodplains outside of existing delineated floodplains within the Theba Watershed. The limits of the Theba Watershed Study Area and existing floodplains are shown on Attachment 1.

Required Tasks

The CONSULTANT will: coordinate the study with the DISTRICT and others; collect and analyze existing data; prepare base maps using the DISTRICT's 10-foot contour mapping, aerial photography, existing United States Geological Survey (USGS) and/or other topographic mapping; perform field surveys as required; develop the 100-year peak discharges; delineate the Zone A floodplains; and deliver all of the study documentation in formats acceptable to the DISTRICT and Federal Emergency Management Agency.

Performance Standards

The CONSULTANT must use sound engineering judgment in the development of the hydrologic data and hydraulic models.

All work completed under this scope of services is to conform to the DISTRICT's Consultant Guidelines dated December 1, 2003, (Consultant Guidelines) except as modified below for this Zone A Floodplain Delineation Study.

All work must also meet Arizona Department of Water Resources (ADWR) and the Federal Emergency Management Agency (FEMA) requirements for Zone A floodplain delineations.

Prior to the finalization of this contract, FEMA and the DISTRICT must review and accept the results of this study, and all items called for in this Scope of Work must be delivered to the DISTRICT.

All work must be completed within seven hundred and thirty (730) calendar days from the Notice to Proceed (NTP). The FEMA submittal package must be completed within three hundred seventy (370) calendar days (which includes one hundred twenty (120) calendar days for the DISTRICT review). The remaining three hundred (360) calendar days are

allotted for obtaining FEMA approval, and the completion of those tasks required after FEMA approval is obtained.

TASK 1 – SCHEDULE AND PROJECT COORDINATION

1.1 Schedule

The CONSULTANT shall prepare and update a project schedule as described in Section 2.1 of the Consultant Guidelines including tasks for this Scope of Work.

1.2 Project Coordination

1.2.1 The CONSULTANT shall meet all the applicable coordination requirements of Section 2.2 of the Consultant Guidelines,

1.2.2 In addition to complying with the meeting requirements of Section 2.4 of the Consultant Guidelines, the CONSULTANT shall prepare an agenda for distribution to attendees prior to any meetings, and distribute minutes of any meeting to attendees within a week after the meeting.

1.2.3 Coordination activities described in Section 11.1 of the Consultant Guidelines will be conducted for this project; however The DISTRICT will be responsible for the advertising and property owner notification requirements of Section 11.1.1 through 11.1.3. The legal advertisement announcing the project will be run twice at the beginning of the study in a widely circulated newspaper, with approximately one week between runs. The DISTRICT will supply the CONSULTANT with a copy of the property owner notification, and, after the newspapers run the advertisements, the original affidavit of publication from each newspaper for each day that the advertisements ran.

1.2.4 No public meeting will be conducted; however towards the end of the study, the DISTRICT will notify property owners located within close proximity of study watercourses by regular mail, if applicable, regarding the floodplain boundary delineations. The DISTRICT will furnish the CONSULTANT with a sample of the notification letter and a list of expected mail recipients. As required by Section 11.1.5 of the Consultant Guidelines, the CONSULTANT shall respond to public comments, and make adjustments to the study if necessary.

1.2.5 Consultant/ DISTRICT Evaluations will be performed as specified by Section 11.1.6 of the Consultant Guidelines.

-

1.2.6 The DISTRICT will provide any public notice beyond that described in the Consultant Guidelines.

1.2.7 OPTIONAL TASK – Certified Structure Coordination
The consultant will coordinate with any other agencies to determine whether any levees or diversion dikes are certified structures. **This optional task is not**

authorized with the Notice to Proceed; it may be authorized in writing by the DISTRICT based upon specific need as determined by the DISTRICT during the contract period.

TASK 2 - DATA COLLECTION

The CONSULTANT will collect and review pertinent data, and submit results as required by Section 11.2 of the Consultant Guidelines.

TASK 3 – TOPOGRAPHIC MAPPING AND PHOTOGRAPHIC IMAGERY

Topographic mapping with 10-foot contour intervals (including digital terrain model data) will be provided for the study area by the DISTRICT. This topographic mapping is in the Arizona Coordinate System Central Zone, 1983 North American Datum (NAD), horizontally; and the North American Vertical Datum 1988 (NAVD 88), vertically. The District will provide the consultant with aerial photography imagery that is recent enough to be appropriate to the level of study and contiguous within the study area.

TASK 4 – WATERCOURSE IDENTIFICATION

The CONSULTANT shall name and label using the topographic base maps approximately 30 miles of watercourses as shown on Attachment 1 to this scope as Study Reaches. Existing watercourses and other feature names from USGS Quadrangles or other maps shall be used to name watercourses where practicable. For example, a tributary to the Gila River may be given a name incorporating "Gila River Tributary". The CONSULTANT shall coordinate the watercourse name with the DISTRICT'S Project Manager prior to the development of the hydrologic model.

TASK 5 - FIELD SURVEY

5.1 Required Surveys

As needed, field surveys and measurements of bridges, culverts, and hydraulic structures are to be obtained by the CONSULTANT when as-built plans are not available, or when conditions have changed that may impact the delineation. GDACS control will be the basis of field survey. This information should be reduced and compiled into an 11"x 17" (maximum size) drawing format approved by the District, for inclusion in the appropriate section of the Technical Data Notebook (TDN) to be prepared for this project. The information presented in the drawing should be in a format appropriate for use in future hydraulic models. It may be necessary to field survey some structures since the as-built plans may not be on the same datum as the study.

5.2 OPTIONAL TASK – Optional Survey

The CONSULTANT shall provide field survey data for cross sections to be used for hydraulic modeling where the DISTRICT's 10-foot contour mapping or USGS data are not adequate. **This optional task is not authorized with the Notice to Proceed; it may be authorized in writing by the DISTRICT based upon specific need as determined by the DISTRICT during the contract period.**

TASK 6 - HYDROLOGY

6.1 Hydrologic Modeling and Documentation

The CONSULTANT shall comply with the requirements of Section 9.0 of the Consultant Guidelines except: 100 year peak discharges for the project area may be developed using SSA 2-96, Level 2 (regression equations) methodology instead of the computer modeling described in Section 9.5 of the Consultant Guidelines; and the hydrologic report described in Section 9.9.1 of the Consultant Guidelines shall be presented as Section 4: Hydrology, Appendix D: Hydrologic Analysis Supporting Documentation and Hydrology Exhibit Maps of the TDN required for this project.

6.2 Maps

The CONSULTANT shall prepare the base maps required by Section 9.4 of the Consultant Guidelines using the topographic mapping and aerial photography supplied by the DISTRICT for the project area, along with USGS contours and digital terrain models for the contributing drainage areas outside the project boundaries. These maps shall also serve as the base maps for the watershed work maps and exhibit maps required by ADWR State Standards Attachment 1-97 (SSA 1-97) for inclusion in the TDN.

6.3 Optional Task –Split Flows

Any flow splits will be approximated by inspection of the topography and aerial photos. Recommendations for split flow portions may total more than 100 percent (i.e. 70:70, or 100:100, etc.) to be conservative. **This optional task is not authorized with the Notice to Proceed; it may be authorized in writing by the DISTRICT based upon specific need as determined by the DISTRICT during the contract period.**

TASK 7 - FLOODPLAIN DELINEATION

General Guidelines

The CONSULTANT shall label the watercourses as defined in Task 4, and delineate Zone A floodplains along the watercourses on topographic base maps. The CONSULTANT shall comply with the requirements of Section 11.5 of the Consultant Guideline during the course of delineating the floodplains, except that floodways will not be delineated, and as specified below.

7.1 Field Reconnaissance

The CONSULTANT will conduct and document a field reconnaissance of the study area in accordance with Section 11.5.7 of the Consultant Guidelines. Up to 15 typical reach types will be identified during the field reconnaissance, and representative "n" values for each typical reach type will be developed.

7.2 Cross Sections

Cross sections shall be developed in accordance with Section 11.5.8.1 of the Consultant Guidelines, except for this A Zone Study the cross sections shall be spaced approximately ¼ mile. Cross sections shall also be located at existing structures such as roads and railways, culverts and bridges, and natural features such as splits and confluences, channel restrictions, and grade changes. Cross sections developed by the HEC-RAS interpolation feature are not to be used. The CONSULTANT must coordinate the methodology for generating the cross section geometric data with the DISTRICT. Acceptable methods might include collecting the data directly off paper copies of the DISTRICT's 10-foot contour map orthophotos, use of a computer program to develop the data from digital information, or from field surveys.

7.3 Drainage Features

Minor conveyance structures such as small culverts (i.e., less than 30" in diameter) or structures considered likely to become clogged during the 100-year peak discharge shall not be included in the hydraulic analyses. These may be modeled as features in the floodplain if it is deemed that they influence the extents of the floodplain. These cases shall be documented in the TDN.

7.4 HEC-RAS Modeling and Descriptions

The CONSULTANT shall accomplish the hydraulic modeling using normal depth determined by Manning's Equation or the U.S. Army Corps of Engineers' most recent version of the HEC-RAS computer model as required by Section 11.5.1 of the Consultant Guidelines.

If HEC-RAS is used, the main project description box of the HEC-RAS models should include the following:

a. project name and DISTRICT contract number;
b. consultant(s) and modeler's name(s);
c. file name and latest run date, or final date if completed;
d. vertical datum, base map date, and base map contractor information;
e. source of the peak discharges used in the hydraulic analysis;
f. version of HEC-RAS used.

In addition, minor descriptions should be added to the model for hydraulic sections located above and below drainage structures, at section lines, at railway crossings, and at confluences. Model descriptions should be added for culverts and lateral structures, and at any other feature considered more important to the modeling.

7.5 Optional Task – Uncertified Dikes and Embankments Hydraulic Impact

For locations within the study area where dikes or embankments are found that do not meet FEMA certification criteria, the Consultant will develop a second Hydraulic model to reflect the "without structure" scenario. **This optional task is not authorized with the Notice to Proceed; it may be authorized in writing by the DISTRICT based upon specific need as determined by the DISTRICT during the contract period.**

7.6 Work-Study Maps

The CONSULTANT shall prepare the work-study maps required by Section 11.5.13 of the Consultant Guidelines and SSA 1-97 using the topographic mapping and aerial photography supplied by the DISTRICT. The CONSULTANT shall prepare the maps in accordance with Section 11.5.13 of the Consultant Guidelines, except that review submittals shall be paper maps and the contour interval for all mapping shall be 10 feet, and the scale may be from 1"=400' to 1"=1000' depending on the terrain, and the floodplain widths will be determined by the CONSULTANT, subject to the DISTRICT Project Manager's approval. Each drawing will also include existing floodplains, any piedmont surface land forms (if developed), and labels for each cross section line that include discharges. Other pertinent data or notes may be added after consultation with the DISTRICT Project Manager.

7.7 Technical Data Notebook

7.7.1 The results of the floodplain delineation study will be presented as Section 5: Hydraulics, Appendix E: Hydraulic Analysis Supporting Documentation, and the Hydraulics Exhibit Maps of the TDN. Cross section plots provided in Section E.2 should be from HEC-RAS, on a scaled grid, and include, at a minimum, water surface elevations, n-values and bank station locations.

7.7.2 The CONSULTANT shall fill out all FEMA forms and include them in the TDN for submittal of the Floodplain Delineation Study.

TASK 8 – DIGITAL DATA

The CONSULTANT shall submit all digital data developed by the CONSULTANT for the watershed and work-study maps and exhibits in either a CADD or GIS format in conformance with the latest version of the DISTRICT's Data Delivery Specifications for the Hydrologic Information System (HIS). At a minimum, sub-basin boundaries, and concentration points from the watershed work maps, and floodplain boundaries, cross sections, and hydraulic baselines from the work-study maps shall be included.

TASK 9 - SUBMITTALS

9.1 District Only Submittals

Both paper and electronic submittals will be delivered at the completion of each task as needed for the DISTRICT's review and approval. In addition, the CONSULTANT will deliver the digital data from the watershed work maps for the DISTRICT's Hydrologic Information System to the DISTRICT concurrent with the items submitted to the DISTRICT for FEMA review.

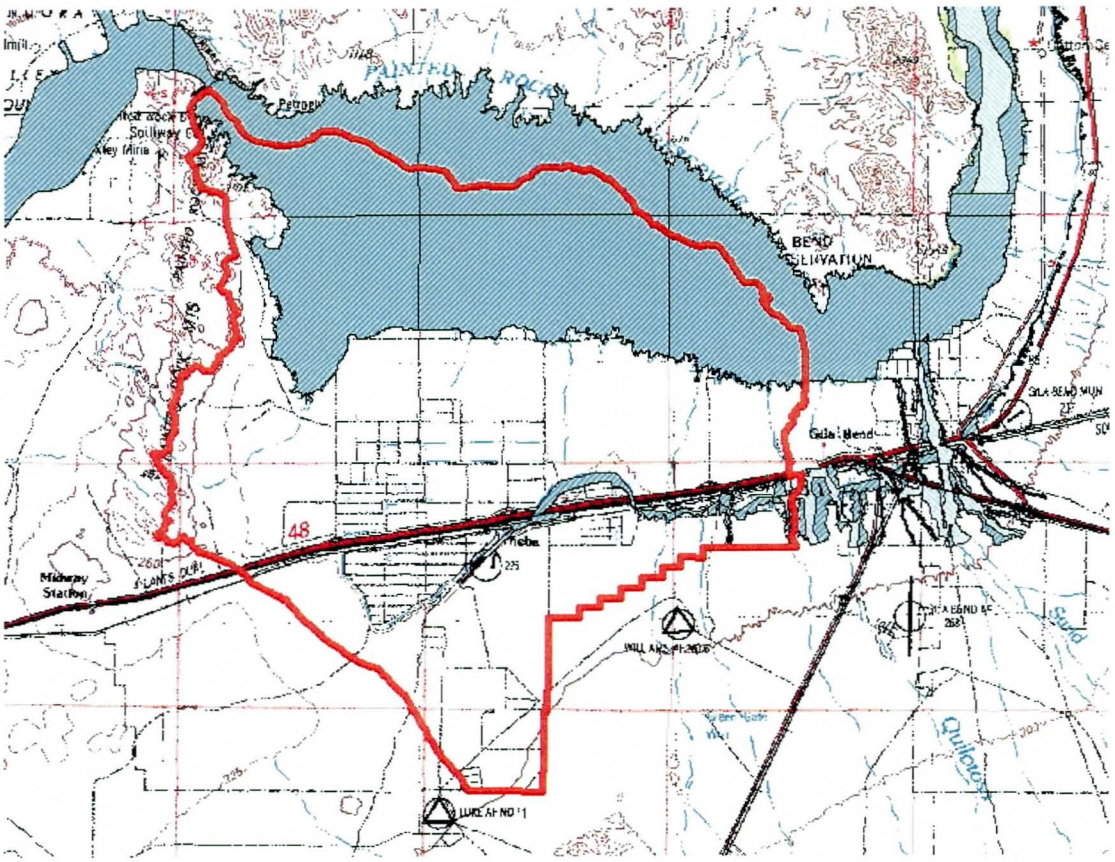
9.2 FEMA and Final Submittals

9.2.1 The FEMA submittal package shall consist of a TDN prepared in accordance with SSA 1-97 and this Scope of Work, including Affidavits of Publication, full sized sealed prints of hydrologic base maps and work study maps, supporting digital files on CD, and any survey report. The CONSULTANT shall submit 3 copies of the

FEMA submittal package to the DISTRICT; and 1 extra set (outside of the TDN) of sealed work study maps.

9.2.2 The CONSULTANT is make and deliver to the DISTRICT any refinements to the FEMA submittal package requested by FEMA during the course of their review. Following FEMA's acceptance of the results of the study, the CONSULTANT shall deliver one complete set of sealed mylars of the hydrologic base maps and work study maps, a copy of any changes to the TDN needed due to refinements made during FEMA review, all remaining or revised digital data developed by the CONSULTANT for the watershed work maps and work-study maps, and the final TDN in PDF format.

ATTACHMENT 1 -- STUDY AREA



B.6 FEMA Correspondence

Appendix C
Survey Field Notes

C.1 Survey Field Notes for Aerial Mapping Control

N/A

C.2 Survey Field Notes for Hydrologic Modeling

N/A

C.3 Survey Field Notes for Hydraulic Modeling

The attached notes were made by surveyors in the field while using electronic survey instruments. These notes were made to help the surveyors and office personnel prepare drawings from the digital data. Survey details are included in Section 3, and the digital data is included in the electronic submittal.

8023.01

SOKKIA

ECONOMY
FIELD BOOK

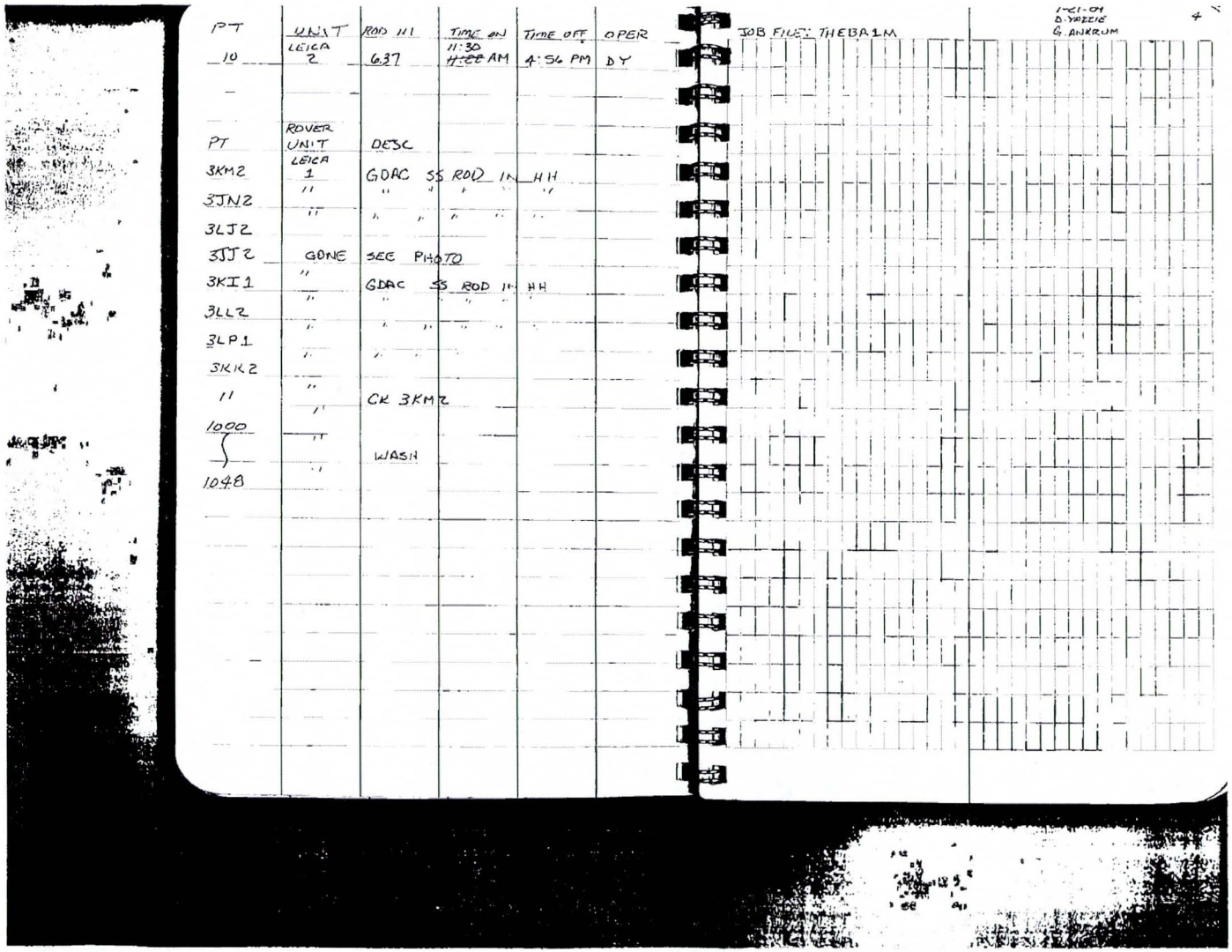
THEBA

No. 8152-05

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
39131
PAUL E.
MILUSKI
Date Signed 12.22.09
ARIZONA U.S.A.

EXP. 6.30.12

PT	DESC
10	SET 1/2" RB W/PEC CONTROL CAP 30'N. OF 3KM2
3KM2	GDAC SS ROD IN HH
3JN2	" " " " "
3LJ2	
3JJ2	GONE SEE PHOTO
3KI1	GDAC SS ROD IN HH
3LL2	"
3LP1	"
3KK2	
13	FD 1 1/2" AL. CAP IN CONC STAMPED T5S, 1/4 6/15 32, LS 22281
14	FD 1/2" RB W/PLS 26409 TAG
15	FD 3/4" RB W/RLS 35545 TAG
16	FD 1/2" RB W/PLS 26409 TAG



PT	UNIT	ROD HT	TIME ON	TIME OFF	OPER
10	LEICA 2	6.37	11:30 ~~4:56~~ AM	4:56 PM	DY
PT	ROVER UNIT	DESC			
3KM2	LEICA 1	GDAC SS ROD IN HH			
3JN2	"	" " " " "			
3LJ2	"	" " " " "			
3JJ2	GONE	SEE PHOTO			
3KI1	"	GDAC SS ROD IN HH			
3LL2	"	" " " " "			
3LP1	"	" " "			
3KK2	"				
"	"	CK 3KM2			
1000	"				
}	"	WASH			
1048	"				

JOB FILE: THEBA1M

1-21-09
D. YAZZIE
G. ANKRUM

1-22-01
G. ANKUM
D YAZZIE

5

JOB FILE: THEBA 1 M

PT	UNIT	HI	TIME ON	TIME OFF	OPER
18	LEICA 2	6.28	7:46AM		DY

PT	ROVER UNIT	DESC
12	LEICA 1	CK 3KMZ
13	"	FD 1½" AL. CAP IN CONC. STAMPED
	"	TSS. 1/4 6/5 32 ; LS2228!
14	"	FD ½" RB W/ PLS 26049 TAG
15	"	FD 3/4" RB W/ PLS 35545 TAG
16	"	FD ½" RB W/ PLS 26049 TAG
5000/5029	"	BERM
4000/4050	"	BERM
17	"	CK 3KKZ
3000/3068		CULVERTS
2000/		

Appendix D
Hydrological Analysis Supporting Documentation

D.1 Precipitation Data

Because this was an approximate study, and the NFF method was used to estimate the flow values, no precipitation data was necessary.

D.2 Physical Parameter Calculations

For the NFF regression equation the only physical parameter of importance is the area for each of the drainage sub-watersheds. These are shown for each concentration point in Table D.6.2

D.3 Routing Data

Routing data is not required with the NFF regression analysis.

D.4 Reservoir Routing Data

Reservoir routing data is not applicable with the NFF regression analysis.

D.5 Flow Split and Diversion

Weir diversion analysis is included in Appendix E.5.2. The hydraulic model is included in the attached digital data disc.

D.6 Hydrologic Calculations

The NFF regression equation was used to calculate the flows using the calculated areas. Information about NFF for Arizona can be found at http://pubs.usgs.gov/fs/fs-111-98/
The NFF Hydrologic flood region was determined using Figure D.6.1.

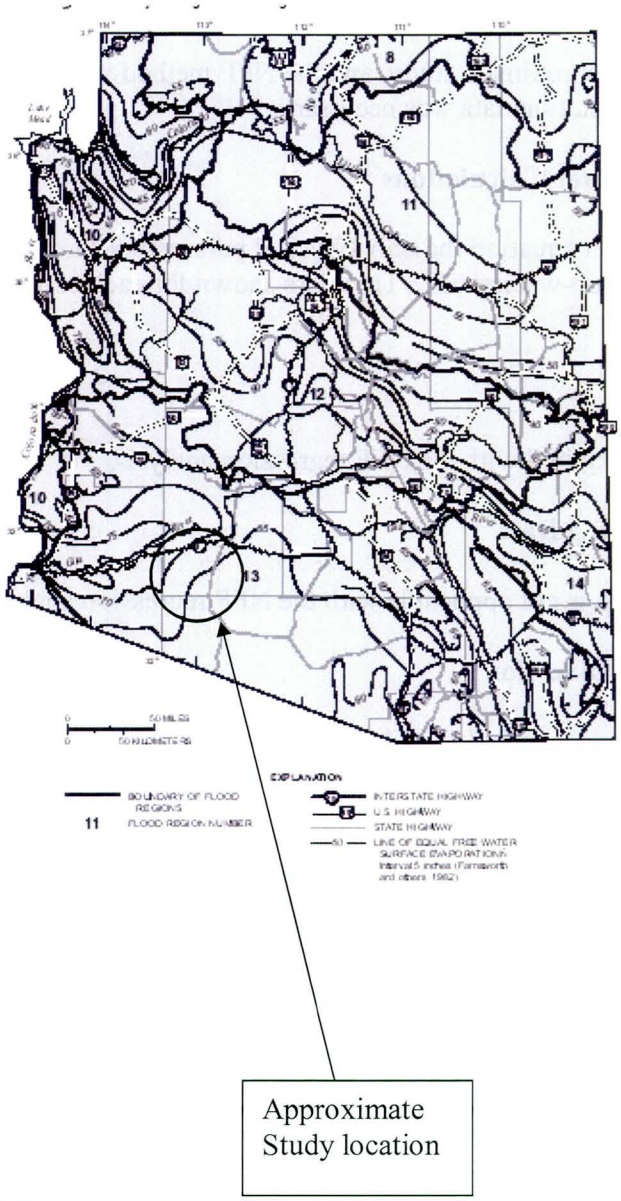


Figure D.6.1. NFF Hydraulic Flood Region.

The study location is in NFF region 13. For this region, the pertinent information is shown in Table D.6.1:

Table D.6.1 Regression Equation for Region 13.

Regression equation	Average standard error of prediction, in percent	Equivalent years of record
Region 13 - 73 stations		
$Q_2 = 10\ (6.38 - 4.29AREA^{-0.06})$	57	2.0
$Q_5 = 10\ (5.78 - 3.31AREA^{-0.08})$	40	6.25
$Q_{10} = 10\ (5.68 - 3.02AREA^{-0.09})$	37	11.1
$Q_{25} = 10\ (5.64 - 2.78AREA^{-0.10})$	39	15.0
$Q_{50} = 10\ (5.57 - 2.59AREA^{-0.11})$	43	15.9
$Q_{100} = 10\ (5.52 - 2.42AREA^{-0.12})$	48	16.1

For this study, only the 100 year flow data was relevant. The equation for this region is:

$Q_{100}=10\text{^}(5.52-2.42AREA^{-0.12})$.

The results of these calculations for each of the concentration points are shown in Figure D.6.2.

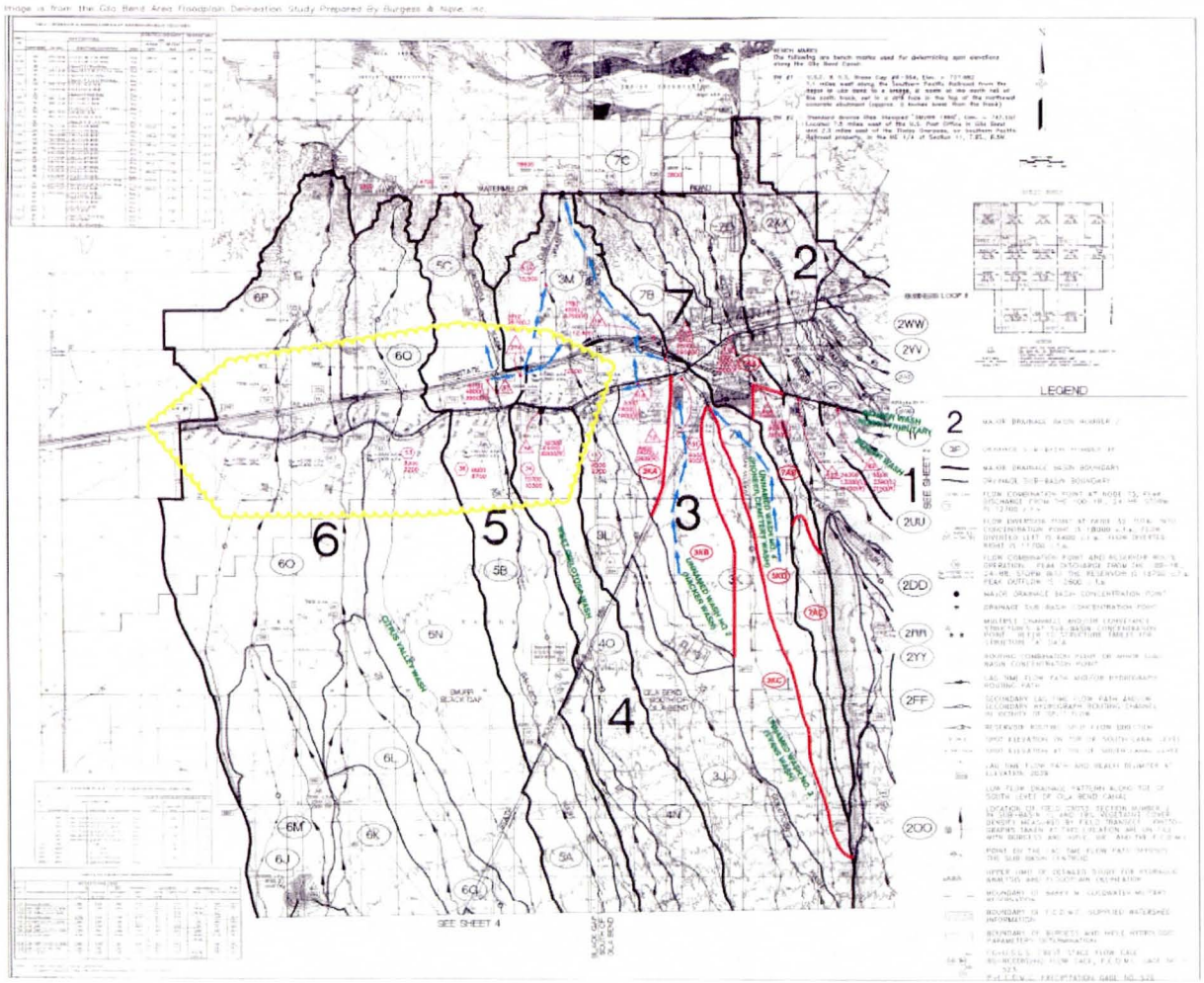
Table D.6.2 Hydologic Modeling Results (calculated 100yr flows)

Drainage Area and Concentration Point Name	Area (mi^2)	Peak flow 100yr (cfs) NFF
ThebaA		
ThebaA_05Cz	0.27	482
ThebaB		
ThebaB_05Cy	0.77	1,049
ThebaB_05Cz	0.41	676
ThebaB_10Cz	0.34	589
ThebaC		
ThebaC_05Cy	5.45	3,512
ThebaC_05Cz	5.21	3,426
ThebaC_10Cy	1.35	1,533
ThebaC_15Cy	3.86	2,898
ThebaC_20Cz	0.59	875
ThebaC_25Cy	1.45	1,605

Drainage Area and Concentration Point Name	Area (mi^2)	Peak flow 100yr (cfs)
		NFF
ThebaC/ThebaE		
ThebaC_30Cz	4.24	3,056
ThebaD		
ThebaD_05Cy	0.36	609
ThebaE		
ThebaE_05Cy	62.23	11,114
ThebaE_05Cz	62.22	11,107
ThebaE_10Cy	14.09	5,731
ThebaE_10Cz	14.00	5,713
ThebaE_15Cy	13.86	5,685
ThebaE_15Cz†	10.76	5,015
ThebaE_20Cz	0.14	284
ThebaE_25Cz	48.13	9,993
ThebaF		
ThebaF_05Cy	0.30	529
ThebaF_05Cz	0.26	474
ThebaG		
ThebaG_05Cz	5.36	3,480
ThebaG_05Cy	6.16	3,752
ThebaG_05Cx	6.31	3,800
ThebaH		
ThebaH_05Cy	0.56	840
ThebaH_05Cz	0.52	801
ThebaI		
ThebaI_05Cy	1.27	1,477
ThebaI_05Cx	1.80	1,840
ThebaJ*		
ThebaJ_05Cz	67.65	11,497
Citrus Valley Wash*		
CVW_05Cw	12.53	5,411
Sauceda*		
Sau_05Cy	150.87	15,649

* For these watersheds, the results of the Gila Bend ADMP are used instead of these calculated values.
† The area of ThebaC/ThebaE is included in this sub-basin.

The flows from ThebaJ, Citrus Valley Wash, and Sauceda wash were taken from the Gila Bend Area Drainage Master Plan as reported on the HEC-1 Schematic with the Gila Bend Canal. The "With Gila Bend Canal" flows were used because they were larger than the "without" flows. This image is included below.



FLOOD CONTROL DISTRICT of MARICOPA COUNTY

GILA BEND
HEC-1 SCHEMATIC
Revised With Gila Bend Canal

LEGEND

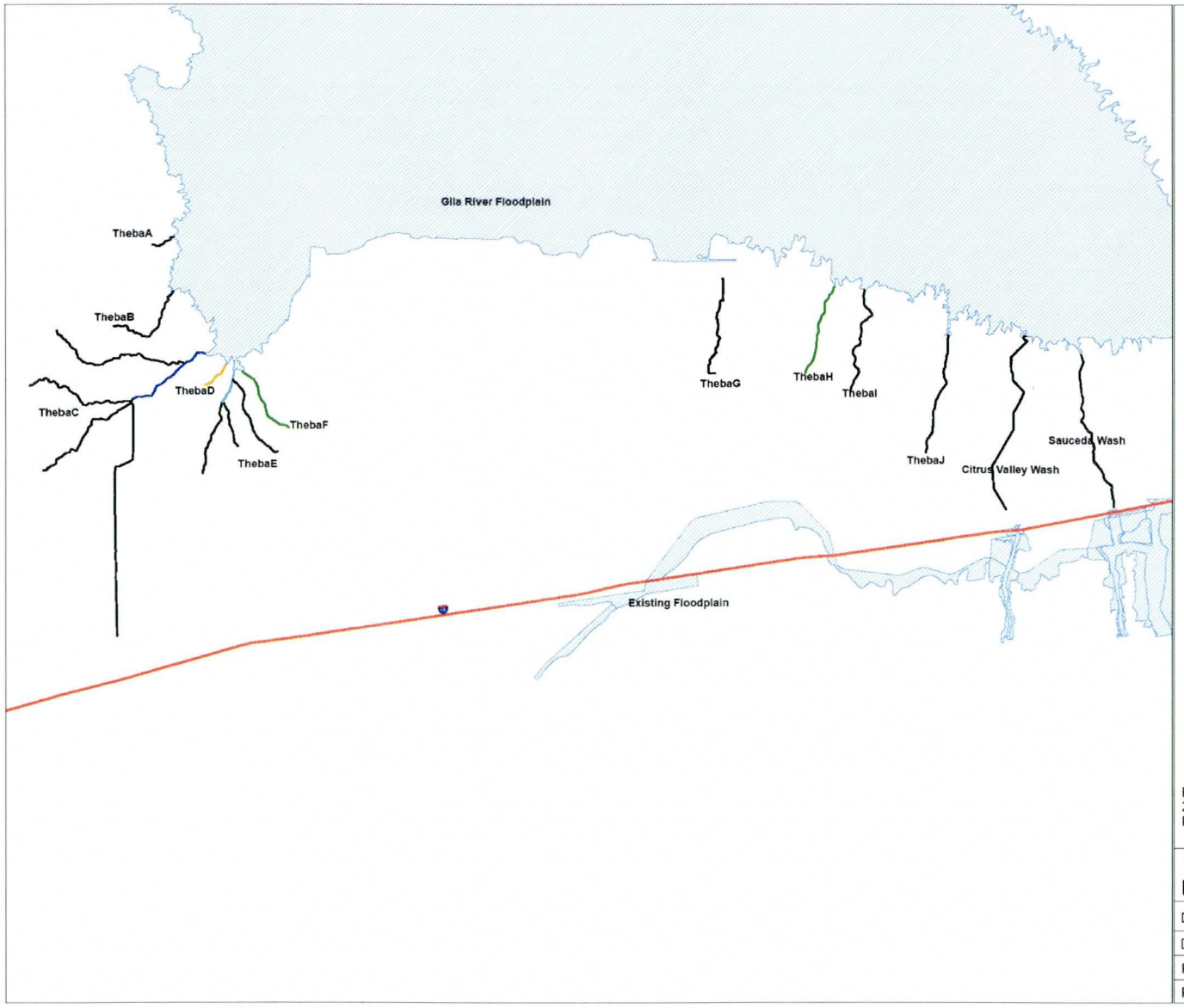
7AA	REVISED SUBBASIN I.D.
	REVISED SUBBASIN BOUNDARIES
	DIRECTION OF FLOW
1700	REVISED FLOW RATES (cfs)
(HACKER WASH)	PROPOSED WASH NAMES
12	DIVERSION OPERATION
1W	CONCENTRATION POINT

eac
Engineering and Environmental Consultants, Inc.
3003 N. Central Avenue, Suite 600
Phoenix, Arizona 85012-2905
TEL (602)248-7702 FAX (602)248-7851

D.7 Hydrologic Modeling Exhibits

Exhibit A (Drainage Area Boundary Map) and Exhibit B (Floodplain Delineation Work Maps) are included in the attached pockets.

Appendix E
Hydraulic Analysis Supporting Documentation



THEBA WATERSHED

ZONE A FLOODPLAIN DELINEATION STUDY

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

FCD 2007C018

LEGEND

- Highways
- Type 2
- Type 3
- Type 4
- Type 5
- Type 5 / Type 3
- Existing Floodplains

0 0.5 1 2 Miles

N

PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, SUITE 4
PHOENIX, ARIZONA 85021

FIGURE E.1.1 N-VALUES		SHEET 1 OF 1	
DESIGN:	DJ	DATE:	07/2009
DESIGN CHK:	MDH	DATE:	07/2009
PLANS:	DJ	DATE:	07/2009
PLANS CHK:	MDH	DATE:	07/2009

E.1. Roughness Value Report

Channel roughness was estimated following a field reconnaissance on August 28, 2008. The reaches were separated into five different basic types, which are shown along with photographs from each type.

Estimation of the roughness values was performed using the FCDMC's "*Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan guidelines for Vegetated Channels in Central Arizona*" by Jeff V. Phillips and Saeid Tadayon, 2006.

Type 1: Engineered Earthen Channel

Computation of Manning's n for Theba Watershed - Engineered Earthen Channel

1. Describe channel: See following figure - The channel bottom is fairly homogenous and is composed mainly of firm earth with minimal gravel. There is a fair amount of vegetation in the channel and along the banks. There is no evidence of bedforms.

Does the use of the stream power relation indicate the vegetation will be laid over or remain in a relatively upright position? The stream power relationship is not used because no bedforms were observed, meaning this is a stable channel.

2. Are present conditions representative of those during flood? The level of vegetation is dependant upon the time of year.

3. Is roughness uniformly distributed across the channel? No - overbanks accounted for seperately.

4. How will the roughness producing effects of the following roughness components be accounted for?

Bank roughness: accounted seperately - bank is sandier, without the armored layer of the channel bed.
Vegetation: The channel is completely filled with vegetation. Little vegetation on banks
Variations in Cross Section: Gradual
Obstructions: Mostly from vegetation/bushes. Could be significant - accounted for in adjustments.
Meander: Some meandering around the farms - Minor effect

5-10. Computation of Manning's n:

		Left OB	Channel	Right OB
Channel Type:	Firm Earth			
Overbank Type:	Gravel	0.030	0.026	0.030

11. Adjustments

				Adjustment	
Factor	**Describe conditions briefly**		**Left OB**	**Channel**	**Right OB**
Irregularity	Smooth		0.000	0.000	0.000
xsec variation	Gradual		0.000	0.000	0.000
Obstructions	Negligible		0.000	0.000	0.000
Vegetation	Negligible for OB, small for channel		0.001	0.006	0.001
Base n + added adjustments =			0.031	0.032	0.031
Meander: Multiplier to n-value					
	Left OB:	Minor 1.00			
	Channel:	Minor 1.00			
	Right OB:	Minor 1.00			
Final n value = (Base n + added adjustments) * Meander			0.031	0.032	0.031

Manning's n values estimated using *Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona* By Jeff V. Phillips and Saeid Tadayon Prepared in cooperation with the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
Scientific Investigations Report 2006–5108
U.S. Department of the Interior
U.S. Geological Survey

Type 1: Engineered Earthen Channel

Picture 1

Picture 2

Picture 3

Picture 4

Type 2: Farmland

Computation of Manning's n for Theba Watershed - Farmland

1. Describe channel: See following figure - Upstream of the location of the pictures is farmland with tailwater channels along the edges of the fields.

Does the use of the stream power relation indicate the vegetation will be laid over or remain in a relatively upright position? The stream power relationship is not used because no bedforms were observed, meaning this is a stable channel.

2. Are present conditions representative of those during flood? Possibly depending upon the crops as well as the time of year.

3. Is roughness uniformly distributed across the channel? No - overbanks accounted for seperately.

4. How will the roughness producing effects of the following roughness components be accounted for?

Bank roughness: Minor - bank is fairly homogenous with channel
Vegetation: Small effect on edges of fields and from crops, with channels/rows through crops.
Variations in Cross Section: Alternating occasionally effect winding through cultivated fields
Obstructions: Minimal - no obstructions
Meander: Appreciable meandering - adjusted for in step 11 (adjustments)

5-10. Computation of Manning's n:

		Left OB	Channel	Right OB
Channel Type:	Firm Earth			
Overbank Type:	Firm Earth / gravel	0.030	0.026	0.030

11. Adjustments

Factor	Describe conditions briefly			Adjustments Left OB	Adjustments Channel	Adjustments Right OB
Irregularity	Minor			0.001	0.001	0.001
xsec variation	Gradual for OB, Channel Alternating occasionally			0.000	0.003	0.000
Obstructions	Minor			0.003	0.000	0.003
Vegetation	Small			0.007	0.003	0.007
Base n + added adjustments =				0.041	0.033	0.041
Meander: Multiplier to n-value						
	Left OB:	Minor	1.00			
	Channel:	Appreciable	1.15			
	Right OB:	Minor	1.00			
Final n value = (Base n + added adjustments) * Meander				0.041	0.038	0.041

Manning's n values estimated using *Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona* By Jeff V. Phillips and Saeid Tadayon Prepared in cooperation with the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
Scientific Investigations Report 2006–5108
U.S. Department of the Interior
U.S. Geological Survey

Type 2: Farmland

Picture 5

Picture 6

Picture 7

Picture 8

Type 3: Gravel Channel

Computation of Manning's n for Theba Watershed - Gravel Channel

1. Describe channel: See following figure - The channel is homogenous with a mostly gravel/cobble base composing an armored layer. There is minimal vegetation in the channel. Some vegetation along the overbank. **Does the use of the stream power relation indicate the vegetation will be laid over or remain in a relatively upright position?** The stream power relationship is not used because no bedforms were observed, meaning this is a stable channel.

2. Are present conditions representative of those during flood? The level of vegetation can be dependant upon the time of year.

3. Is roughness uniformly distributed across the channel? No - overbanks accounted for seperately.

4. How will the roughness producing effects of the following roughness components be accounted for?

Bank roughness: Minimal - bank is homogenous with channel - some trees in places.
Vegetation: Mostly bushes - an adjustment will be added in step 11
Variations in Cross Section: Could be significant - possible overflowing of banks.
Obstructions: Mostly from vegetation/bushes. Could be significant.
Meander: Minimal meandering

5-10. Computation of Manning's n:

		Left OB	Channel	Right OB
Channel Type:	Gravel			
Overbank Type:	Gravel	0.032	0.032	0.032

11. Adjustments

Factor	Describe conditions briefly	Adjustments Left OB	Channel	Right OB
Irregularity	Smooth	0.000	0.000	0.000
xsec variation	Alternating occasionally	0.000	0.002	0.000
Obstructions	Negligible	0.000	0.000	0.000
Vegetation	Channel = Negligible, OB = Small	0.008	0.001	0.008
Base n + added adjustments =		0.040	0.035	0.040
Meander: Multiplier to n-value				
	Left OB: Minor 1.00			
	Channel: Minor 1.00			
	Right OB: Minor 1.00			
Final n value = (Base n + added adjustments) * Meander		0.040	0.035	0.040

Manning's n values estimated using *Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona* By Jeff V. Phillips and Saeid Tadayon Prepared in cooperation with the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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U.S. Geological Survey

Type 3: Gravel Channel

Picture 9

Picture 10

Picture 11

Picture 12

Type 4: Gravel/Sand Bed Channel

Computation of Manning's n for Theba Watershed - Gravel/Sand bed

1. Describe channel: See following figure - The channel bottom is fairly homogenous and is composed mainly of sand and gravel. There is a some vegetation in the channel and along the banks. There is an armored layer on the channel bed.

Does the use of the stream power relation indicate the vegetation will be laid over or remain in a relatively upright position? The stream power relationship is not used because no bedforms were observed, meaning this is a stable channel.

2. Are present conditions representative of those during flood? Yes

3. Is roughness uniformly distributed across the channel? No - overbanks accounted for seperately.

4. How will the roughness producing effects of the following roughness components be accounted for?

Bank roughness: More vegetation than the channel, otherwise similar to channel.
Vegetation: Medium along bank, small in channel
Variations in Cross Section: Alternating Occasionally
Obstructions: Negligible
Meander: Minor

5-10. Computation of Manning's n:

		Left OB	Channel	Right OB
Channel Type:	Gravel/sand	0.028	0.030	0.028
Overbank Type:	Gravel/sand			

11. Adjustments

		Adjustements		
Factor	**Describe conditions briefly**	**Left OB**	**Channel**	**Right OB**
Irregularity	Smooth	0.000	0.000	0.000
xsec variation	Alternating occasionally	0.001	0.003	0.001
Obstructions	Negligible	0.001	0.000	0.001
Vegetation	Channel = negligible, overbank = small	0.008	0.001	0.008
Base n + added adjustments =		0.038	0.034	0.038
Meander: Multiplier to n-value				
	Left OB: Minor 1.15			
	Channel: Minor 1.15			
	Right OB: Minor 1.15			
Final n value = (Base n + added adjustments) * Meander		0.044	0.039	0.044

Manning's n values estimated using *Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona* By Jeff V. Phillips and Saeid Tadayon Prepared in cooperation with the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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U.S. Department of the Interior
U.S. Geological Survey

Type 4: Gravel/Sand Bed Channel

Picture 13

Picture 14

Picture 15

Picture 16

Type 5: Thickly Vegetated Channel

Computation of Manning's n for Theba Watershed - Thick Vegetation

1. Describe channel: See following figure - Thick vegetation will provide a higher roughness value than would otherwise be the case. It is fairly likely the roughness from vegetation will be similar year round.

Does the use of the stream power relation indicate the vegetation will be laid over or remain in a relatively upright position? The stream power relationship is not used because no bedforms were observed, meaning this is a stable channel.

2. Are present conditions representative of those during flood?Yes with minimal level of change depending upon the time of year.

3. Is roughness uniformly distributed across the channel? Yes

4. How will the roughness producing effects of the following roughness components be accounted for?

Bank roughness: Bank is homogenous with channel
Vegetation: Lots of vegetation with significant impact on roughness
Variations in Cross Section: Relatively minimal
Obstructions: Minimal
Meander: Minimum meandering

5-10. Computation of Manning's n:

		Left OB	Channel	Right OB
Channel Type:	Firm Earth			
Overbank Type:	Firm Earth	0.025	0.025	0.025

11. Adjustments

				Adjustments		
Factor	**Describe conditions briefly**			**Left OB**	**Channel**	**Right OB**
Irregularity	Smooth			0.000	0.000	0.000
xsec variation	Gradual			0.000	0.000	0.000
Obstructions	Negligible			0.001	0.001	0.001
Vegetation	Large			0.035	0.030	0.035
Weighted n + added adjustments =				0.061	0.056	0.061
Meander: Multiplier to n-value						
	Left OB:	Minor	1.00			
	Channel:	Minor	1.00			
	Right OB:	Minor	1.00			
Final n value = (Base n + added adjustments) * Meander				0.061	0.056	0.061

Manning's n values estimated using *Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona* By Jeff V. Phillips and Saeid Tadayon Prepared in cooperation with the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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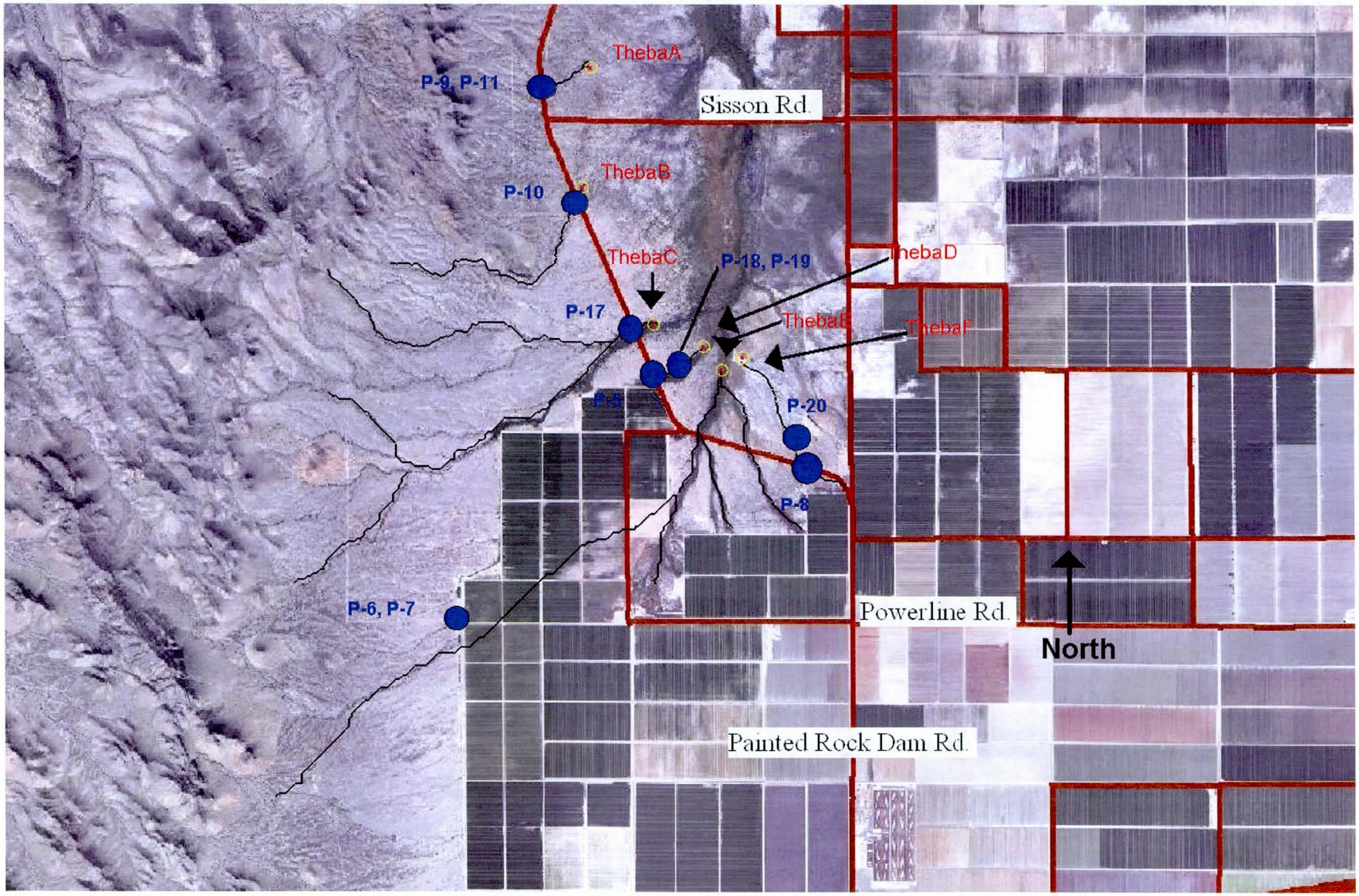
Type 5: Thickly Vegetated Channel

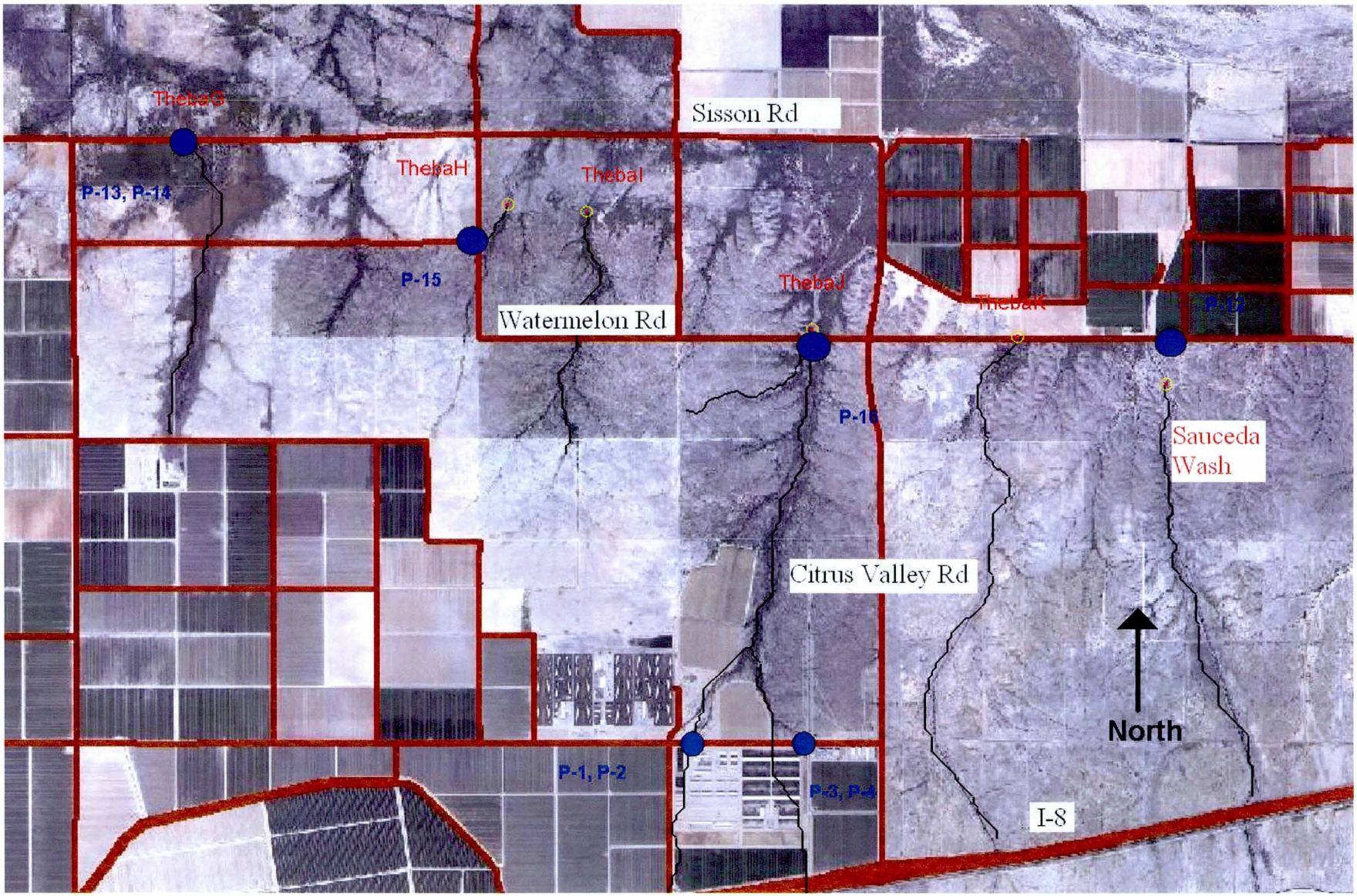
Picture 17

Picture 18

Picture 19

Picture 20


ThebaA
P-9, P-11
Sisson Rd.
ThebaB
P-10
ThebaC
P-18, P-19
ThebaD
P-17
ThebaE
ThebaF
P-5
P-20
P-8
P-6, P-7
Powerline Rd.
North
Painted Rock Dam Rd.


ThebaG
Sisson Rd
ThebaH
ThebaI
P-13, P-14
P-15
Watermelon Rd
ThebaJ
ThebaK
P-12
P-16
Sauceda
Wash
Citrus Valley Rd
North
P-1, P-2
P-3, P-4
I-8

Explanation and Location of Photographs

(Pictures taken 28 August, 2008)

Channels

- Picture 1: ThebaJ – Looking upstream, showing 2 of the channels leading next to the cattle/farming.
  - Location: 32°56'29.15"N 112°49'19.79"W
- Picture 2: ThebaJ – Looking Downstream, showing another of the channels full of vegetation.
  - Location: 32°56'29.15"N 112°49'19.79"W
- Picture 3: ThebaJ – Looking Upstream, less grass/vegetation.
  - Location: 32°56'29.34"N 112°48'37.33"W
- Picture 4: ThebaJ – Looking downstream.
  - Location: 32°56'29.37"N 112°48'37.37"W

Farmland

- Picture 5: ThebaD – Looking upstream – water shown coming from a tail-water ditch.
  - Location: 32°57'39.07"N 112°58'46.36"W
- Picture 6: ThebaE – From the top of the Dike looking downstream showing farmland.
  - Location: 32°56'25.12"N 112°59'58.37"W
- Picture 7: ThebaE – Also from the top of the Dike looking downstream.
  - Location: 32°56'18.09"N 112°59'58.14"W
- Picture 8: ThebaF – Showing a tail-water drain from a field into a marshy area.
  - Location: 32°57'7.29"N 112°57'53.74"W

Gravel

- Picture 9: ThebaA – Looking upstream.
  - Location: 32°59'11.31"N 112°59'30.29"W
- Picture 10: ThebaB – Looking upstream.
  - Location: 32°58'35.77"N 112°59'16.41"W
- Picture 11: ThebaA – Showing representative particle size.
  - Location: 32°59'11.31"N 112°59'30.29"W
- Picture 12: ThebaL – Looking downstream.
  - Location: 32°56'26.14"N 112°58'37.49"W

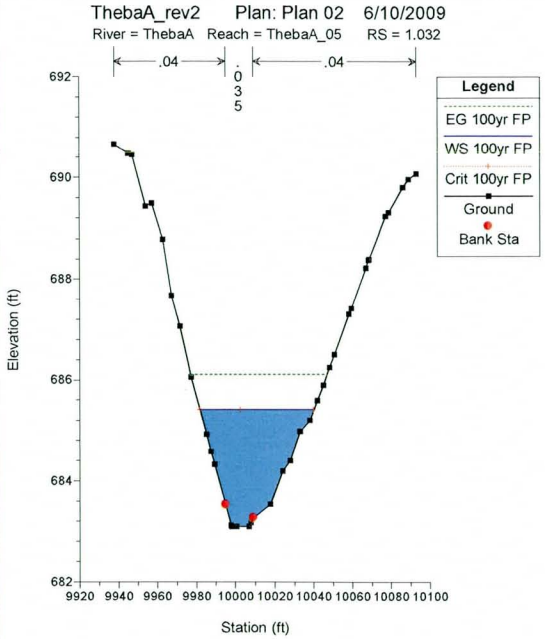
Gravel-Sand

- Picture 13: ThebaG – Looking off to the side of the channel.
  - Location: 32°58'38.03"N 112°51'43.15"W
- Picture 14: ThebaG – Looking upstream.
  - Location: 32°58'38.03"N 112°51'43.15"W
- Picture 15: ThebaH – Looking upstream.
  - Location: 32°58'29.40"N 112°50'20.19"W
- Picture 16: ThebaJ – Looking Downstream.
  - Location: 32°58'14.67"N 112°48'36.18"W

Thick Vegetation

- Picture 17: ThebaC – Looking downstream.
  - Location: 32°57'54.36"N 112°58'54.46"W
- Picture 18: ThebaD – Looking downstream.
  - Location: 32°57'39.07"N 112°58'46.36"W
- Picture 19: ThebaD – Looking upstream just after the overflow from the farmland/tail-water ditch.
  - Location: 32°57'39.07"N 112°58'46.36"W
- Picture 20: ThebaE – Looking downstream from the farmland into the thicker vegetation.
  - Location: 32°57'7.19"N 112°57'53.61"W

E.2 Cross Section Plots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River = ThebaA Reach = ThebaA_05 RS = 1.032
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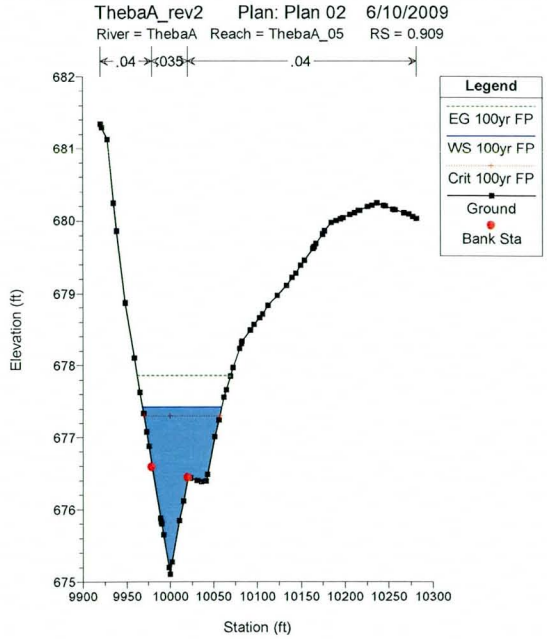
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)


ThebaA_rev2 Plan: Plan 02 6/10/2009
River = ThebaA Reach = ThebaA_05 RS = 0.909
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Legend
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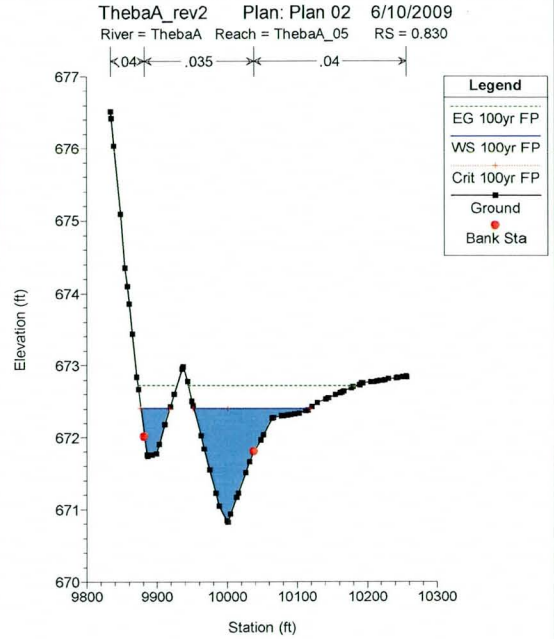
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)


ThebaA_rev2 Plan: Plan 02 6/10/2009
River = ThebaA Reach = ThebaA_05 RS = 0.830
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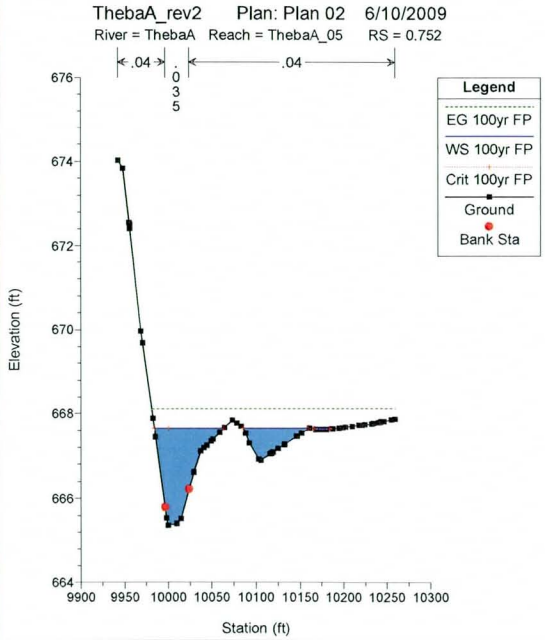
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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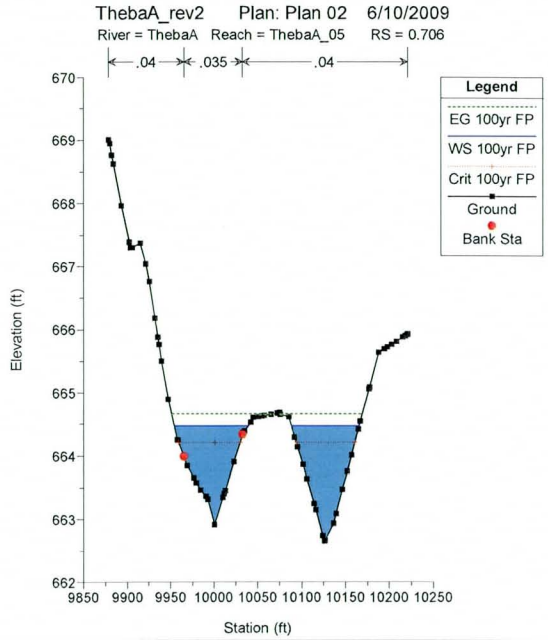
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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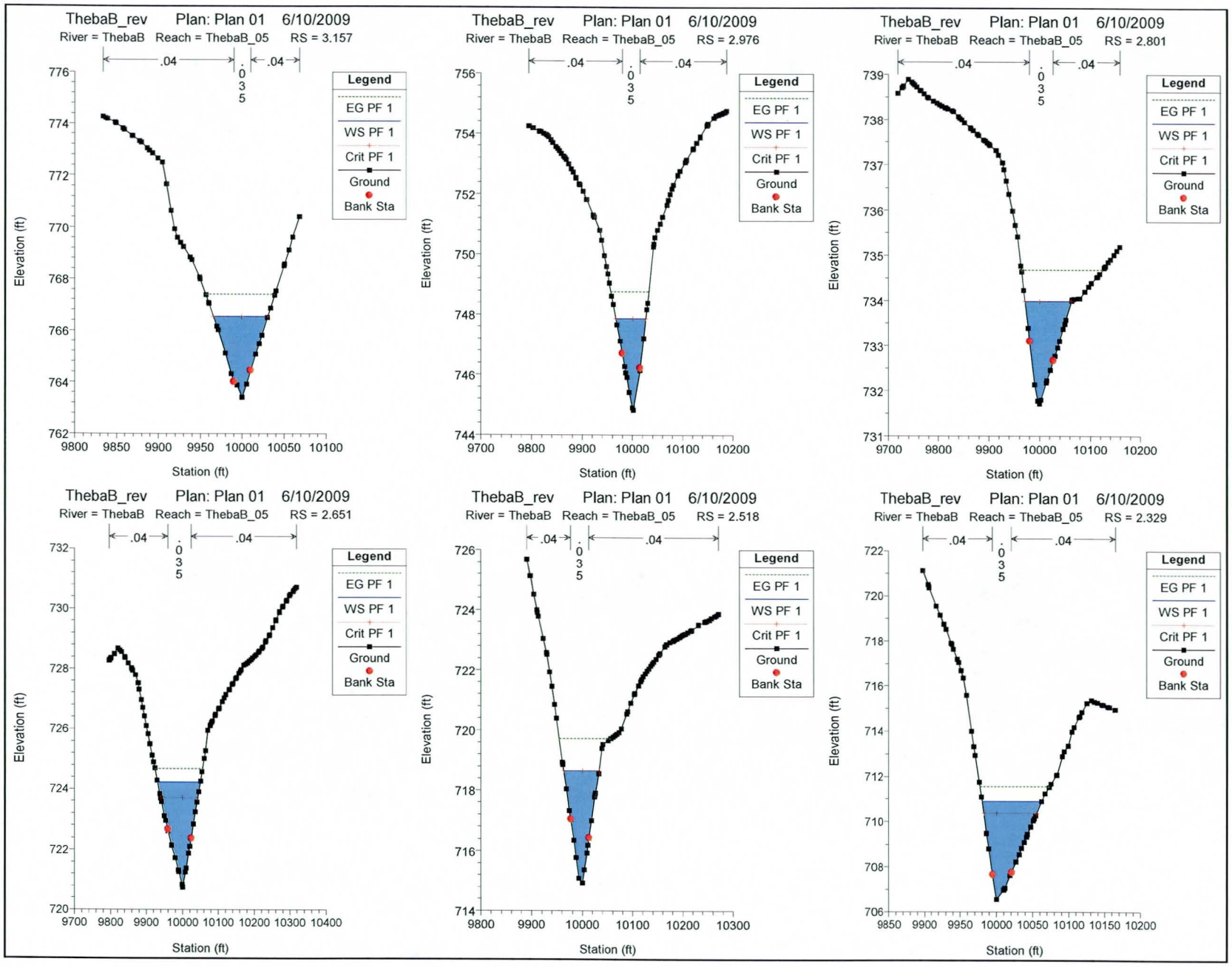
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 2.976
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 2.801
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 2.651
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 2.518
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 2.329
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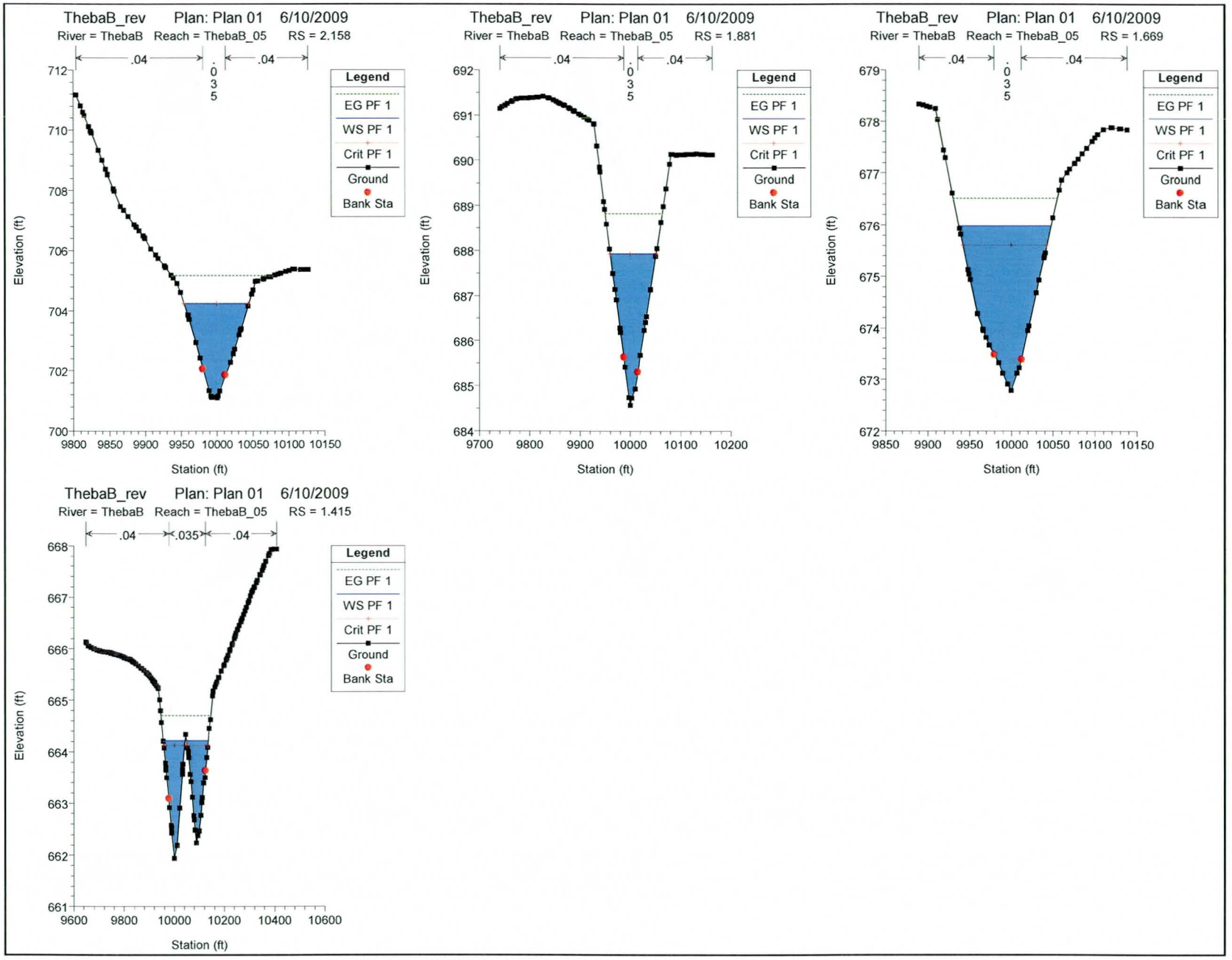
.035
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaB Reach = ThebaB_05 RS = 2.158
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Legend
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WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 1.881
.04
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 1.669
.04
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaB_rev Plan: Plan 01 6/10/2009
River = ThebaB Reach = ThebaB_05 RS = 1.415
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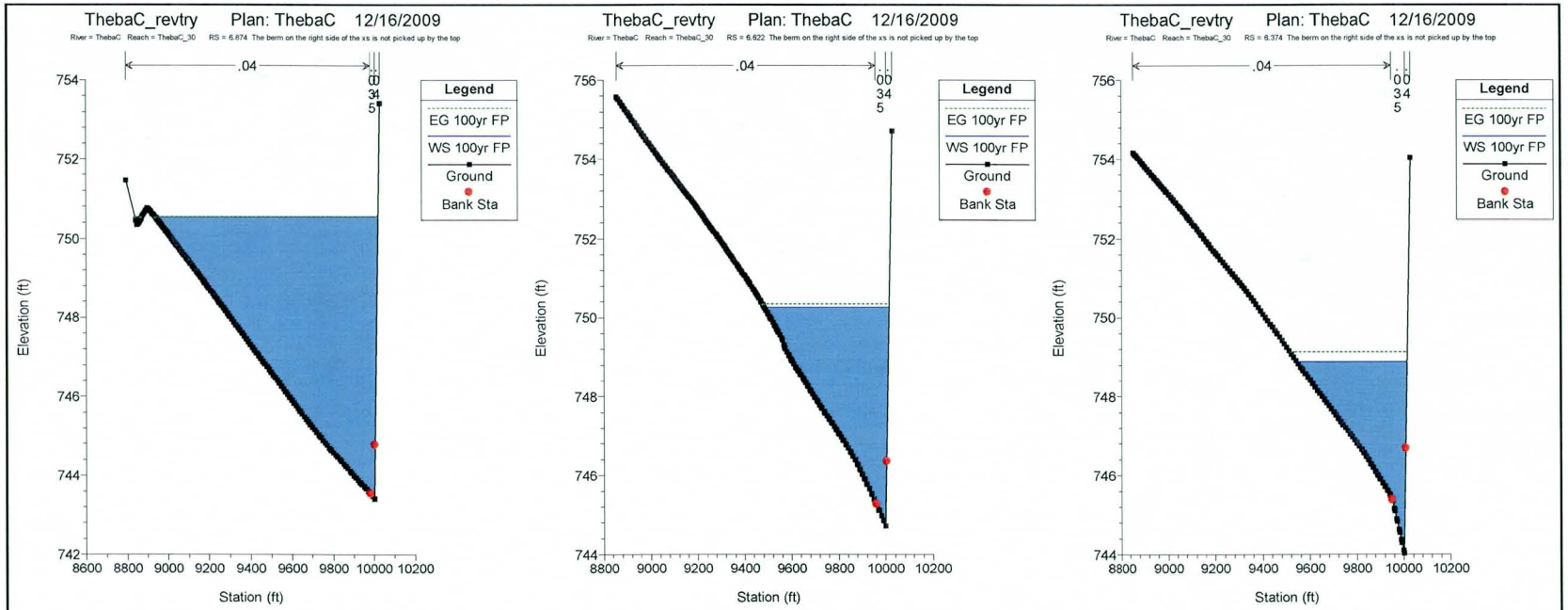
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_30 RS = 6.874 The berm on the right side of the xs is not picked up by the top
.04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 6.622 The berm on the right side of the xs is not picked up by the top
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Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 6.374 The berm on the right side of the xs is not picked up by the top
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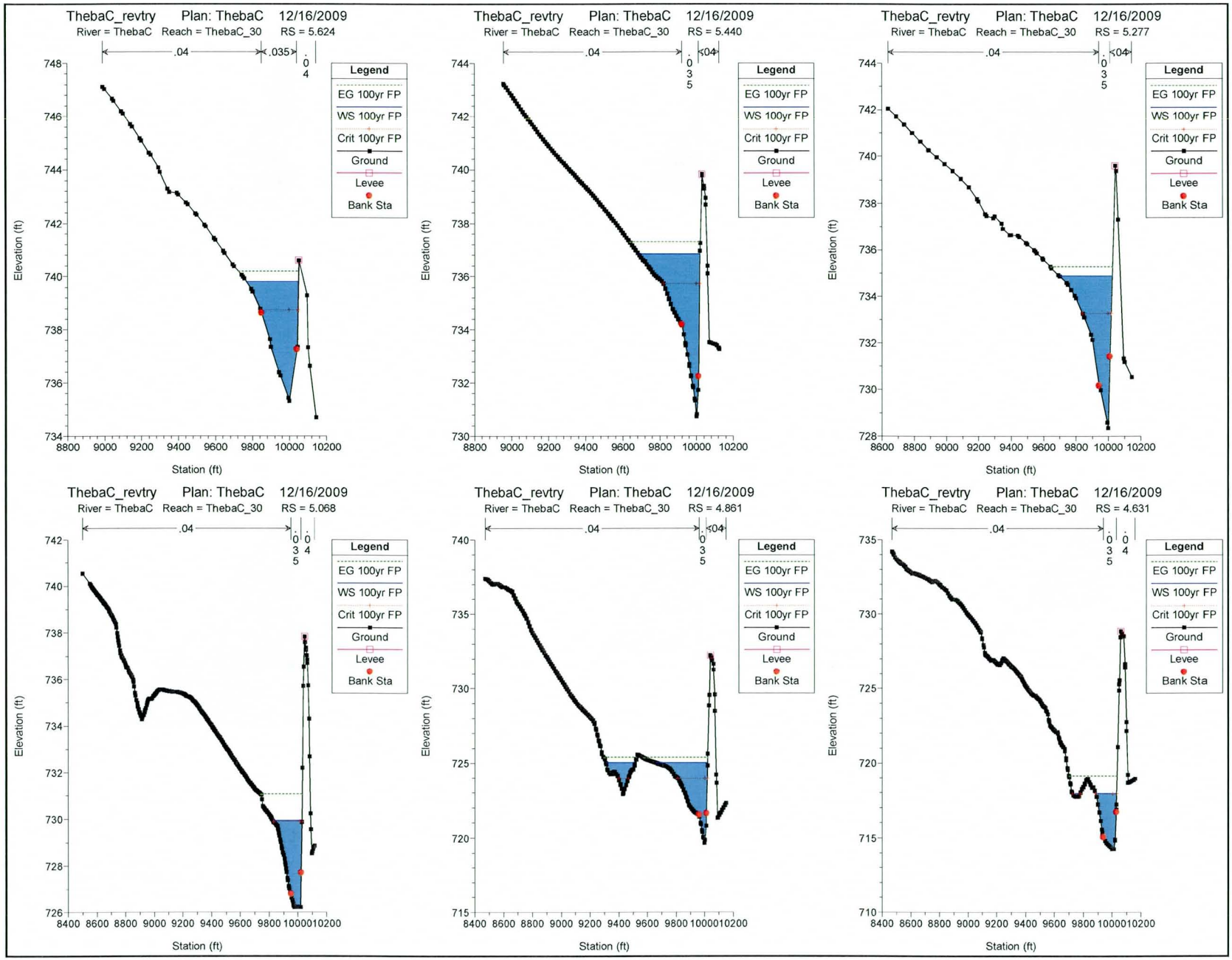
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 6.180
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 6.002
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 5.784
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_30 RS = 5.624
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.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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River = ThebaC Reach = ThebaC_30 RS = 5.440
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 5.277
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 5.068
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 4.861
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 4.631
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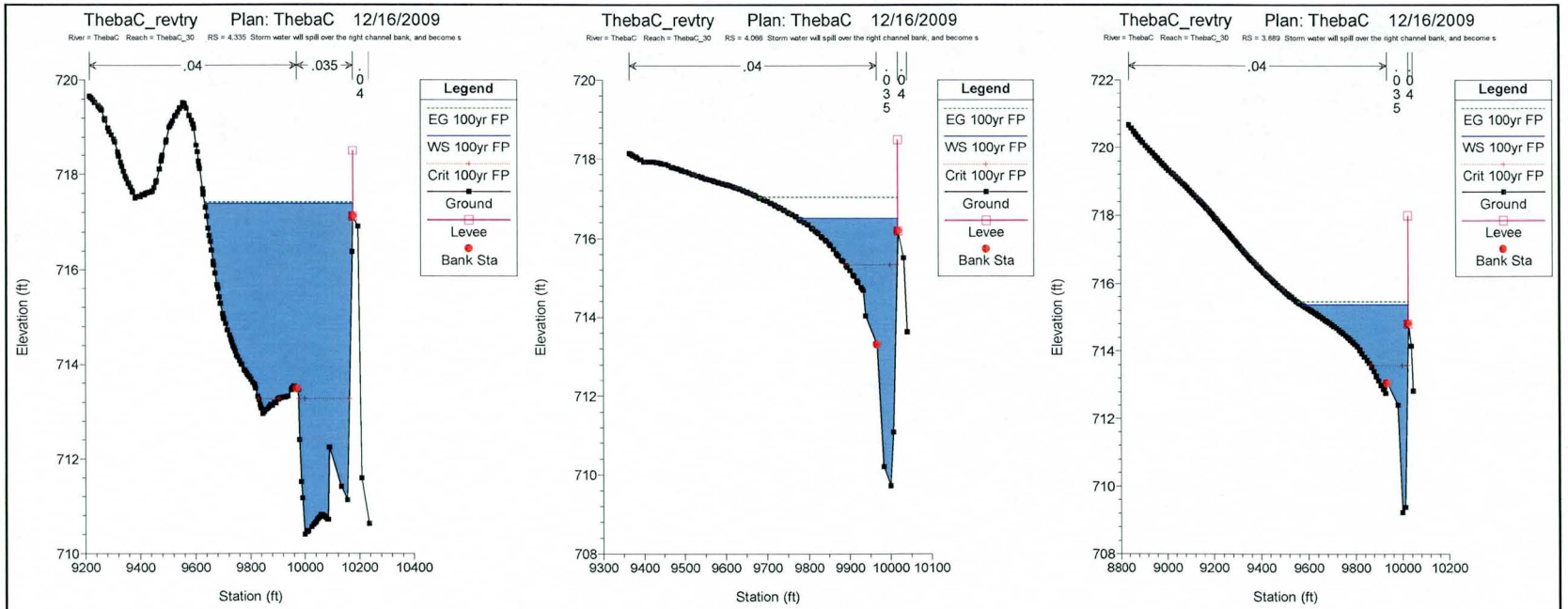
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_30 RS = 4.335 Storm water will spill over the right channel bank, and become s
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 4.066 Storm water will spill over the right channel bank, and become s
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 3.889 Storm water will spill over the right channel bank, and become s
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 3.662
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_30 RS = 3.539
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_25 RS = 5.200
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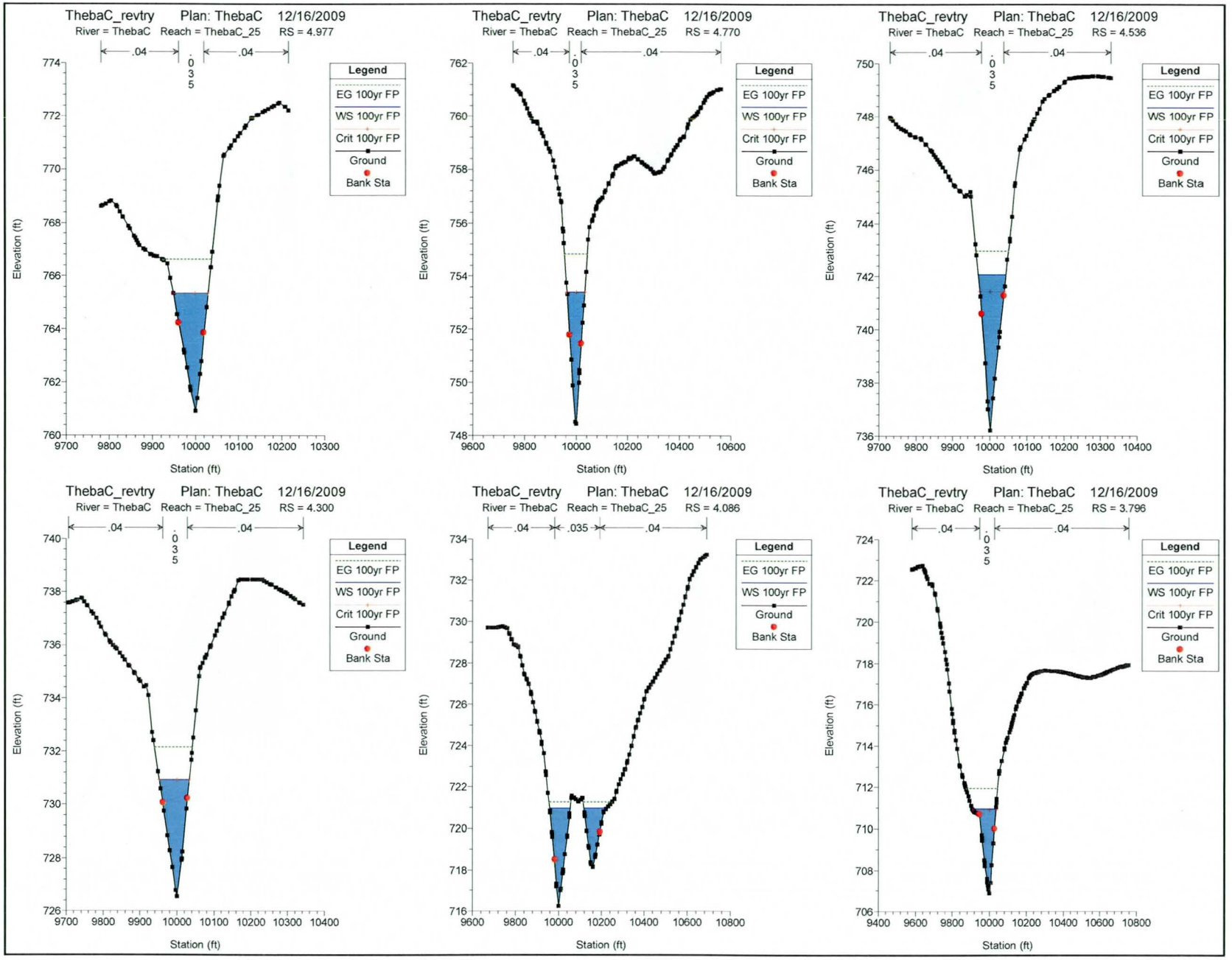
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_25 RS = 4.977
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_25 RS = 4.770
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_25 RS = 4.536
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_25 RS = 4.300
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_25 RS = 4.086
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_25 RS = 3.796
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Legend
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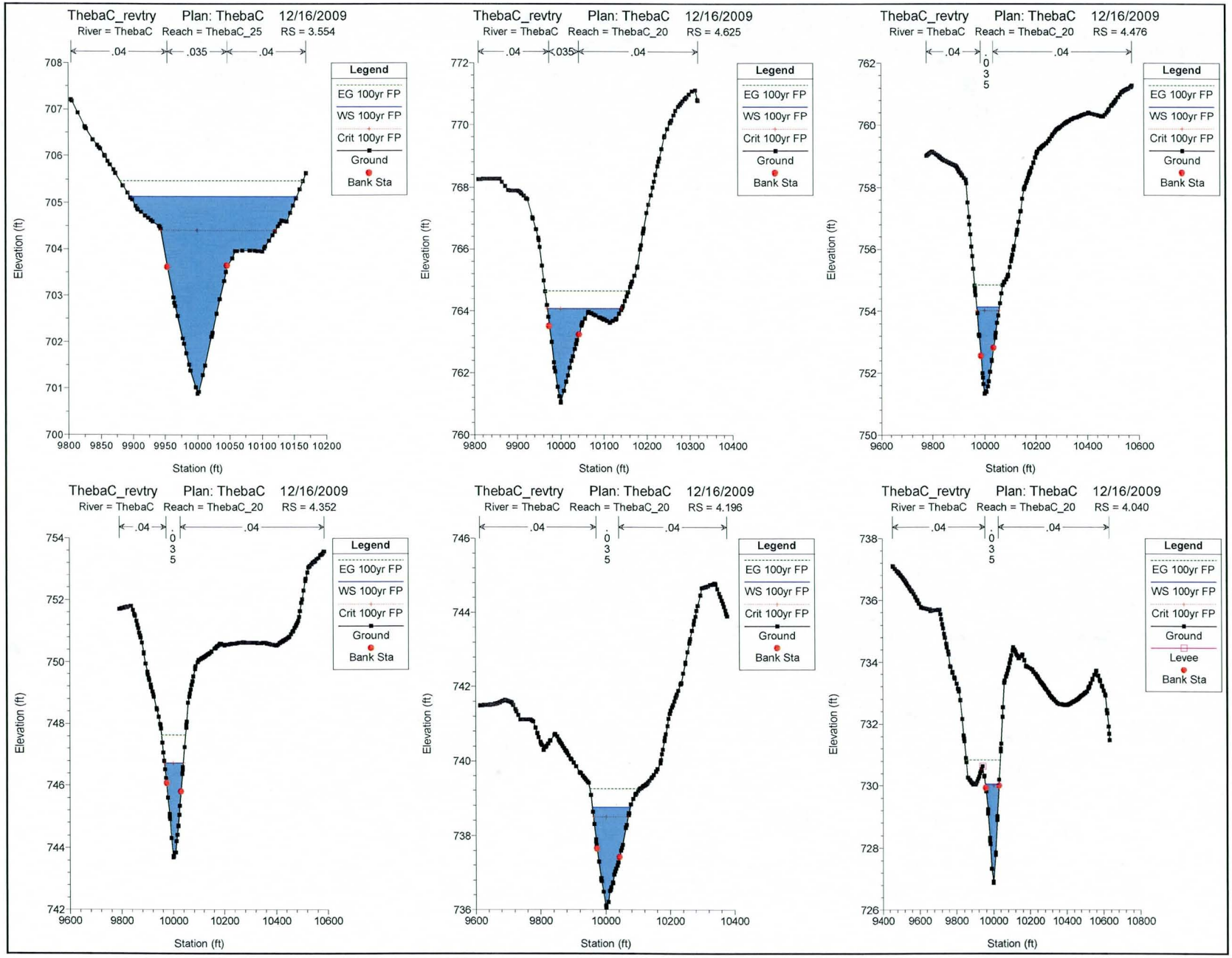
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_25 RS = 3.554
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River = ThebaC Reach = ThebaC_20 RS = 4.625
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ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_20 RS = 4.476
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ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_20 RS = 4.352
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ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_20 RS = 4.196
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ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_20 RS = 4.040
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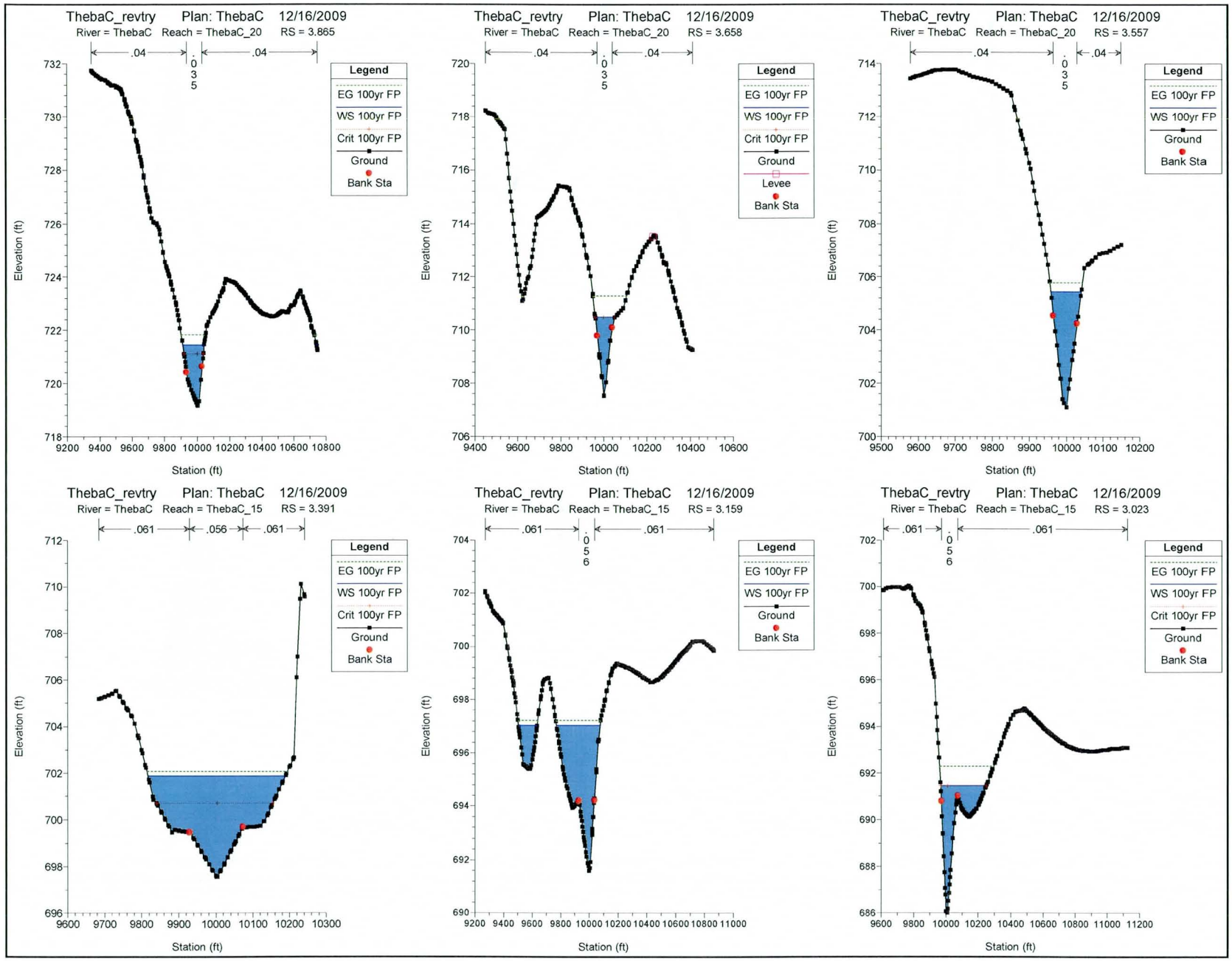
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_20 RS = 3.865
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Legend
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WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_20 RS = 3.658
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_20 RS = 3.557
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_15 RS = 3.391
.061 .056 .061
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_15 RS = 3.159
.061 .056 .061
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_15 RS = 3.023
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Legend
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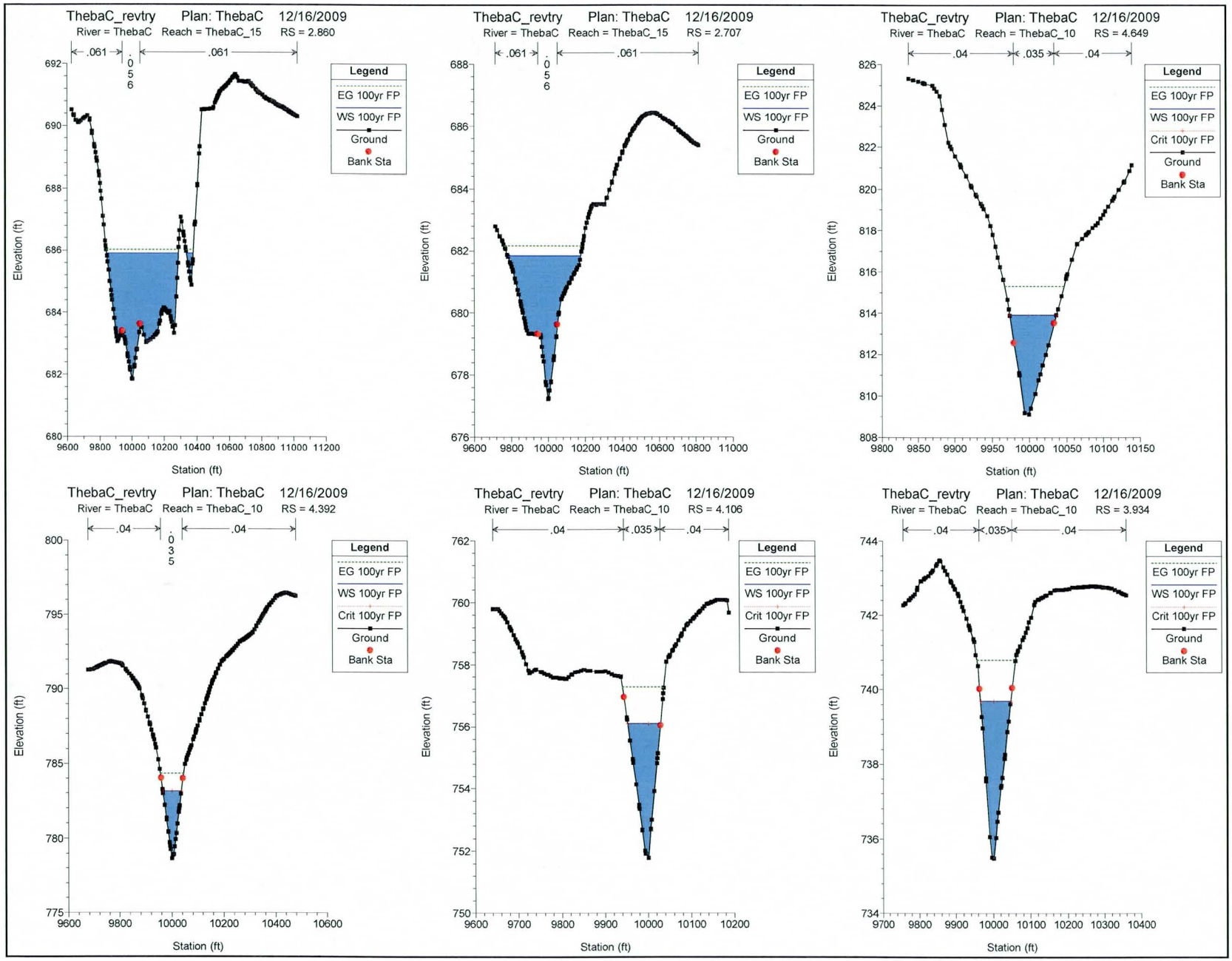
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_15 RS = 2.860
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Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_15 RS = 2.707
.061 .056 .061
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 4.649
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 4.392
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 4.106
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 3.934
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Legend
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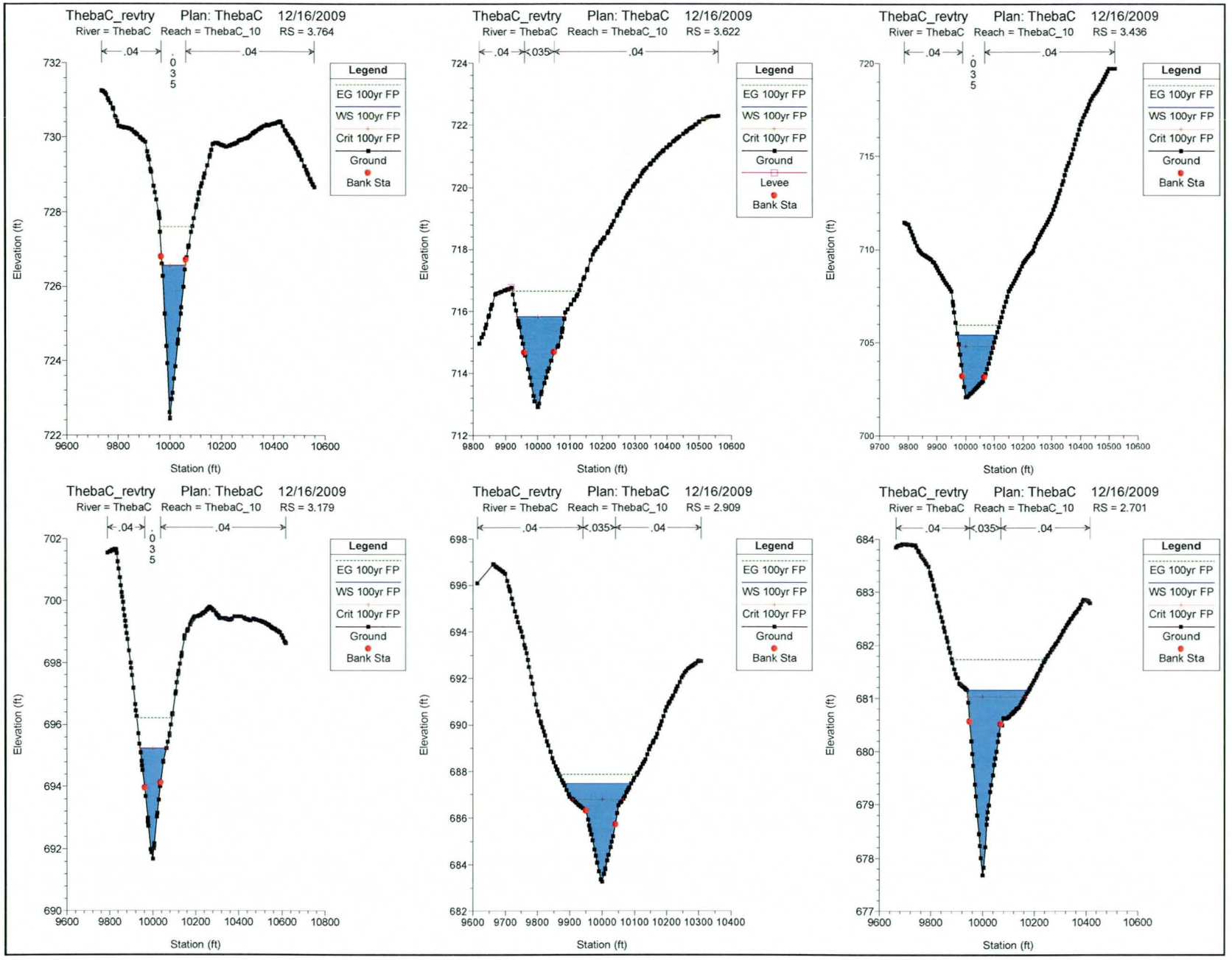
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_10 RS = 3.764
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 3.622
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 3.436
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 3.179
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 2.909
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_10 RS = 2.701
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Legend
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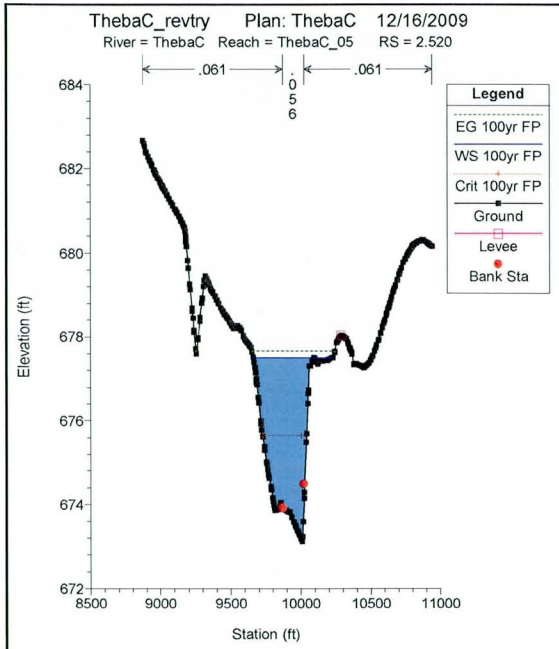
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_05 RS = 2.520
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Legend
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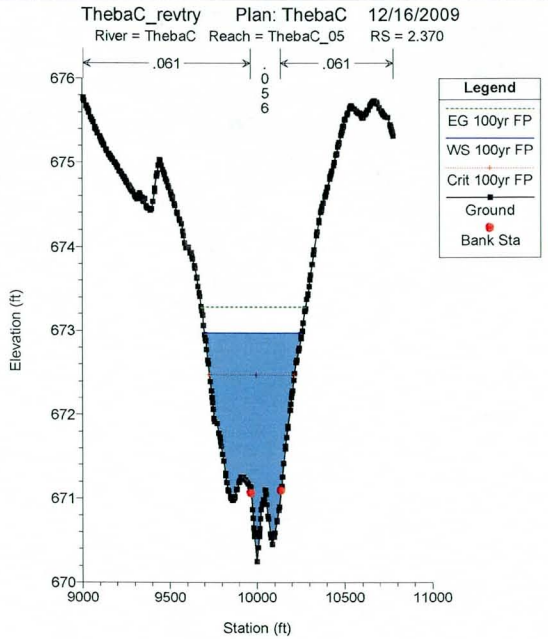
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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River = ThebaC Reach = ThebaC_05 RS = 2.370
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.061
Legend
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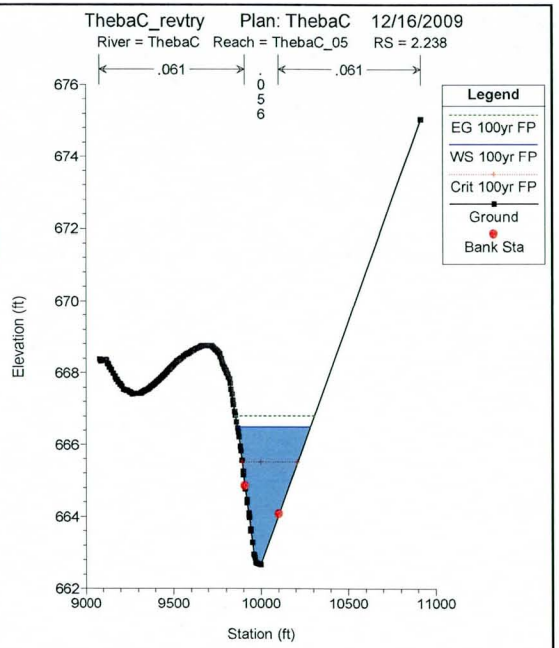
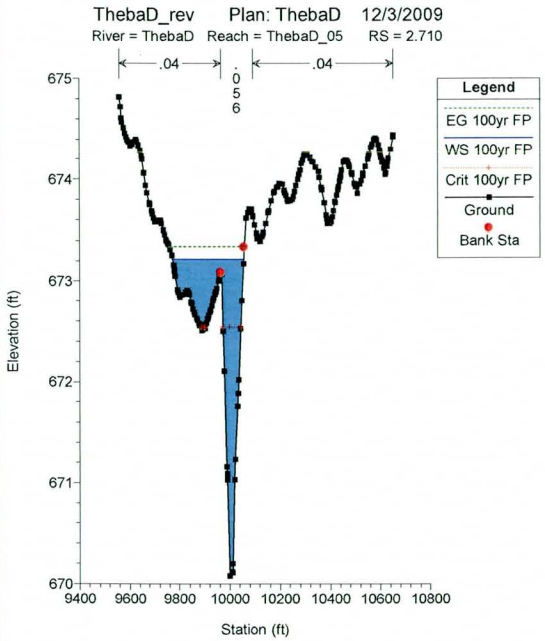
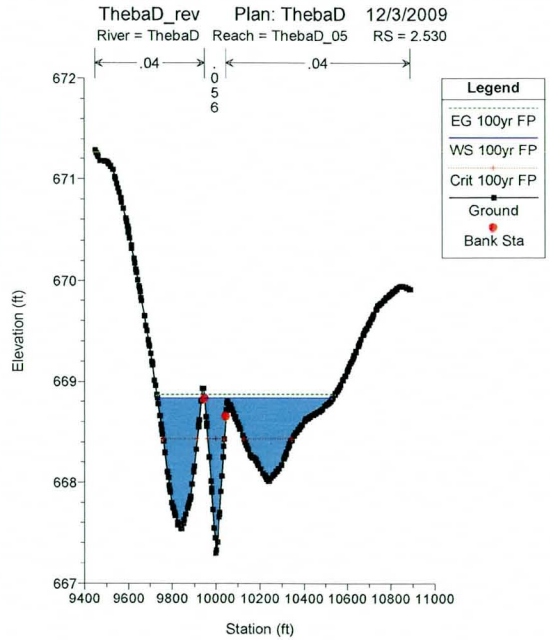
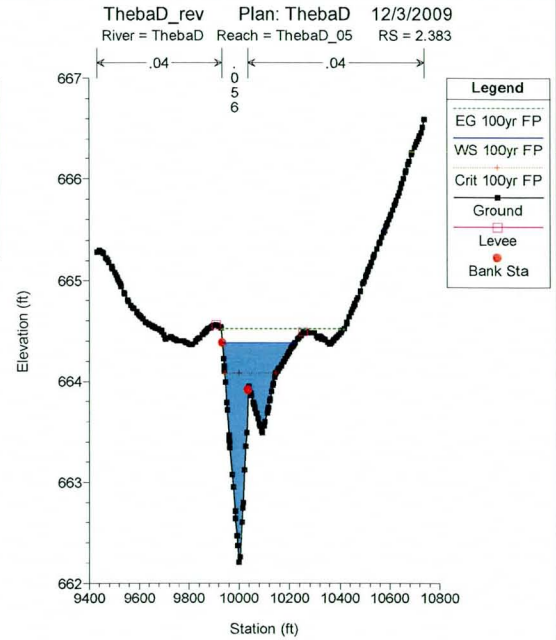
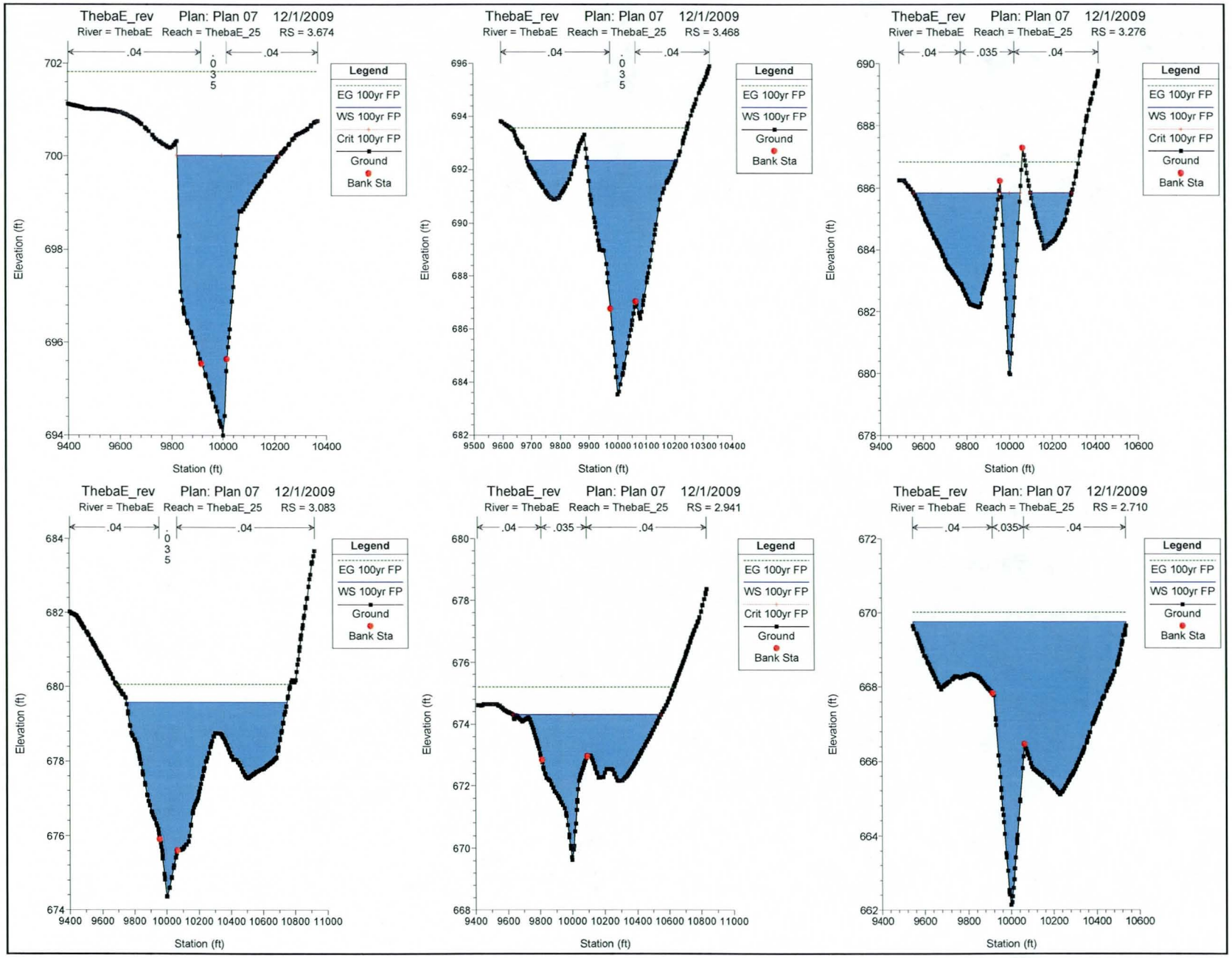
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

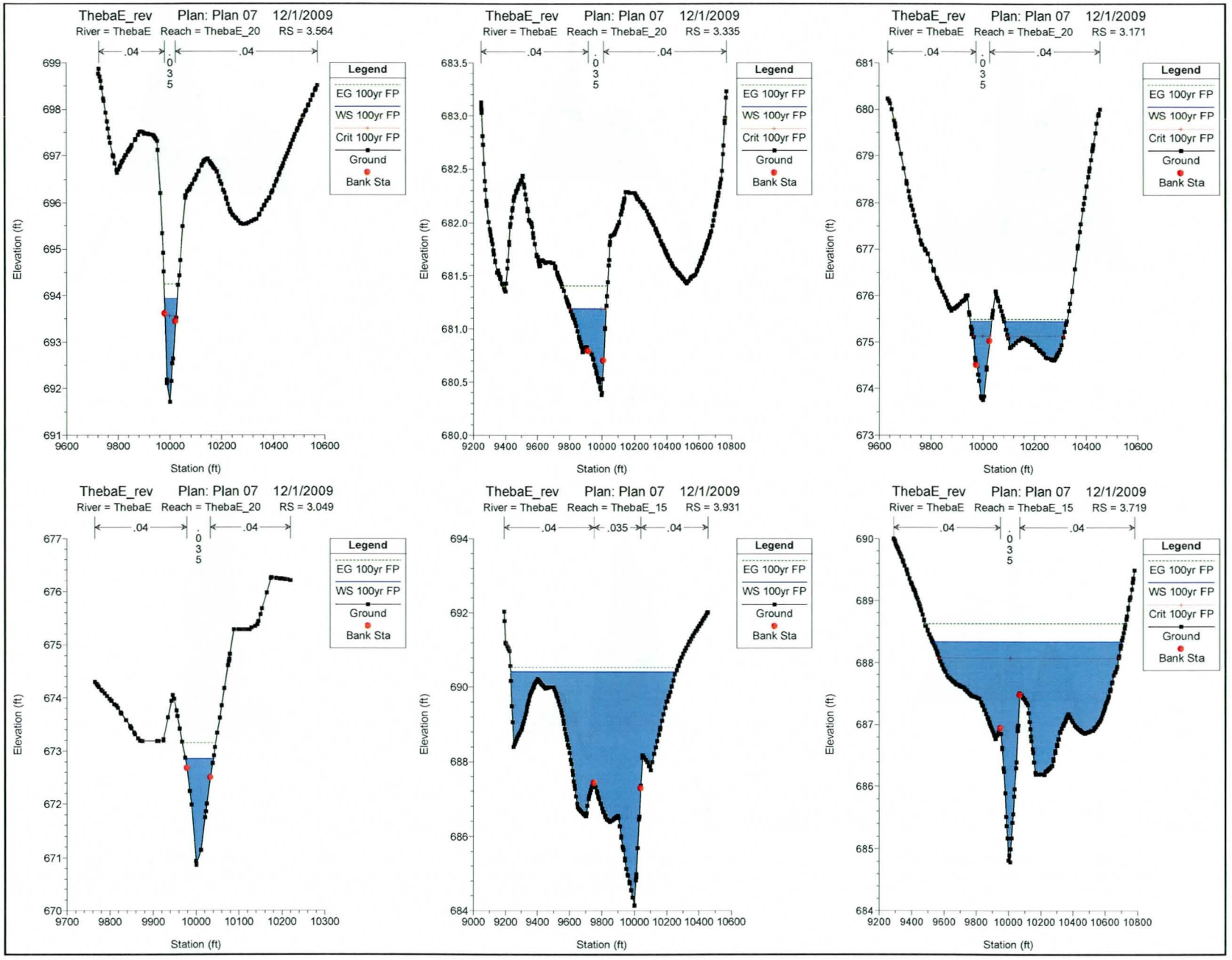

ThebaC_revtry Plan: ThebaC 12/16/2009
River = ThebaC Reach = ThebaC_05 RS = 2.238
.061
.056
.061
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

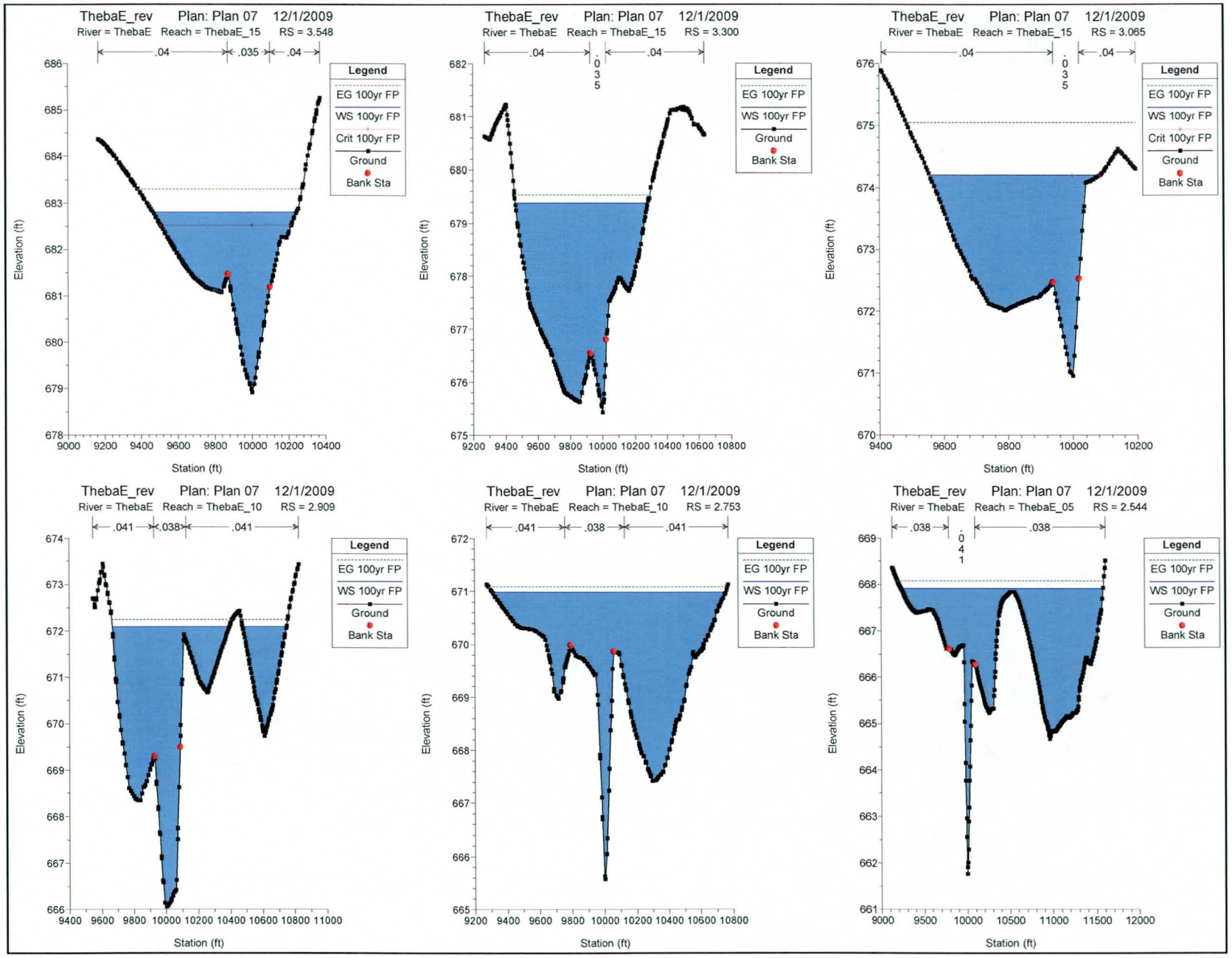

ThebaD_rev Plan: ThebaD 12/3/2009
River = ThebaD Reach = ThebaD_05 RS = 2.710
.04
.056
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

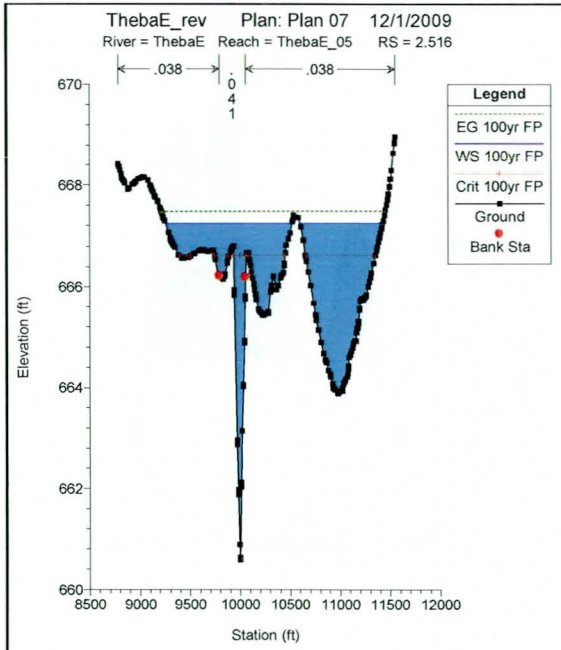

ThebaD_rev Plan: ThebaD 12/3/2009
River = ThebaD Reach = ThebaD_05 RS = 2.530
.04
.056
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

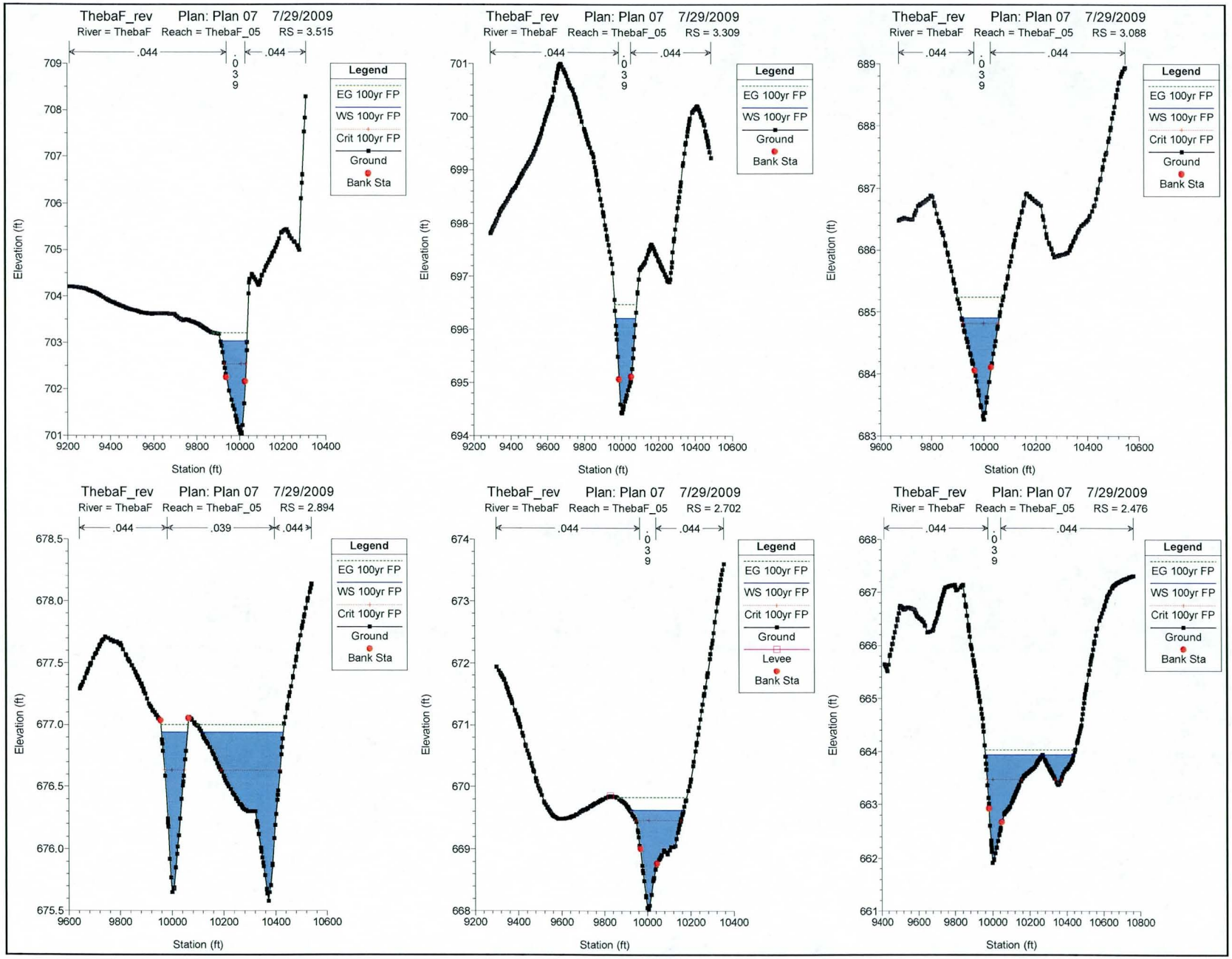

ThebaD_rev Plan: ThebaD 12/3/2009
River = ThebaD Reach = ThebaD_05 RS = 2.383
.04
.056
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

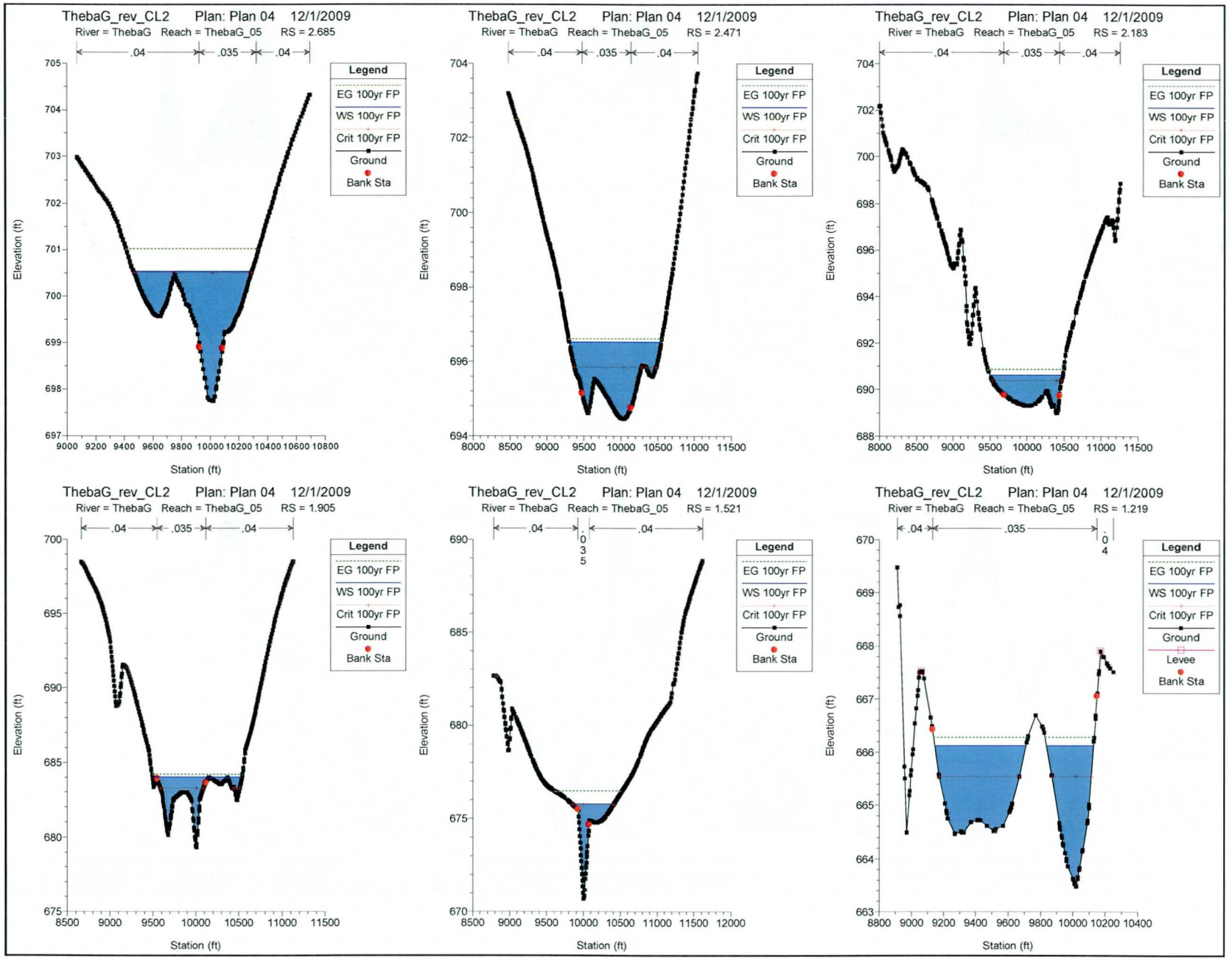

ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_25 RS = 3.674
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_25 RS = 3.468
.04 .035 .04
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_25 RS = 3.276
.04 .035 .04
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_25 RS = 3.083
.04 .035 .04
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_25 RS = 2.941
.04 .035 .04
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_25 RS = 2.710
.04 .035 .04

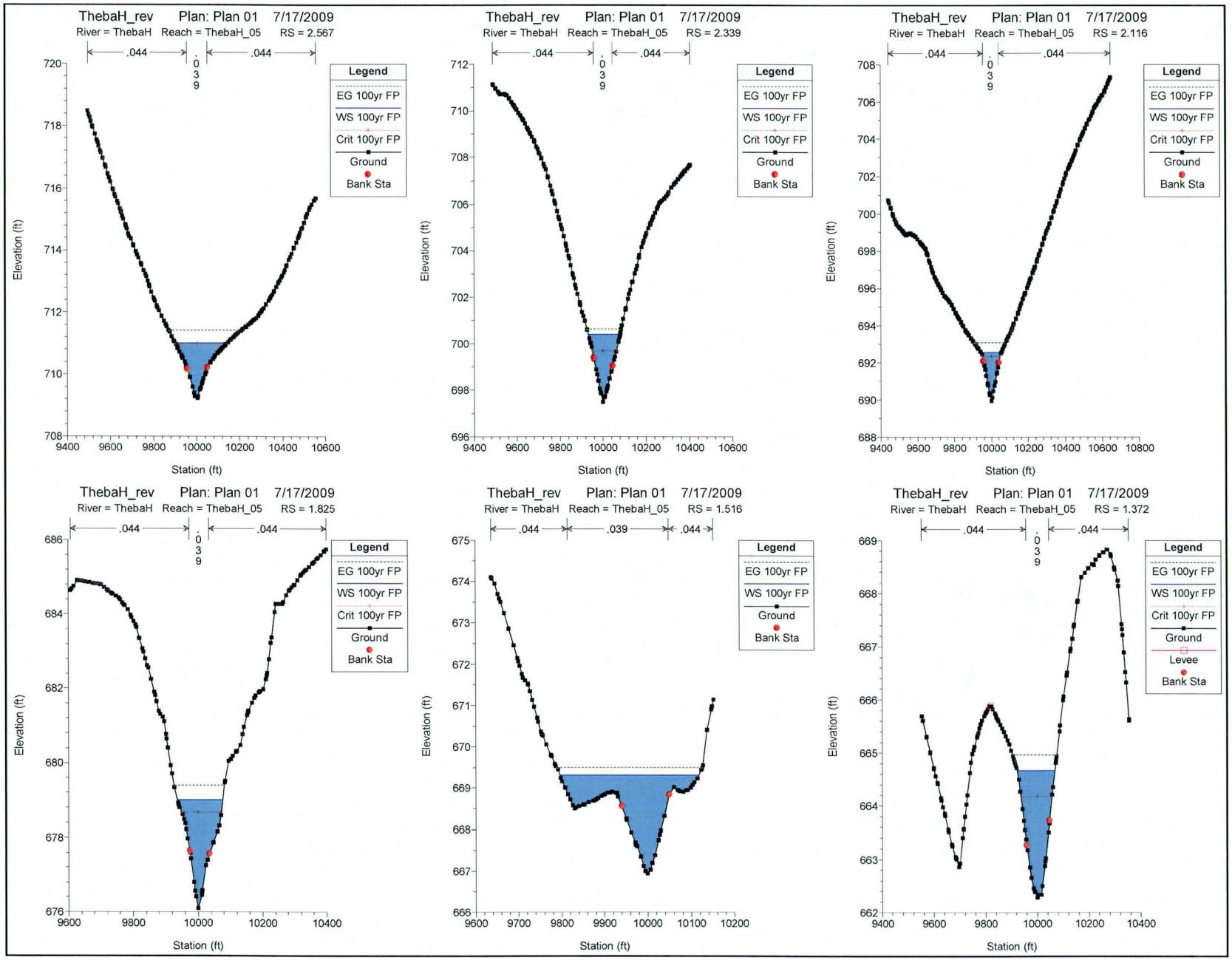

ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_20 RS = 3.564
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_20 RS = 3.335
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_20 RS = 3.171
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_20 RS = 3.049
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_15 RS = 3.931
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_15 RS = 3.719
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

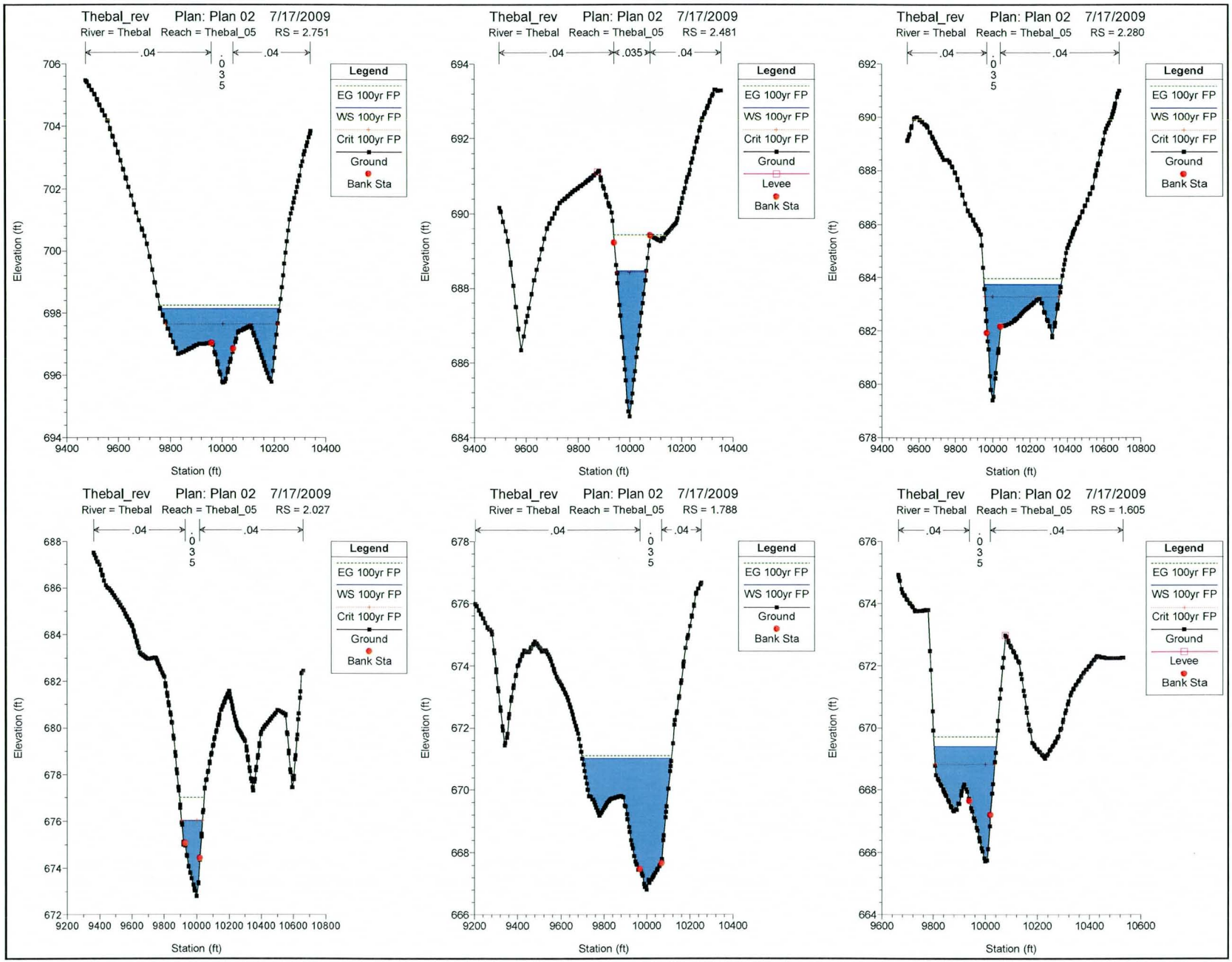

ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_15 RS = 3.548
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_15 RS = 3.300
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_15 RS = 3.065
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_10 RS = 2.909
.041 .038 .041
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_10 RS = 2.753
.041 .038 .041
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_05 RS = 2.544
.038 .041 .038
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

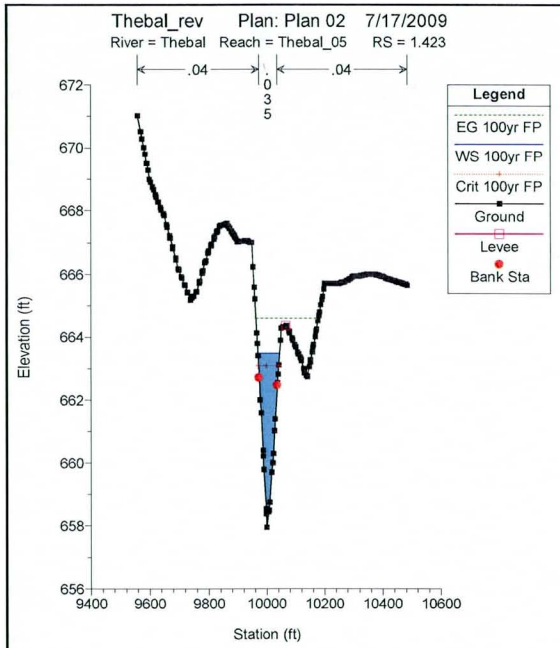

ThebaE_rev Plan: Plan 07 12/1/2009
River = ThebaE Reach = ThebaE_05 RS = 2.516
.038
.041
.038
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
670
668
666
664
662
660
8500 9000 9500 10000 10500 11000 11500 12000
Station (ft)

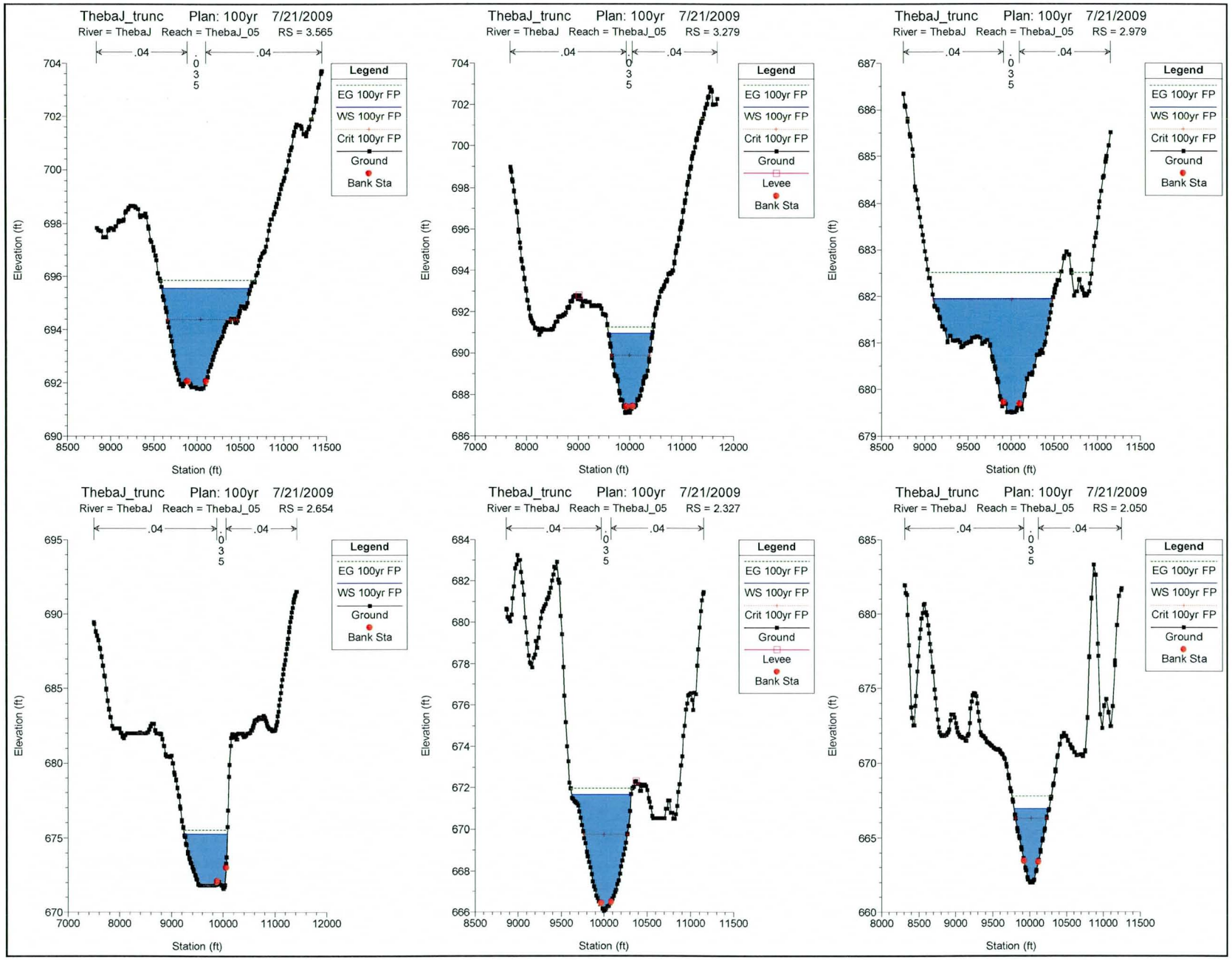

ThebaF_rev Plan: Plan 07 7/29/2009
River = ThebaF Reach = ThebaF_05 RS = 3.515
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaF_rev Plan: Plan 07 7/29/2009
River = ThebaF Reach = ThebaF_05 RS = 3.309
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaF_rev Plan: Plan 07 7/29/2009
River = ThebaF Reach = ThebaF_05 RS = 3.088
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaF_rev Plan: Plan 07 7/29/2009
River = ThebaF Reach = ThebaF_05 RS = 2.894
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaF_rev Plan: Plan 07 7/29/2009
River = ThebaF Reach = ThebaF_05 RS = 2.702
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
ThebaF_rev Plan: Plan 07 7/29/2009
River = ThebaF Reach = ThebaF_05 RS = 2.476
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

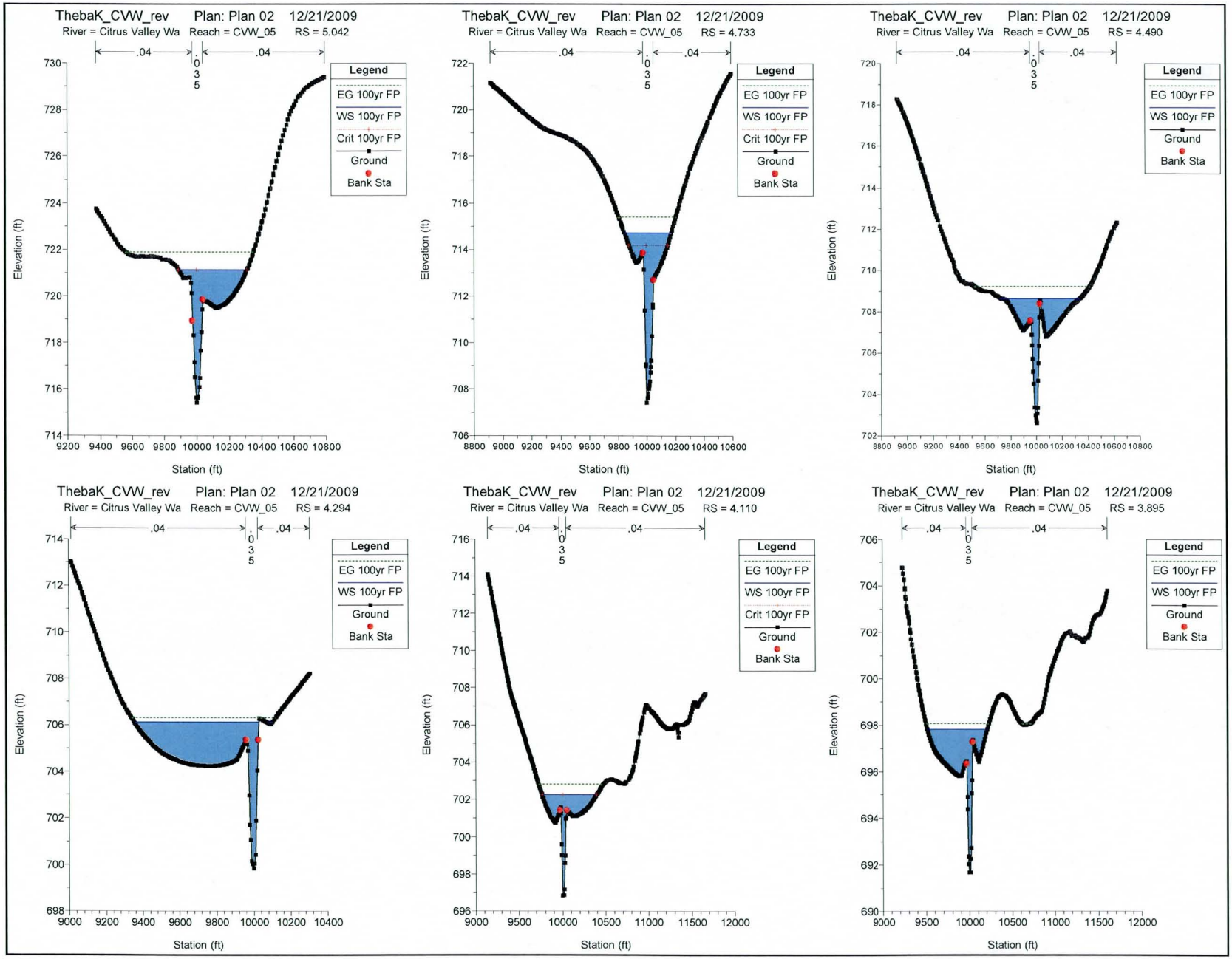

ThebaG_rev_CL2 Plan: Plan 04 12/1/2009
River = ThebaG Reach = ThebaG_05 RS = 2.685
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaG_rev_CL2 Plan: Plan 04 12/1/2009
River = ThebaG Reach = ThebaG_05 RS = 2.471
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaG_rev_CL2 Plan: Plan 04 12/1/2009
River = ThebaG Reach = ThebaG_05 RS = 2.183
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaG_rev_CL2 Plan: Plan 04 12/1/2009
River = ThebaG Reach = ThebaG_05 RS = 1.905
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaG_rev_CL2 Plan: Plan 04 12/1/2009
River = ThebaG Reach = ThebaG_05 RS = 1.521
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaG_rev_CL2 Plan: Plan 04 12/1/2009
River = ThebaG Reach = ThebaG_05 RS = 1.219
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

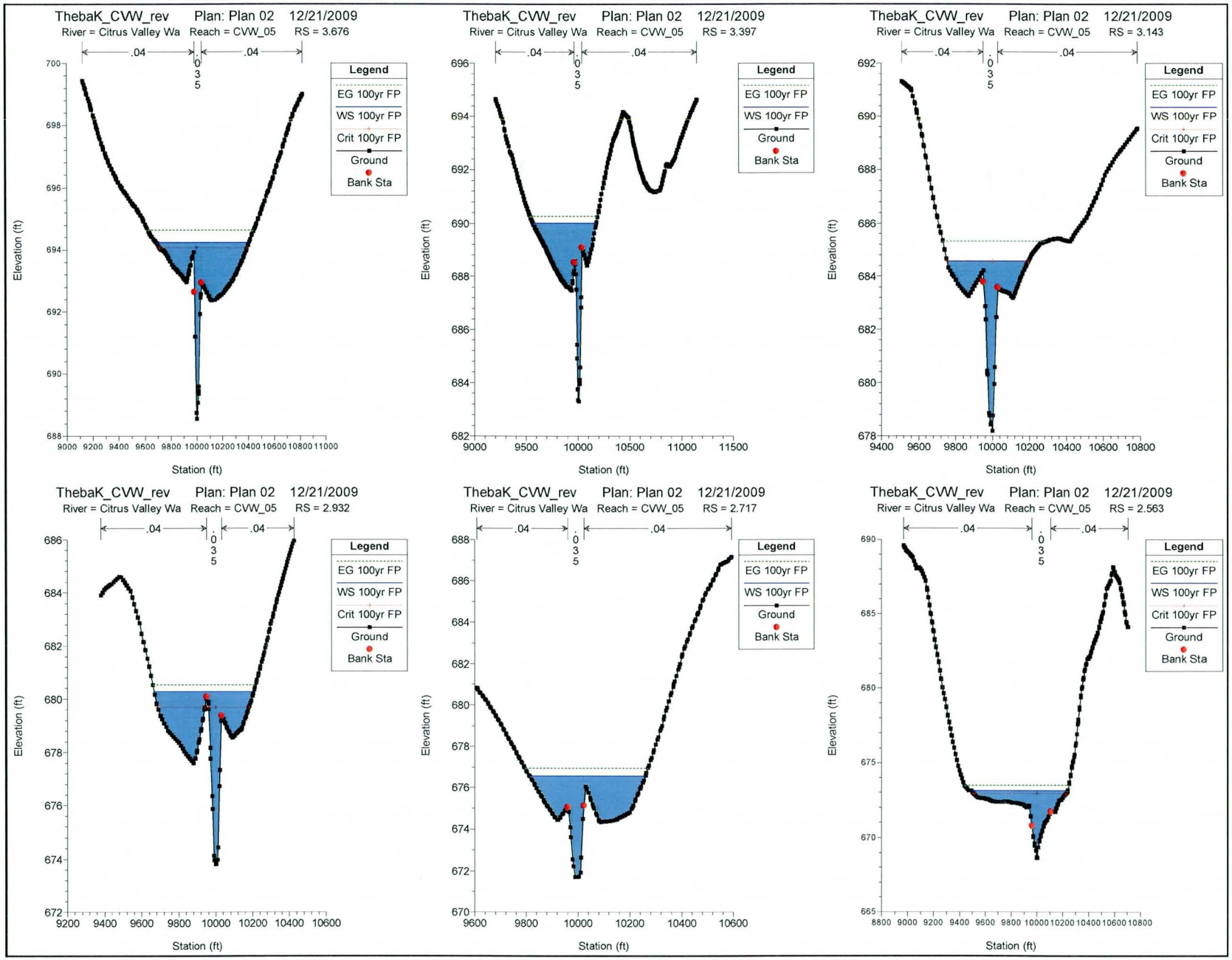

ThebaH_rev Plan: Plan 01 7/17/2009
River = ThebaH Reach = ThebaH_05 RS = 2.567
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaH_rev Plan: Plan 01 7/17/2009
River = ThebaH Reach = ThebaH_05 RS = 2.339
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaH_rev Plan: Plan 01 7/17/2009
River = ThebaH Reach = ThebaH_05 RS = 2.116
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaH_rev Plan: Plan 01 7/17/2009
River = ThebaH Reach = ThebaH_05 RS = 1.825
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaH_rev Plan: Plan 01 7/17/2009
River = ThebaH Reach = ThebaH_05 RS = 1.516
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
ThebaH_rev Plan: Plan 01 7/17/2009
River = ThebaH Reach = ThebaH_05 RS = 1.372
.044 .039 .044
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

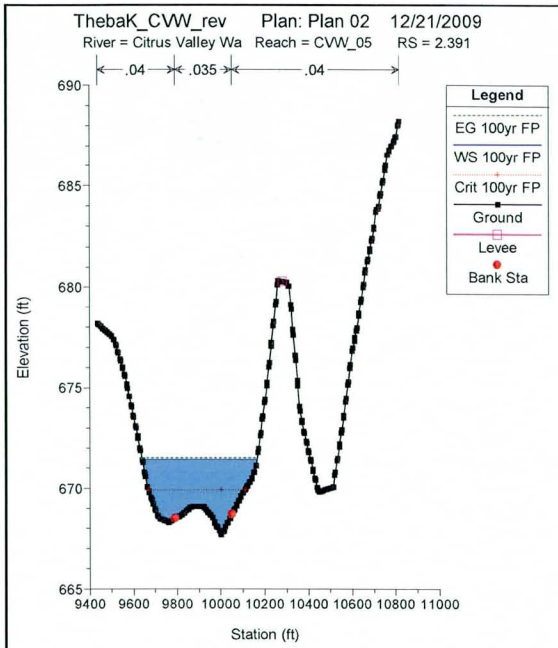

Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 2.751
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 2.481
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 2.280
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 2.027
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 1.788
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)
Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 1.605
.04 .035 .04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

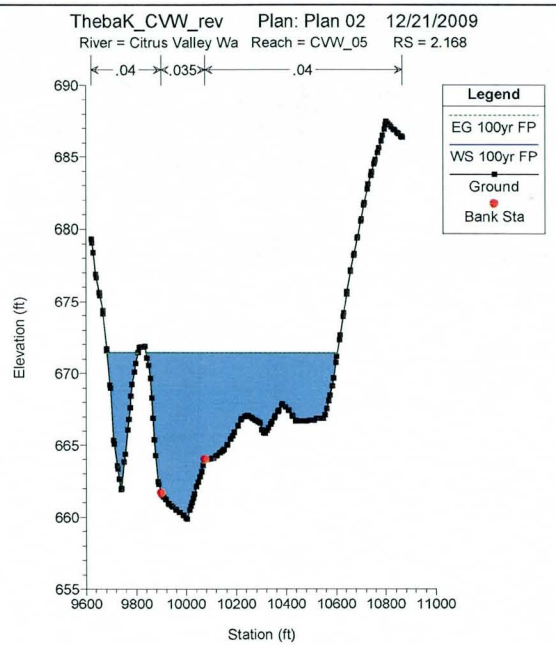

Thebal_rev Plan: Plan 02 7/17/2009
River = Thebal Reach = Thebal_05 RS = 1.423
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
672
670
668
666
664
662
660
658
656
9400
9600
9800
10000
10200
10400
10600
Station (ft)

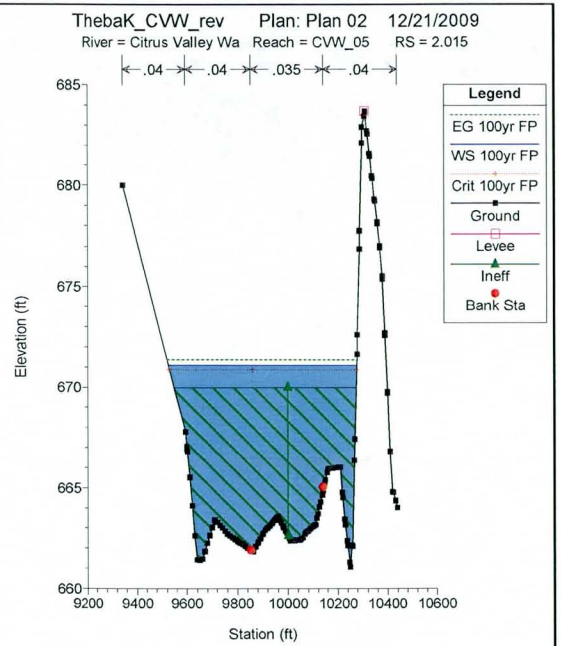

ThebaJ_trunc Plan: 100yr 7/21/2009
River = ThebaJ Reach = ThebaJ_05 RS = 3.565
ThebaJ_trunc Plan: 100yr 7/21/2009
River = ThebaJ Reach = ThebaJ_05 RS = 3.279
ThebaJ_trunc Plan: 100yr 7/21/2009
River = ThebaJ Reach = ThebaJ_05 RS = 2.979
ThebaJ_trunc Plan: 100yr 7/21/2009
River = ThebaJ Reach = ThebaJ_05 RS = 2.654
ThebaJ_trunc Plan: 100yr 7/21/2009
River = ThebaJ Reach = ThebaJ_05 RS = 2.327
ThebaJ_trunc Plan: 100yr 7/21/2009
River = ThebaJ Reach = ThebaJ_05 RS = 2.050
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

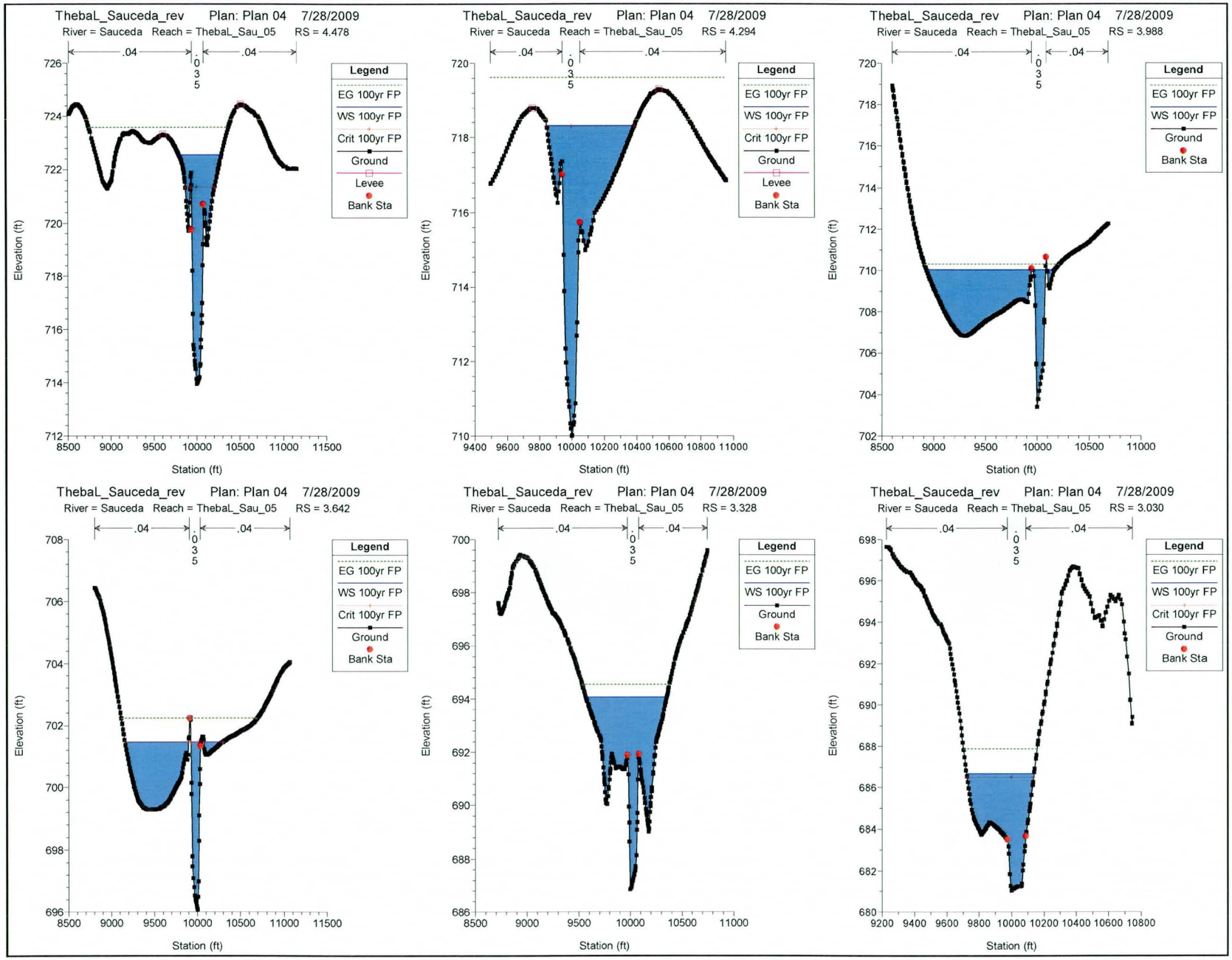

ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 5.042
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 4.733
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 4.490
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 4.294
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 4.110
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 3.895
.04
.035
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

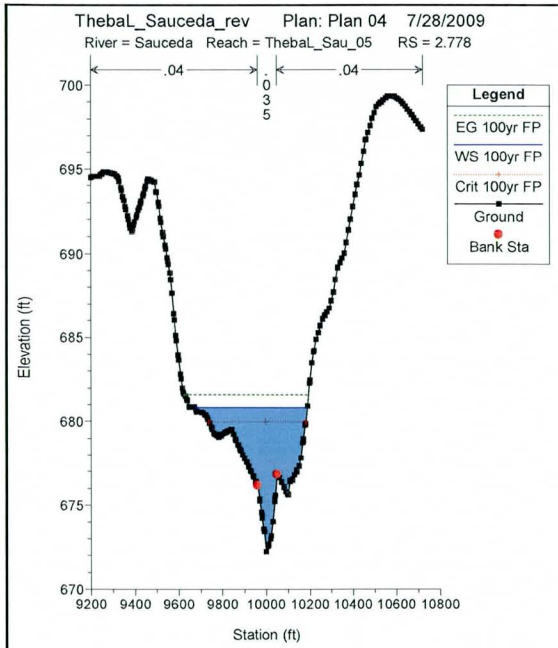

ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 3.676
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 3.397
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 3.143
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 2.932
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 2.717
ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 2.563
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)

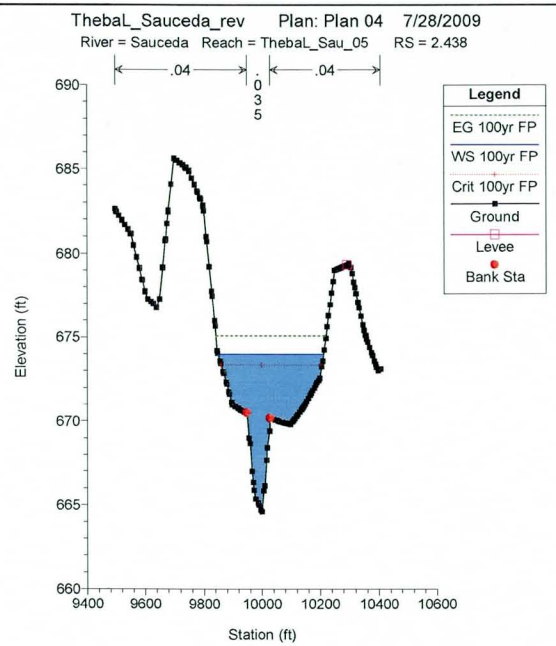

ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 2.391
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

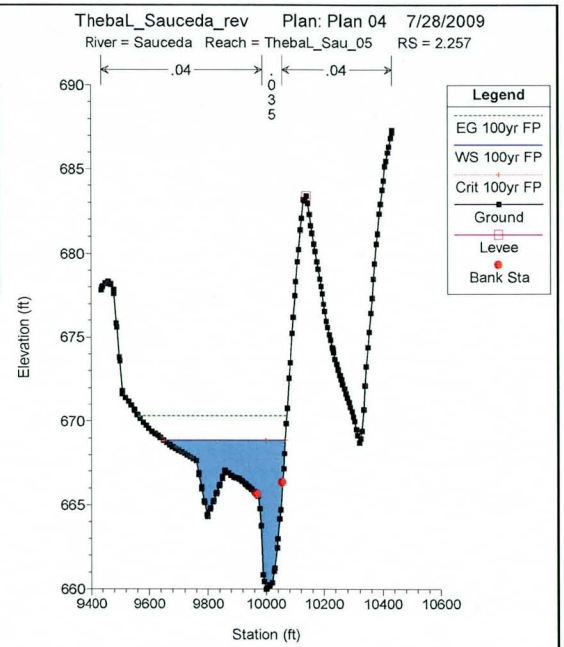

ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 2.168
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)


ThebaK_CVW_rev Plan: Plan 02 12/21/2009
River = Citrus Valley Wa Reach = CVW_05 RS = 2.015
.04
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 4.478
ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 4.294
ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 3.988
ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 3.642
ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 3.328
ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 3.030
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 2.778
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Bank Sta
Elevation (ft)
Station (ft)


ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 2.438
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


ThebaL_Sauceda_rev Plan: Plan 04 7/28/2009
River = Sauceda Reach = ThebaL_Sau_05 RS = 2.257
.04
.035
.04
Legend
EG 100yr FP
WS 100yr FP
Crit 100yr FP
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

E.3 Expansion and Contraction Coefficients

N/A

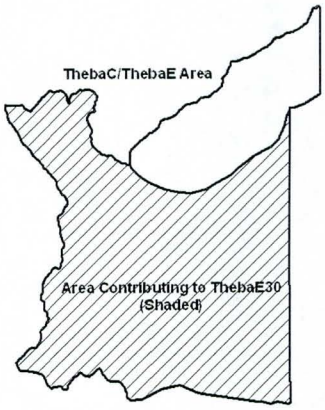
E.4 Structure Analysis

No bridge or culvert analysis was performed for this project.

E.5 Hydraulic Calculations

E.5.1 Slope Calculations

Overland slope calculations for the flow through the berm to ThebaE in the case of a concentrated flow of water through the berm:

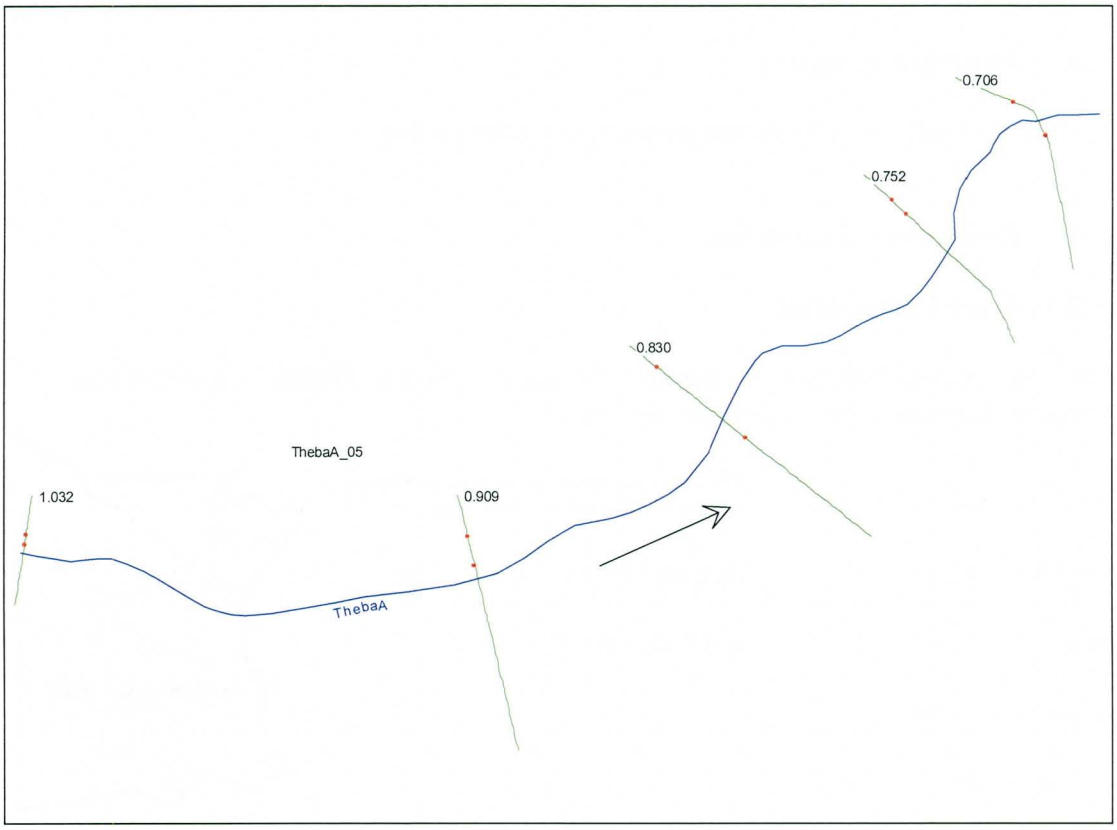


Area	2.7666	mi^2	The area is upstream of the high-rise berm, not the whole ThebaC/ThebaE area.
100yr flow	2388.8	cfs	eq: Q100 = 10^(5.52-2.42Area^-.12)
slope	0.00497	ft/ft	eq: (722.533-691.515)/6241.53
Assume 1 foot depth			
n = farmland OB =		0.041	
Width:	935.0	feet	Mannings eq: width = Q/((m/n)s^1/2) Rh = 1 ft

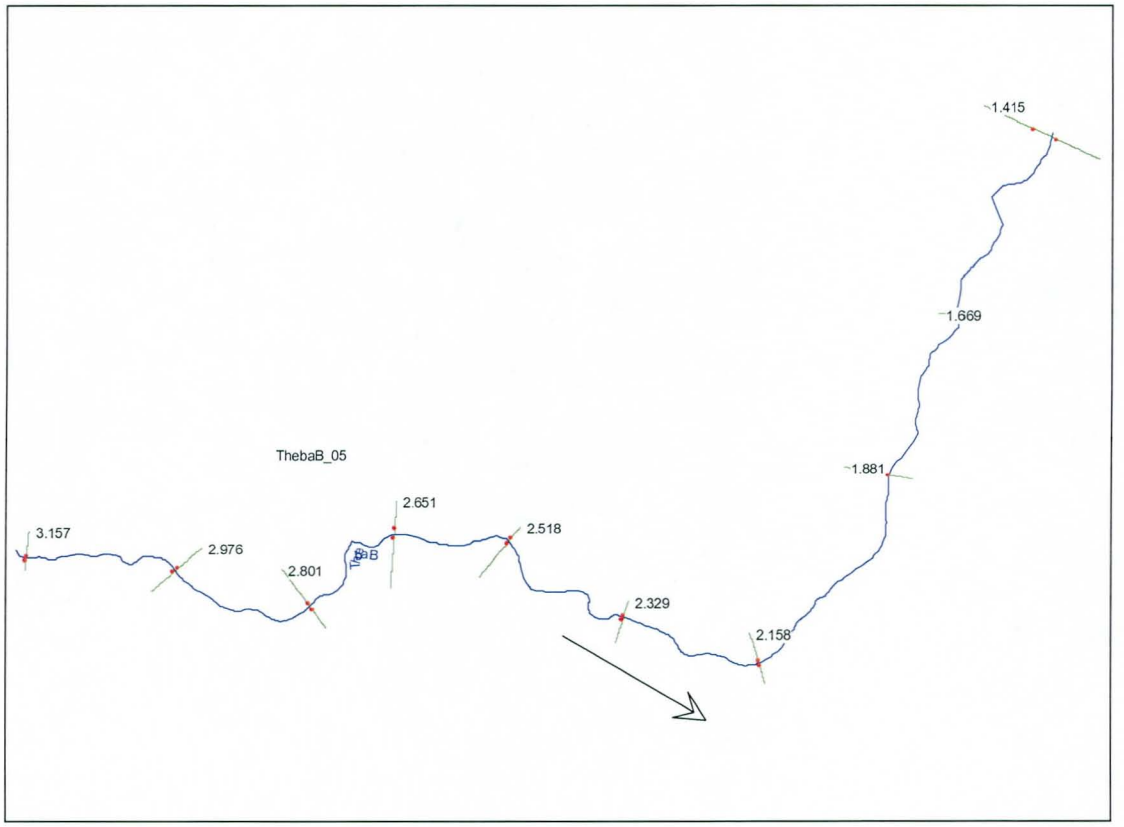
Downstream slope calculations for each of the river sections:

	Down Elev	Next Pt	Dist Between	Slope
ThebaA	663.074	658.54	500	0.009
ThebaB	662.5	656.16	500	0.013
ThebaC	662.77	655.43	1000	0.007
ThebaD	663.88	657.75	500	0.012
ThebaE	662.48	657.95	1000	0.005
ThebaF	662.19	658.85	1000	0.003
ThebaG	667.12	662.66	1000	0.004
ThebaH	662.51	656.62	1000	0.006
ThebaI	659.42	655.03	500	0.009
ThebaJ	661.99	651.8	2000	0.005
CVW	662.42	652.48	1000	0.010
Sauceda	665.93	655.51	1000	0.010

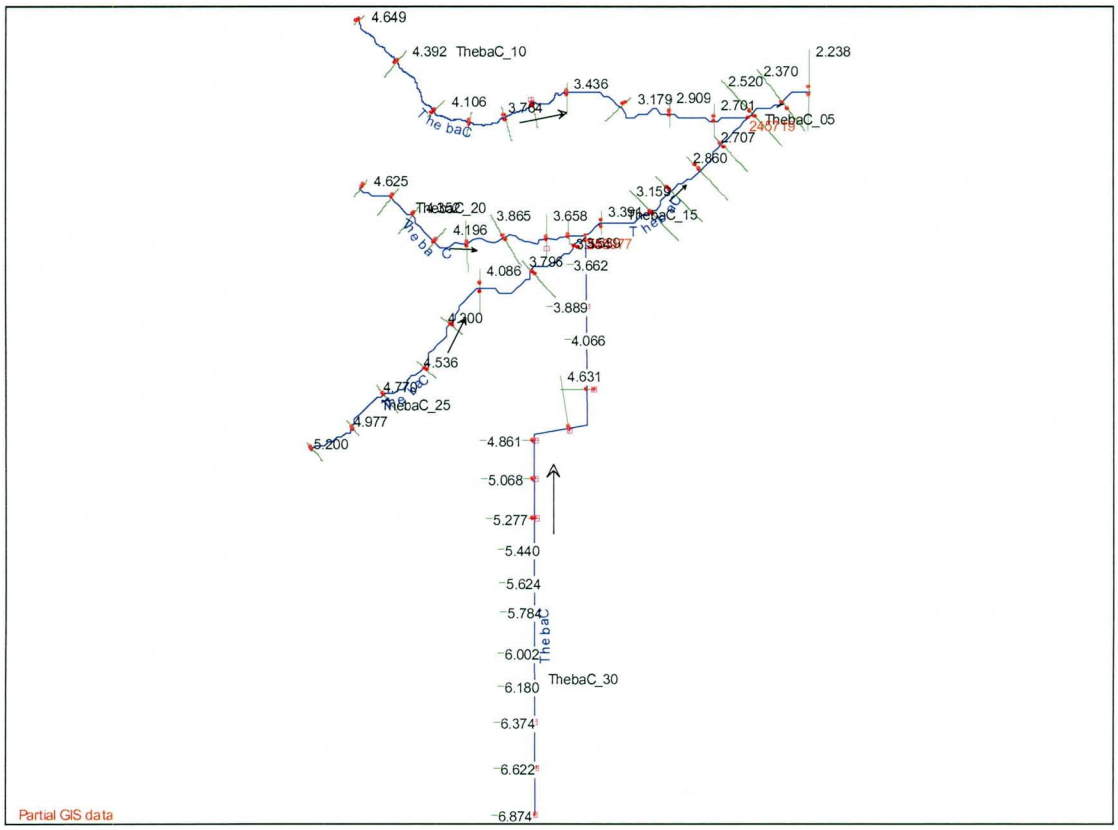
E.5.2 Hydraulic Modeling Schematics



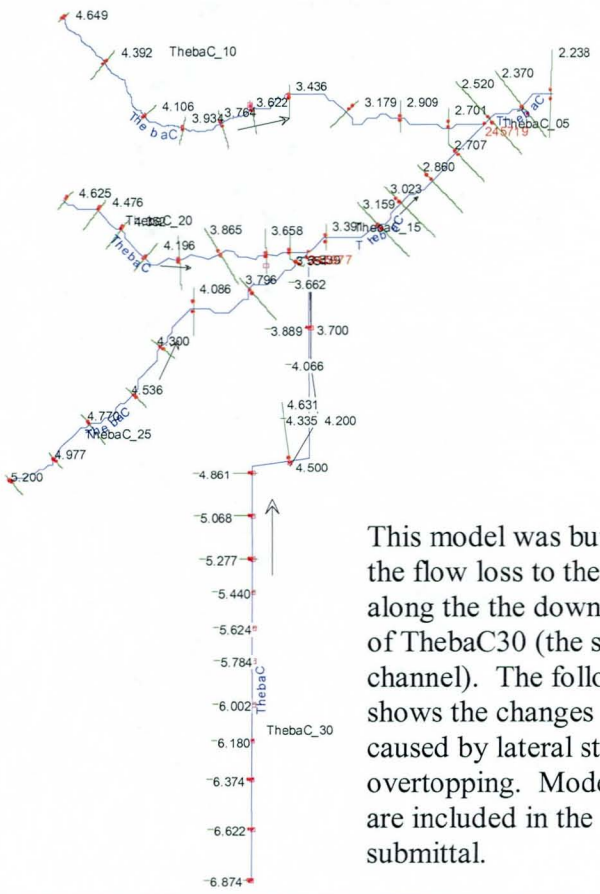
ThebaA



ThebaB


4.649
4.392
ThebaC_10
4.106
3.784
3.436
3.179
2.909
2.520
2.370
2.238
2.701
ThebaC_05
2.707
2.860
4.625
3.865
3.658
3.159
ThebaC_15
4.196
3.796
3.662
4.086
3.889
4.200
4.066
4.536
4.631
ThebaC_25
4.977
5.200
4.861
5.068
5.277
5.440
5.624
5.784
6.002
6.180
ThebaC_30
6.374
6.622
6.874
Partial GIS data

ThebaC

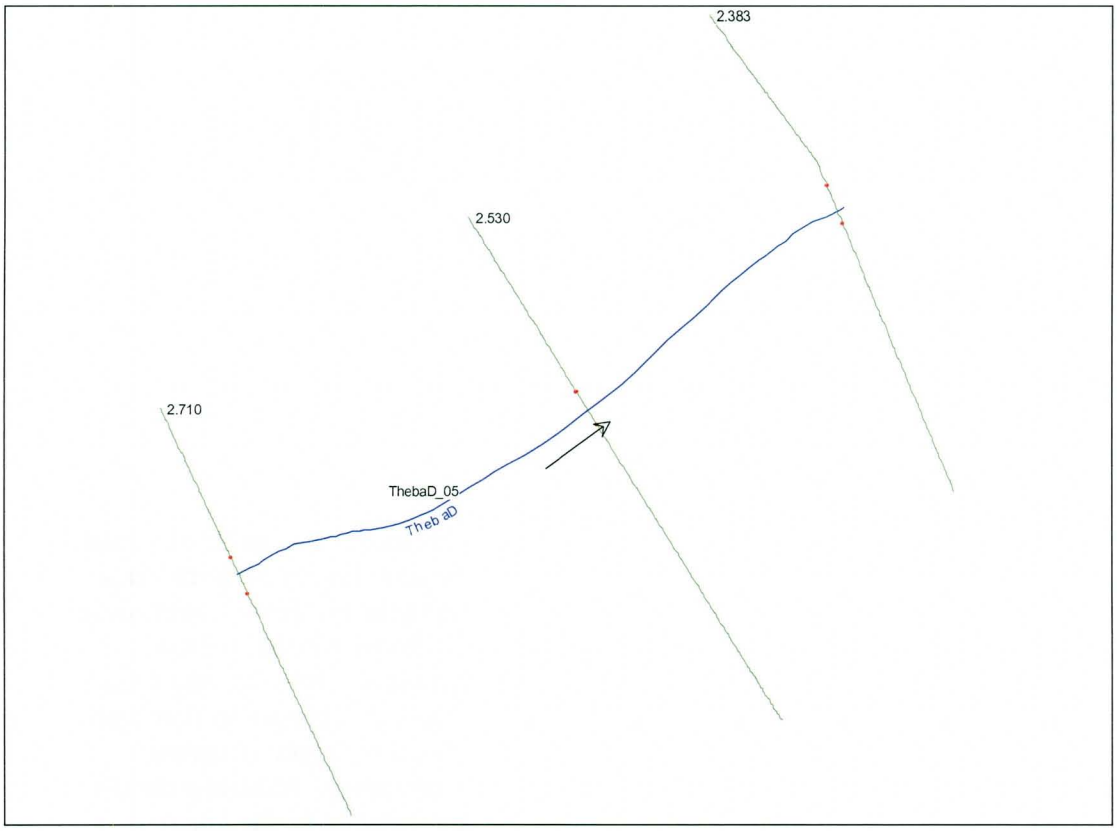


This model was built to calculate the flow loss to the farm lands along the the downstream portion of ThebaC30 (the shallow channel). The following table shows the changes in flow rates caused by lateral structure overtopping. Modeling details are included in the digital submittal.

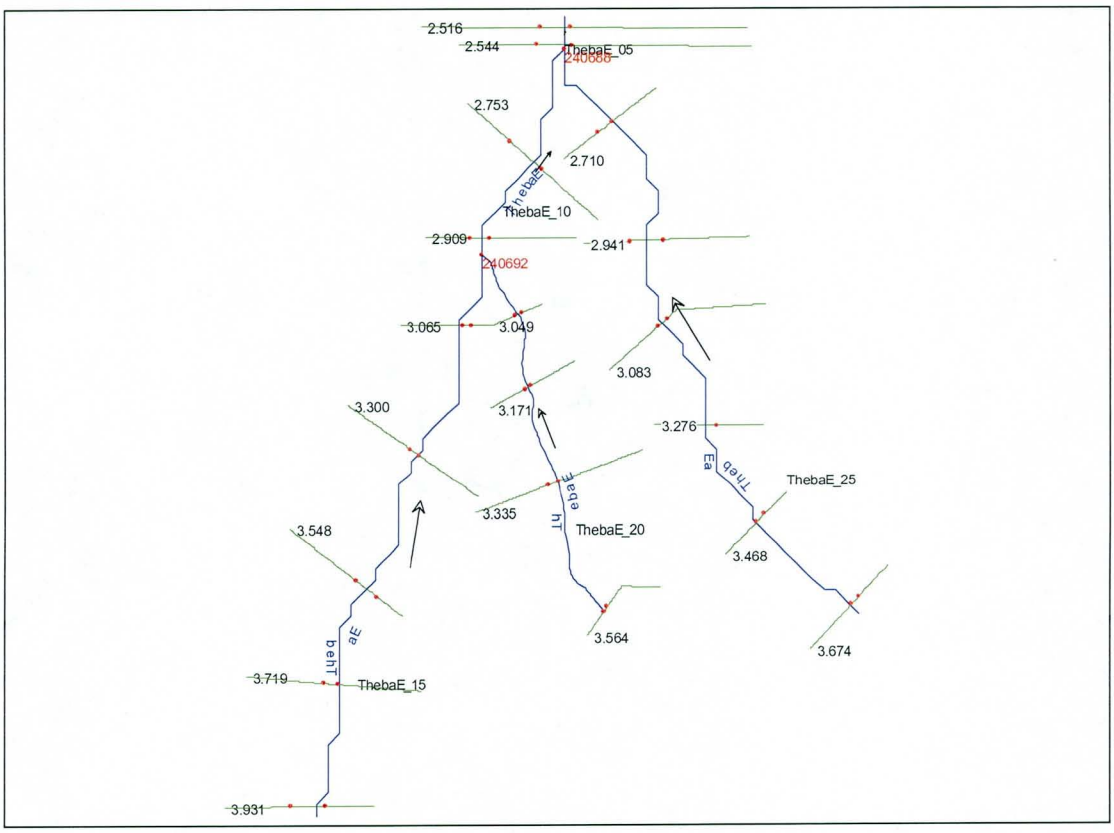
ThebaC Weir Flow

HEC-RAS Plan: ThebaC River: ThebaC Reach: ThebaC_30 Profile: 100yr FP

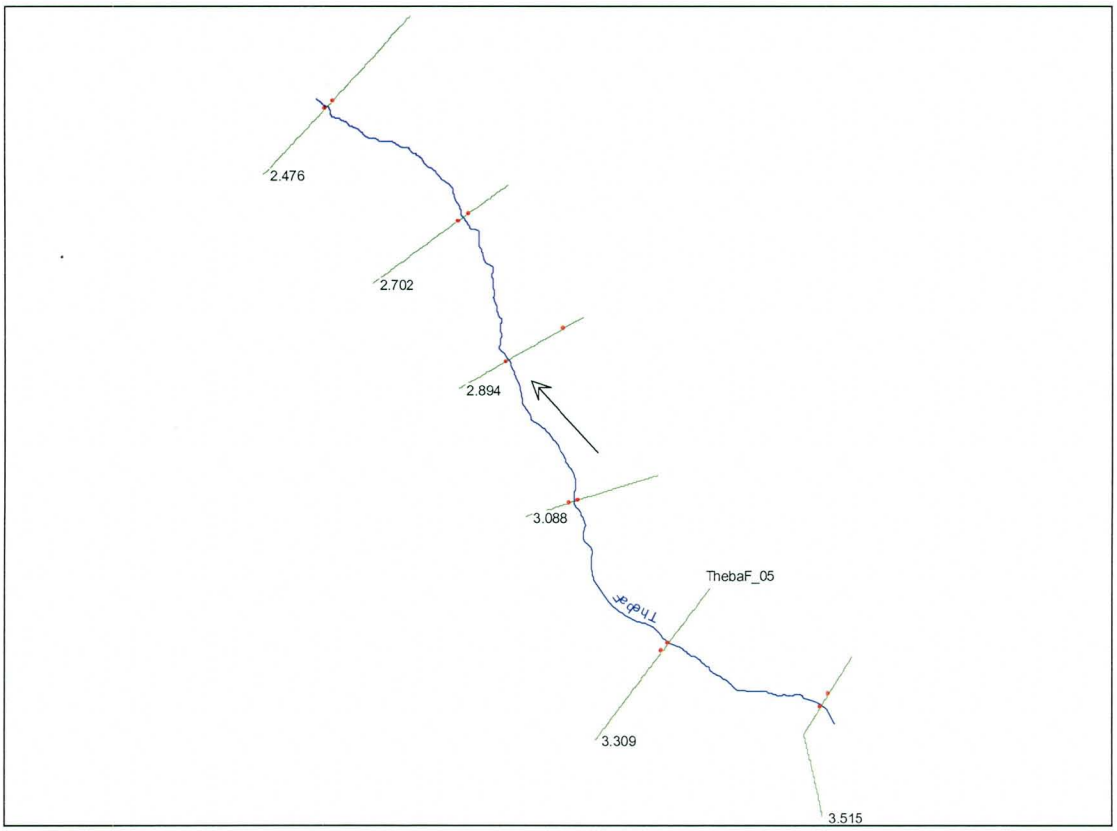
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
ThebaC_30	6.874	100yr FP	3056.00	743.22	750.44	745.76	750.45	0.000069	1.19	4009.69	1094.94
ThebaC_30	6.622	100yr FP	3056.00	744.71	750.15	747.83	750.23	0.000620	3.17	1506.78	540.22
ThebaC_30	6.374	100yr FP	3056.00	744.02	748.69	747.51	748.92	0.001869	4.78	980.35	472.77
ThebaC_30	6.180	100yr FP	3056.00	741.24	747.11	745.79	747.30	0.001333	4.74	1043.14	400.47
ThebaC_30	6.002	100yr FP	3056.00	737.74	744.95	744.20	745.46	0.003039	7.04	683.03	304.18
ThebaC_30	5.784	100yr FP	3056.00	736.37	742.15	741.09	742.43	0.002202	5.78	906.86	420.05
ThebaC_30	5.624	100yr FP	3056.00	735.31	739.80	738.74	740.19	0.003213	5.07	640.45	281.17
ThebaC_30	5.440	100yr FP	3056.00	730.73	736.85	735.73	737.30	0.002776	5.98	696.92	335.30
ThebaC_30	5.277	100yr FP	3056.00	728.36	734.88	733.27	735.28	0.001978	5.86	772.84	326.56
ThebaC_30	5.068	100yr FP	3056.00	726.21	729.90	729.88	731.07	0.009501	9.59	409.40	198.90
ThebaC_30	4.861	100yr FP	3056.00	719.67	725.02	723.99	725.39	0.003057	6.41	874.83	568.04
ThebaC_30	4.631	100yr FP	3056.00	714.27	717.94	717.94	719.12	0.010186	9.15	378.54	198.84
ThebaC_30	4.500		Lat Struct								
ThebaC_30	4.335	100yr FP	3047.47	710.40	717.42	713.28	717.45	0.000138	1.62	2328.96	543.80
ThebaC_30	4.200		Lat Struct								
ThebaC_30	4.066	100yr FP	2109.61	709.72	716.48	715.33	717.02	0.002884	6.51	465.96	241.38
ThebaC_30	3.900		Lat Struct								
ThebaC_30	3.889	100yr FP	1249.50	709.23	715.41	713.59	715.49	0.000682	2.59	721.30	462.05
ThebaC_30	3.700		Lat Struct								
ThebaC_30	3.662	100yr FP	1145.87	706.43	711.82	711.82	713.26	0.014389	9.64	118.84	41.37
ThebaC_30	3.539	100yr FP	0.90	701.76	703.53		703.53	0.000000	0.02	37.24	29.24



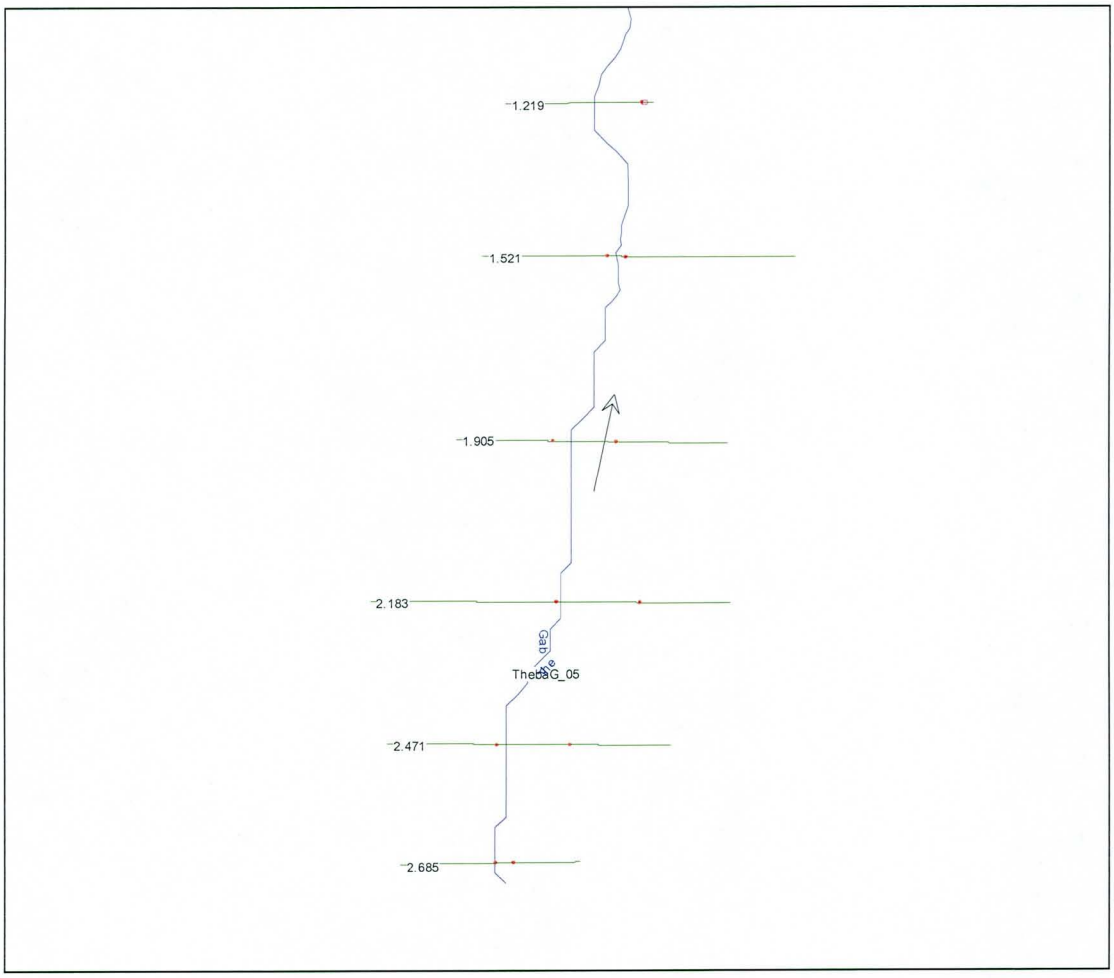
ThebaD


2.516
2.544
ThebaE_05
240686
2.753
2.710
ThebaE_10
2.909
2.941
240692
3.065
3.049
3.083
3.300
3.171
3.276
ThebaE_25
3.335
ThebaE_20
3.548
3.468
3.564
3.674
3.719
ThebaE_15
3.931

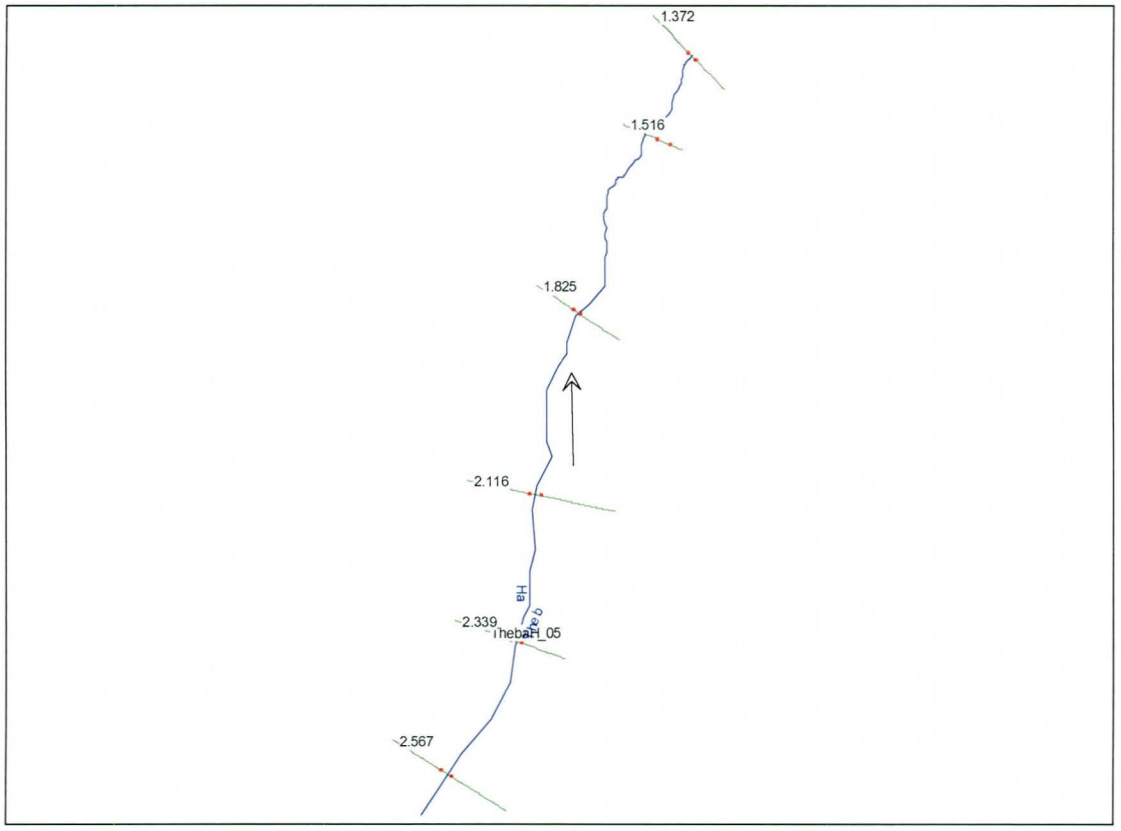
ThebaE



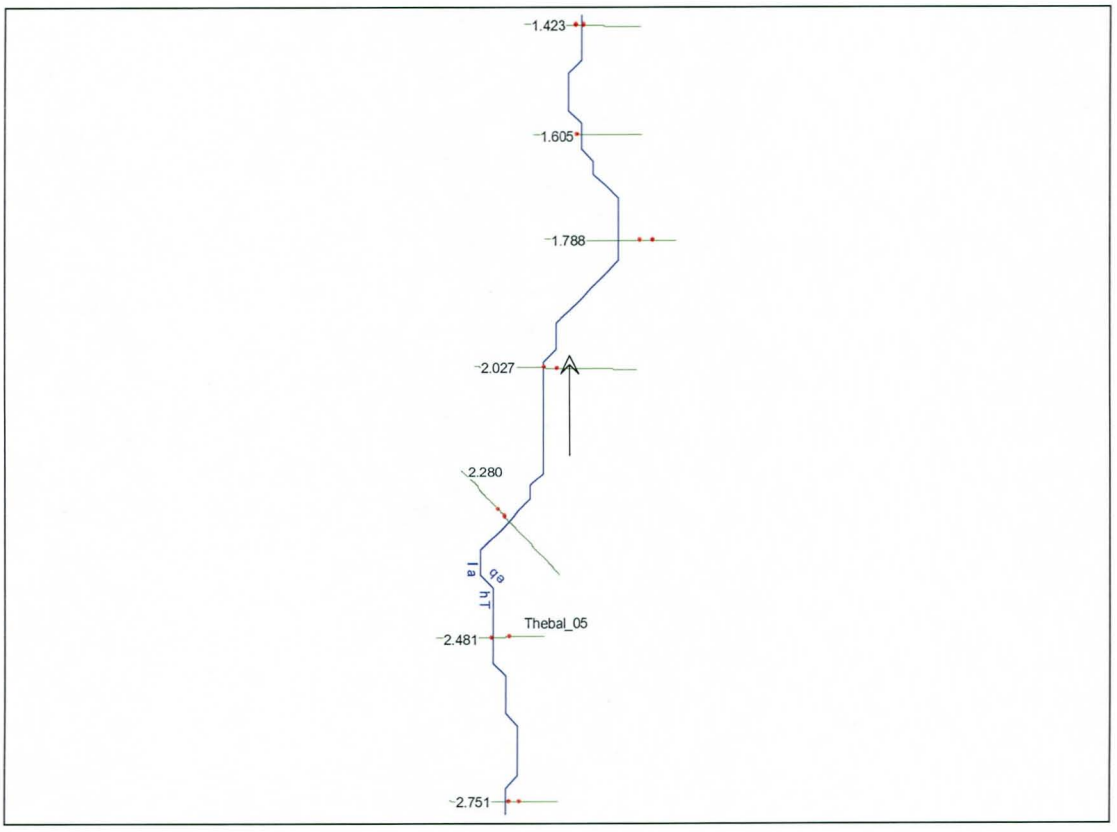
ThebaF



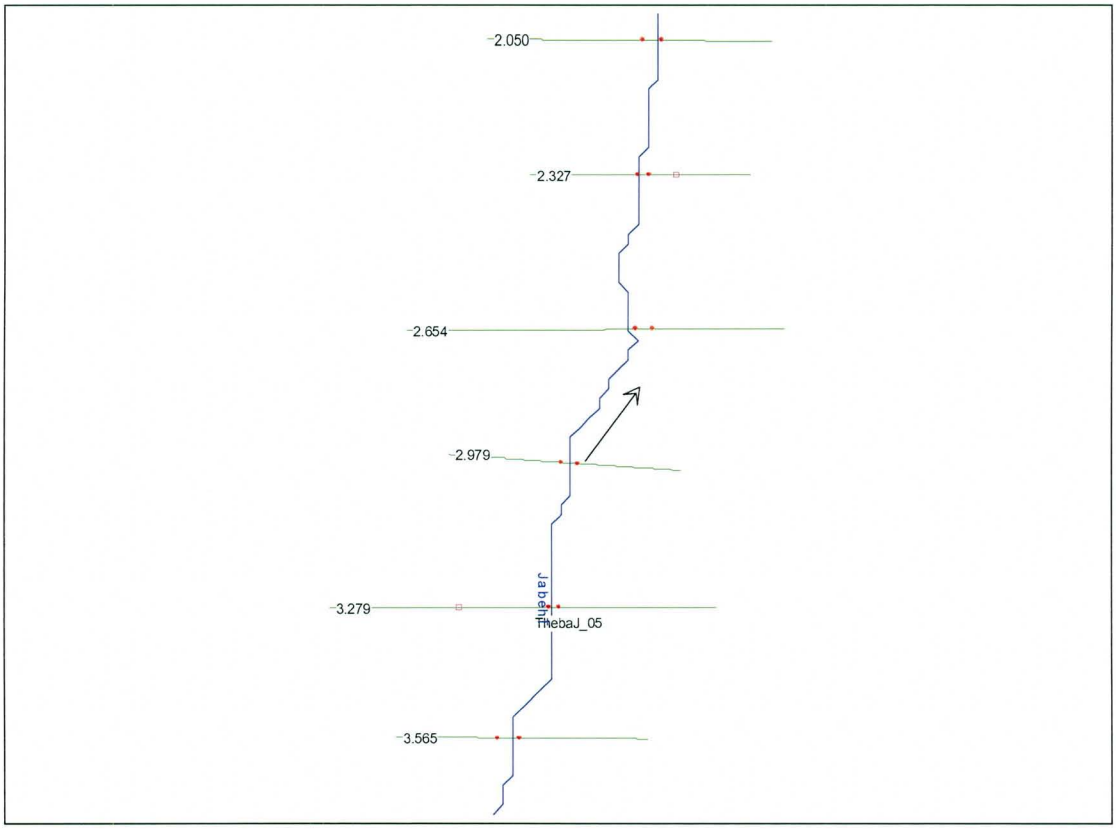
ThebaG



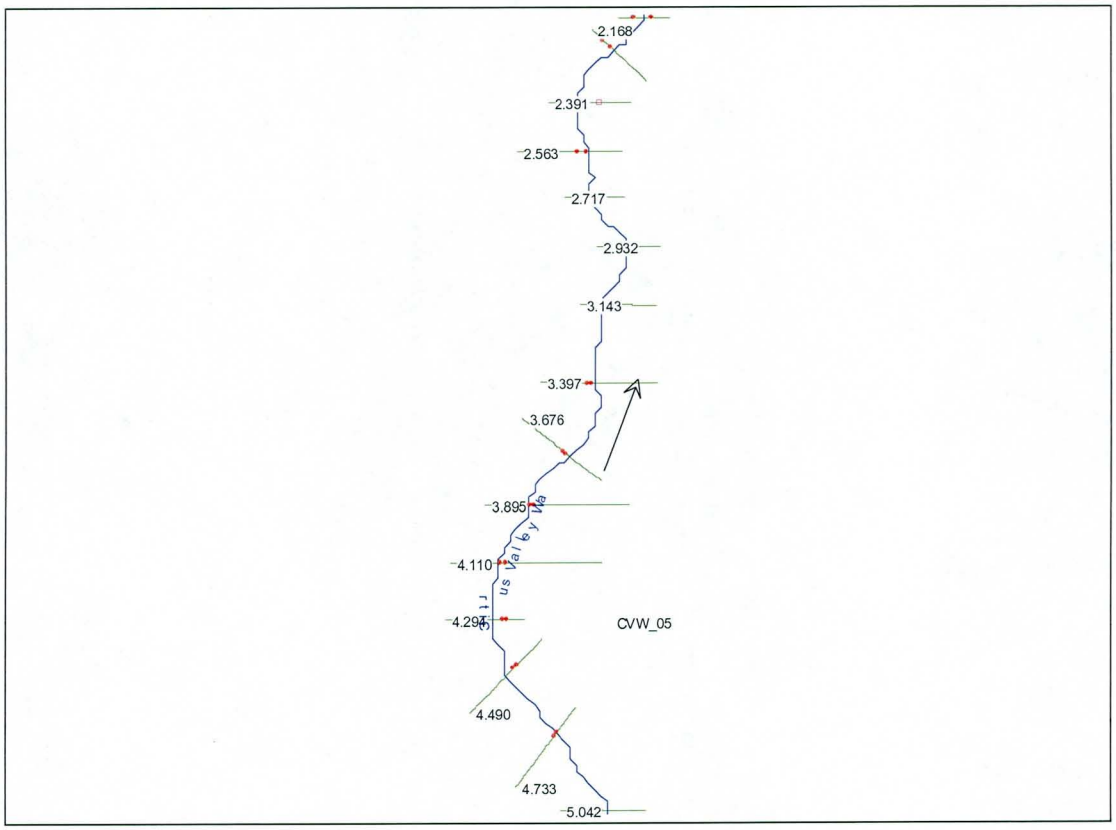
ThebaH



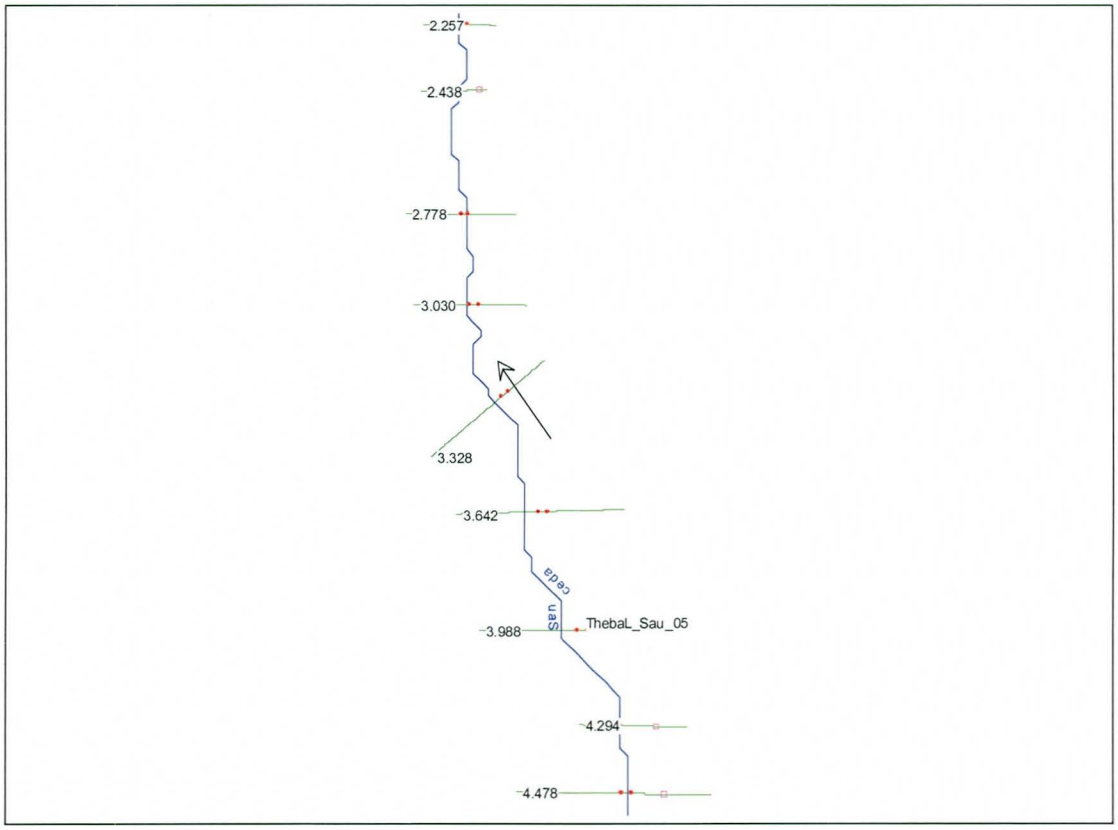
ThebaI



ThebaJ



Citrus Valley Wash



Sauceda Wash

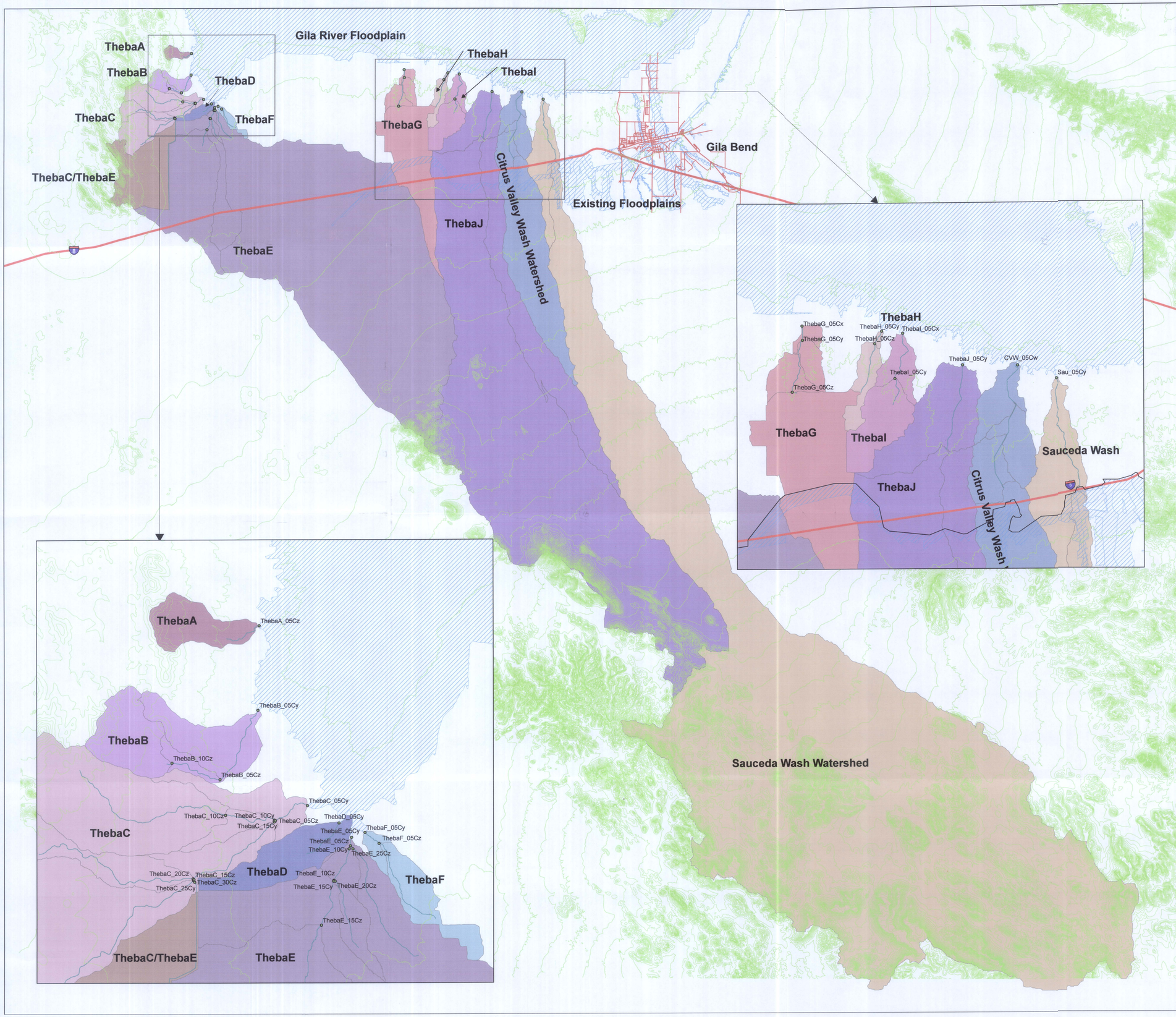
E.5.3 Hydraulic Modeling Results

The hydraulic modeling results are summarized in Table 5-2. The HEC-RAS report files are included in the attached digital data disc.

THEBA WATERSHED
ZONE A FLOODPLAIN DELINEATION STUDY

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

FCD 2007C018



LEGEND

- Concentration Points
- Watercourses
- Streets
- Highways
- Contours
- Sub-Basin Boundaries
- Existing Floodplains
- Citrus Valley Wash Watershed
- Sauceda Wash Watershed
- ThebaA Watershed
- ThebaB Watershed
- ThebaC Watershed
- ThebaC/ThebaE Watershed
- ThebaD Watershed
- ThebaE Watershed
- ThebaF Watershed
- ThebaG Watershed
- ThebaH Watershed
- ThebaI Watershed
- ThebaJ Watershed

0 1.25 2.5 5 Miles

N

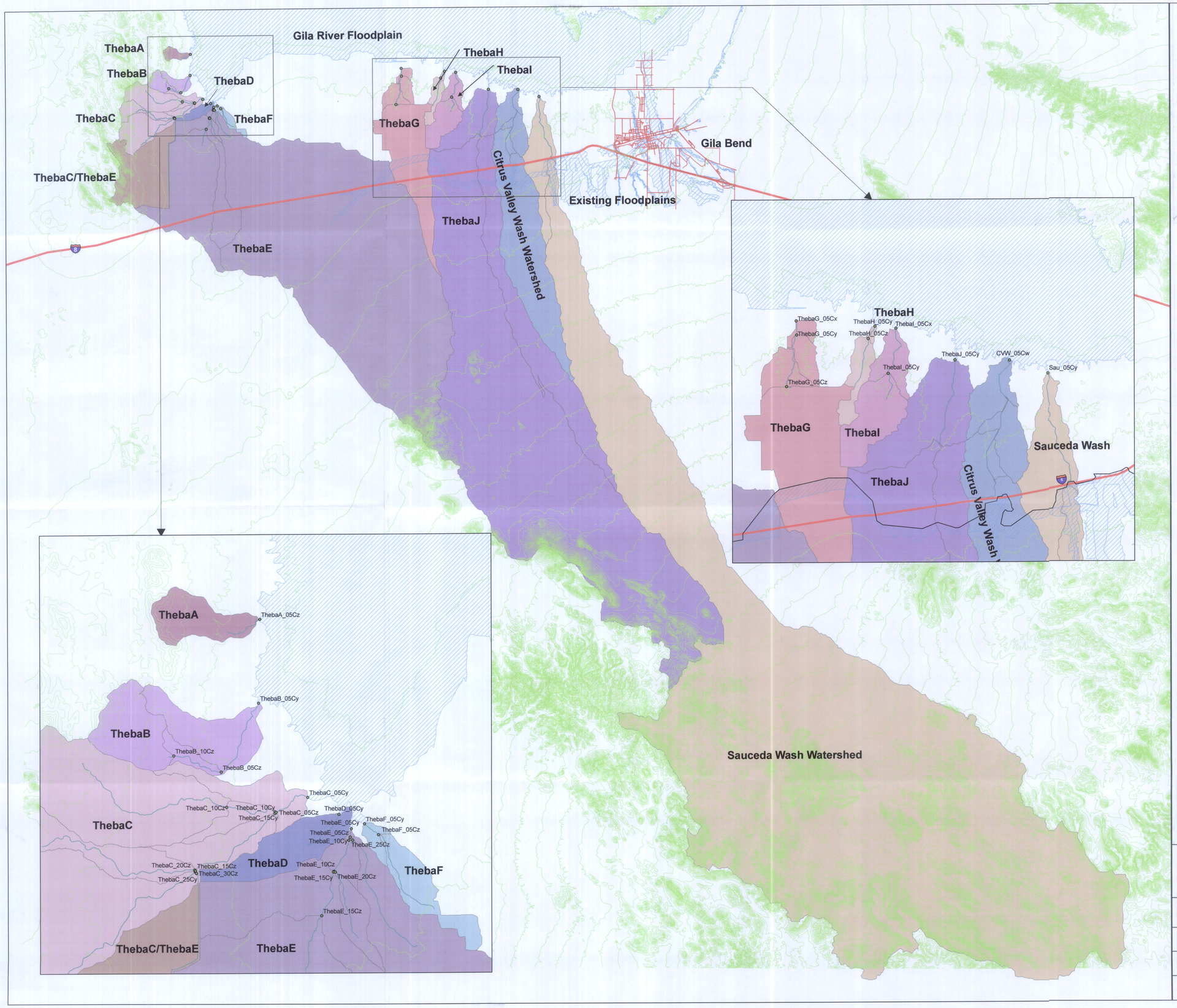
PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, SUITE 4
PHOENIX, ARIZONA 85021

EXHIBIT A SUB-BASIN MAP		SHEET 1 OF 1	
DESIGN:	YX	DATE:	12/2009
DESIGN CHK:	MDH	DATE:	12/2009
PLANS:	YX	DATE:	12/2009
PLANS CHK:	MDH	DATE:	12/2009

THEBA WATERSHED
ZONE A FLOODPLAIN DELINEATION STUDY

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

FCD 2007C018



LEGEND

- Concentration Points
- Watercourses
- Streets
- Highways
- Contours
- Sub-Basin Boundaries
- Existing Floodplains
- Citrus Valley Wash Watershed
- Sauceda Wash Watershed
- ThebaA Watershed
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- ThebaC Watershed
- ThebaC/ThebaE Watershed
- ThebaD Watershed
- ThebaE Watershed
- ThebaF Watershed
- ThebaG Watershed
- ThebaH Watershed
- Thebal Watershed
- ThebaJ Watershed

0 1.25 2.5 5 Miles

N

PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, SUITE 4
PHOENIX, ARIZONA 85021

EXHIBIT A SUB-BASIN MAP		SHEET 1 OF 1	
DESIGN:	YX	DATE:	5/2010
DESIGN CHK:	MDH	DATE:	5/2010
PLANS:	YX	DATE:	5/2010
PLANS CHK:	MDH	DATE:	5/2010

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD 29). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was *Arizona State Plane Zone 3176 (central Arizona)*. The **horizontal datum** was *NAD83, GRS80 spheroid*. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the *National Geodetic Vertical Datum of 1929*. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(310) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by Maricopa County. Orthophoto images were produced at a scale of 1:6000 using HARN for control. Aerial photography is dated December 2000 to December 2002.

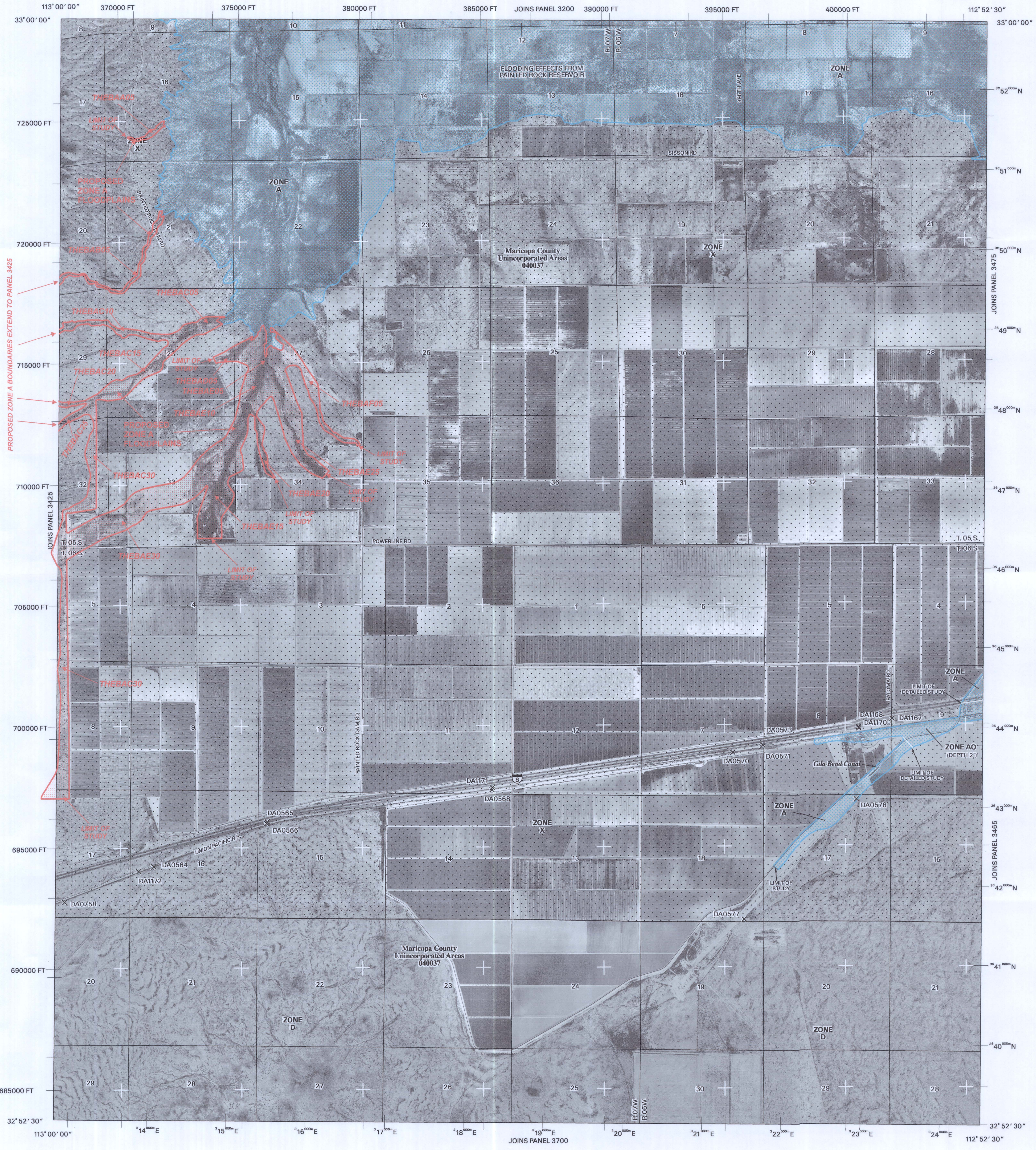
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMAMAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones, and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

~~~513~~~ Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the National Geodetic Vertical Datum of 1929

(A)—(A) Cross section line

(2)- - -(2) Transect line

112° 07′ 08″, 33° 25′ 41″ Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.

$^{42}76^{000m}$E 1000-meter Universal Transverse Mercator grid tick values zone 12.

875000 FT 5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)

×DV2313 Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORY

Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

July 19, 2001

September 30, 2005 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to incorporate previously issued Letters of Map Amendment.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 3450F

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 3450 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	3450	F

THEBA FDS PROPOSED ZONE A FLOODPLAINS

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

04013C3450F

PROPOSED MAP REVISION
~~~

NOTES TO USERS

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD 29). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was *Arizona State Plane Zone 3176 (central Arizona)*. The **horizontal datum** was *NAD83, GRS80 spheroid*. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the *National Geodetic Vertical Datum of 1929*. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(310) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by Maricopa County. Orthophoto images were produced at a scale of 1:6000 using HARN for control. Aerial photography is dated December 2000 to December 2002.

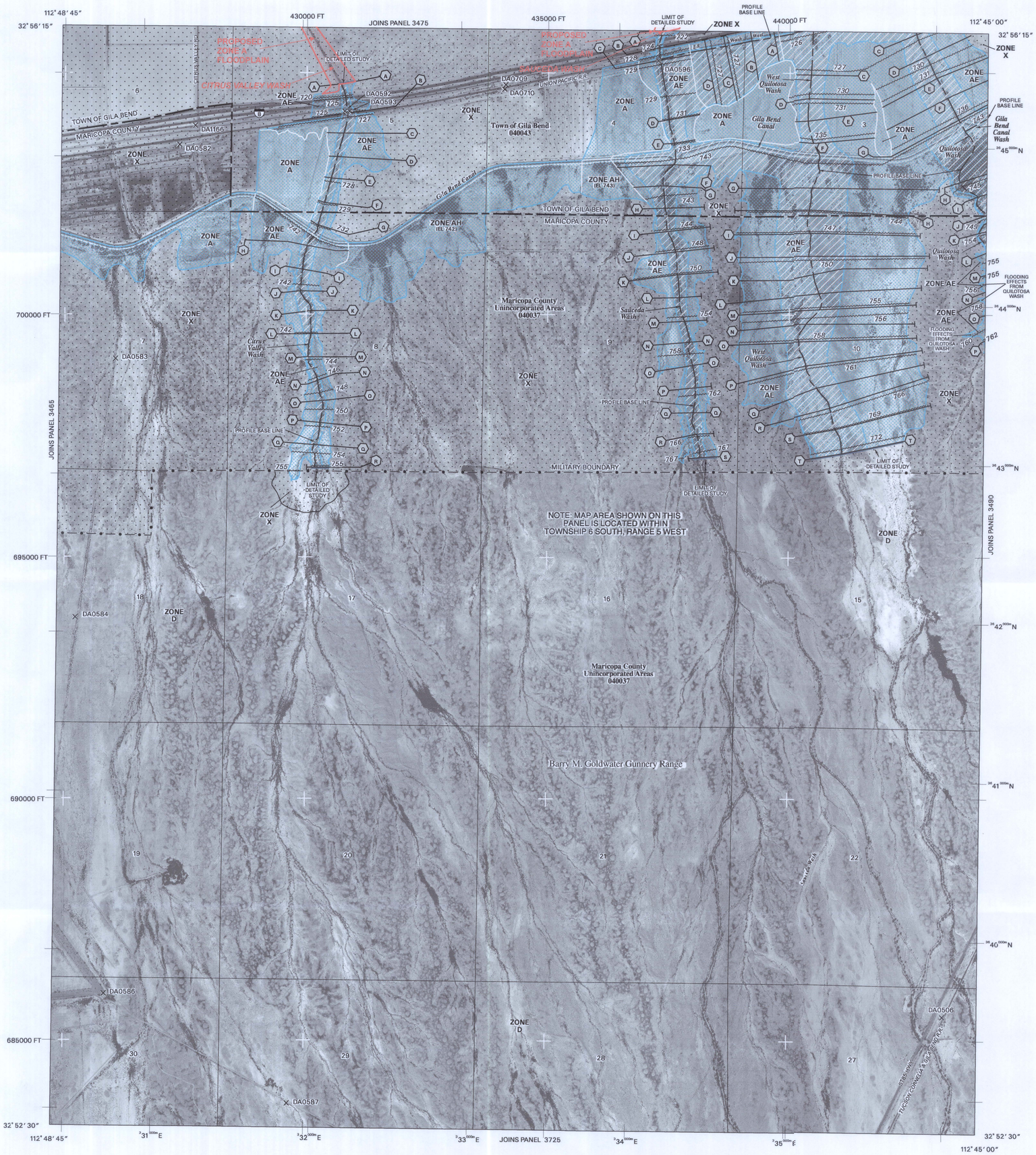
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMAMAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones, and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513	Base Flood Elevation line and value; elevation in feet *
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet *

* Referenced to the National Geodetic Vertical Datum of 1929

(A)———(A)	Cross section line
(2)- - - -(2)	Transect line
112° 07′ 08″, 33° 25′ 41″	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.
4276000mE	1000-meter Universal Transverse Mercator grid tick values zone 12.
875000 FT	5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)
×DV2313	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
July 19, 2001

September 30, 2005 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to incorporate previously issued Letters of Map Amendment.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 3470F

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 3470 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GILA BEND, TOWN OF	040043	3470	F
MARICOPA COUNTY	040037	3470	F

THEBA FDS PROPOSED ZONE A FLOODPLAINS

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MAP NUMBER
04013C3470F

PROPOSED MAP REVISION

NOTES TO USERS

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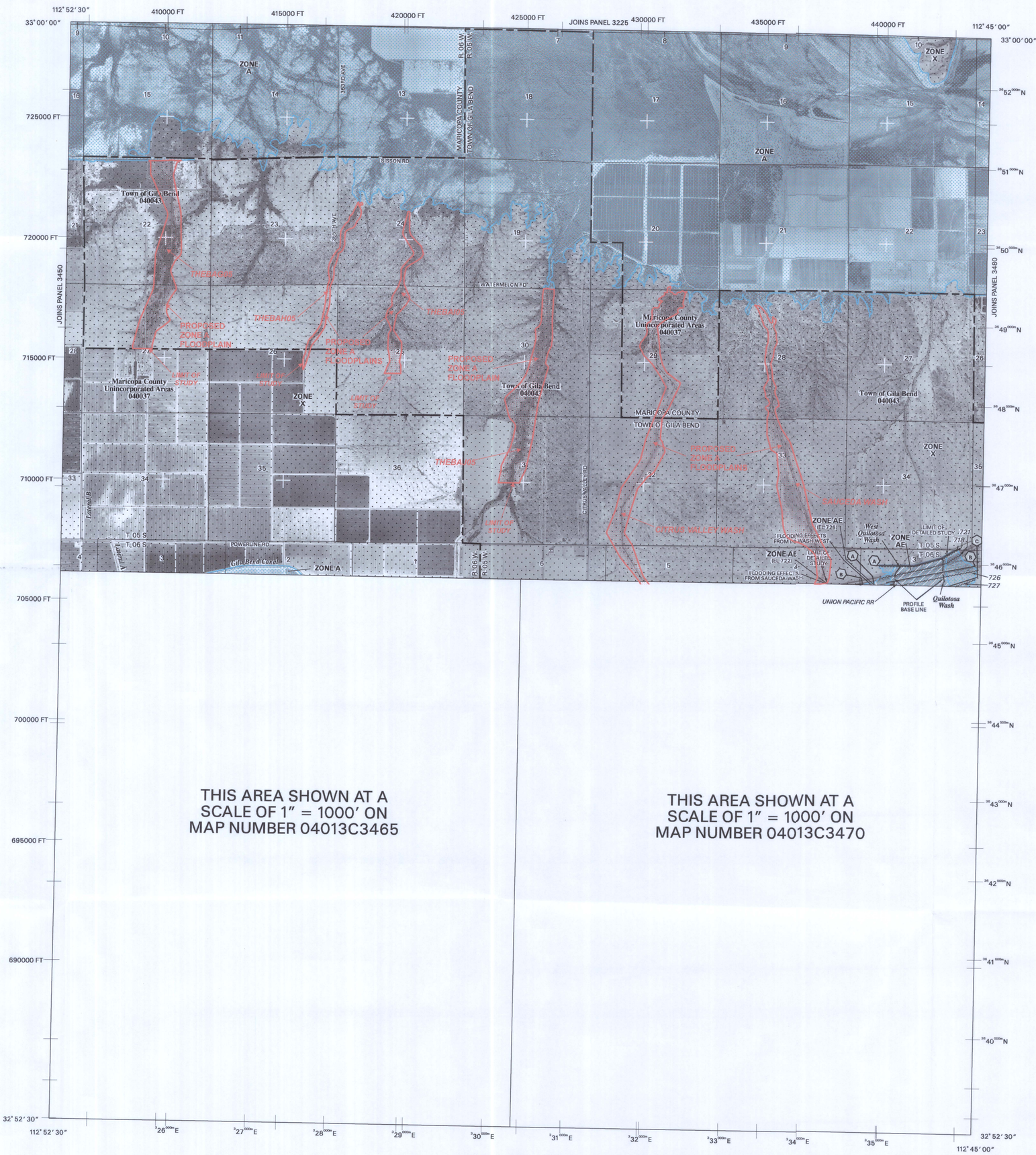

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Zone D boundary

CBRS and OPA boundary

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1000 0 2000 4000 FEET
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NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 3475F

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 3475 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
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MARICOPA COUNTY	040037	3475	F

THEBA FDS
PROPOSED ZONE A
FLOODPLAINS

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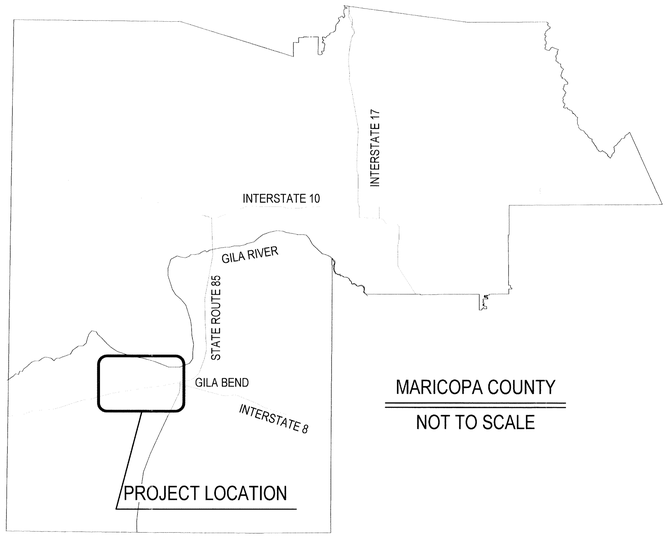
MAP NUMBER
04013C3475F

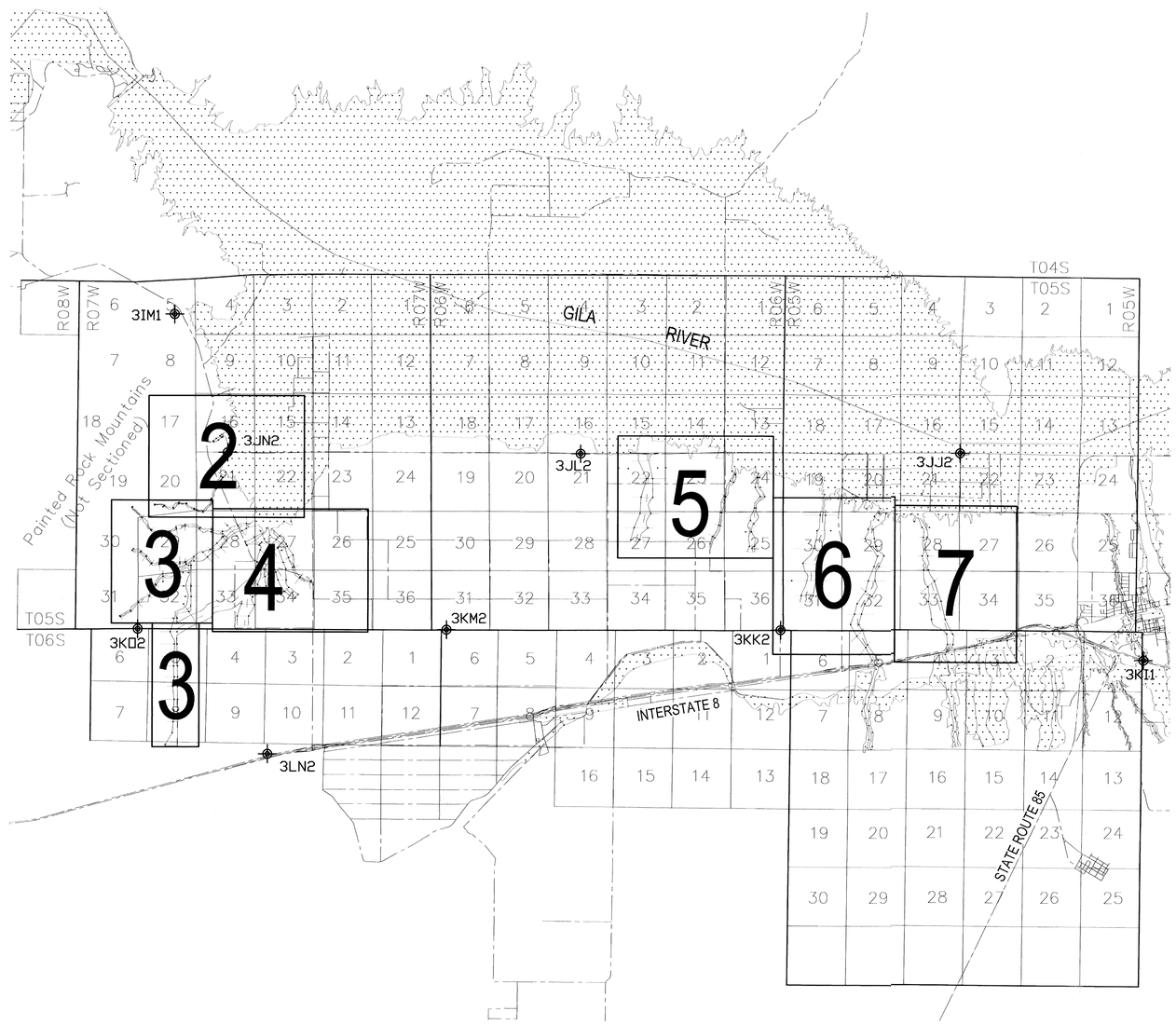
PROPOSED MAP REVISION

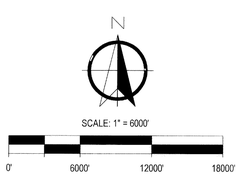
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

THEBA WATERSHED
FLOODPLAIN DELINEATION STUDY CONTRACT F.C.D. 2007C018



MARICOPA COUNTY
NOT TO SCALE





LEGEND

- PROPOSED ZONE A
- HYDRAULIC BASE LINE
- ROAD
- HIGHWAY
- EXISTING FLOODPLAIN
- ERM101 — ERM LOCATION
- 14 — SECTION
- 5 — SHEET

HYDROLOGY & HYDRAULICS

PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, SUITE 4
PHOENIX, ARIZONA 85021
(602) 906-1901

AERIAL PHOTOGRAPH

STEWART GEO TECHNOLOGIES, INC.
DECEMBER 2000
CONTOUR INTERVAL: 10 FEET

DATUM

HORIZONTAL: NORTH AMERICAN DATUM 1983
VERTICAL: NORTH AMERICAN VERTICAL DATUM 1988

STUDY AREA MAP AND SHEET INDEX

ELEVATION REFERENCE MARKS

ID	ELEVATION
3IM1	851.41
3JN2	659.51
3KO2	767.32
3LN2	725.43
3KM2	724.77
3JL2	678.41
3KK2	717.29
3JJ2	628.31
3KI1	773.75

NOTES

THIS MAP WAS PREPARED FROM MARICOPA COUNTY DIGITAL TERRAIN MODELS (DTM) PREPARED FROM AERIAL PHOTOGRAPHS FLOWN ON DECEMBER 17, 2000, BY STEWART GEO TECHNOLOGIES, INC.

DATE	REVISION	BY

EXPIRES 3-31-13
Registered Professional Engineer (Civil)
CERTIFICATE NO. 25972
MICHAEL D. HEATON
Date Signed 5-10-10
ARIZONA, U.S.A.

PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, STE. 4
PHOENIX, ARIZONA 85021

EXHIBIT F
FLOODPLAIN DELINEATION WORK MAPS

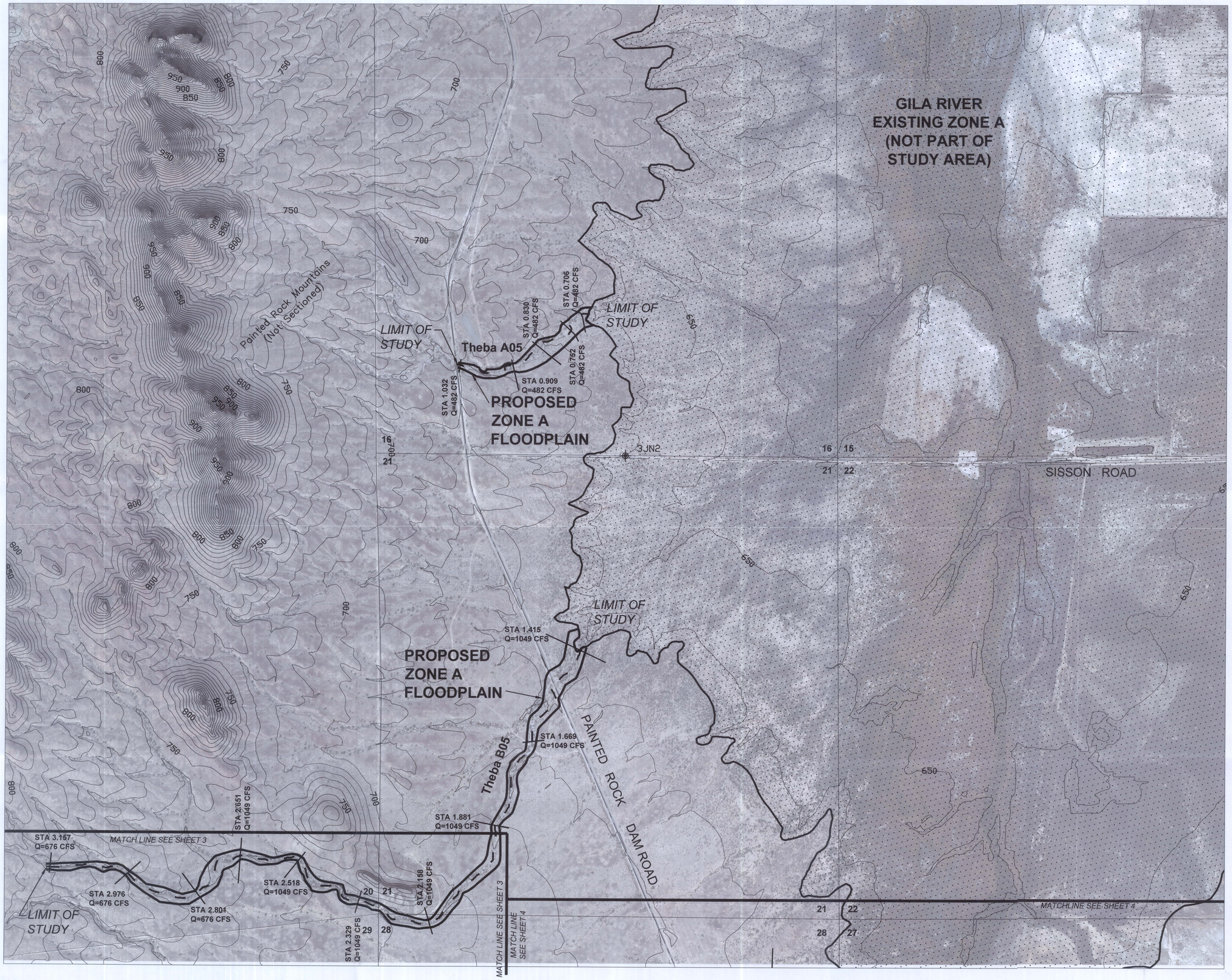
	BY	DATE
DESIGN	YX	5/10/10
DESIGN CHK.	MDH	5/10/10
PLANS	HC	5/10/10
PLANS CHK.	LSM	5/10/10

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE:
APPROVED BY: DATE:
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 7



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

THEBA WATERSHED FLOODPLAIN DELINEATION STUDY

CONTRACT FCD 2007C018

LEGEND

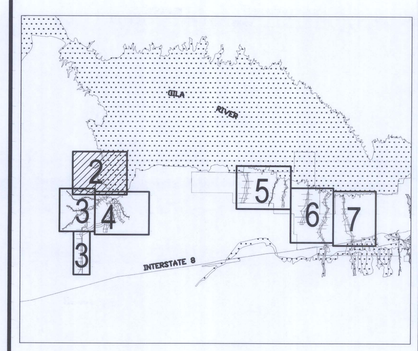
- PROPOSED ZONE A
- HYDRAULIC BASE LINE
- CITY LIMITS
- River Sta. (mi) Discharge (cfs) — CROSS SECTION
- ZONE A — ZONE DESIGNATIONS
- EXISTING FLOODPLAIN
- 16 15 / 21 22 — SECTION
- ERM101 — ERM LOCATION

N

SCALE: 1" = 500'

0' 500' 1000' 1500'

SHEET INDEX



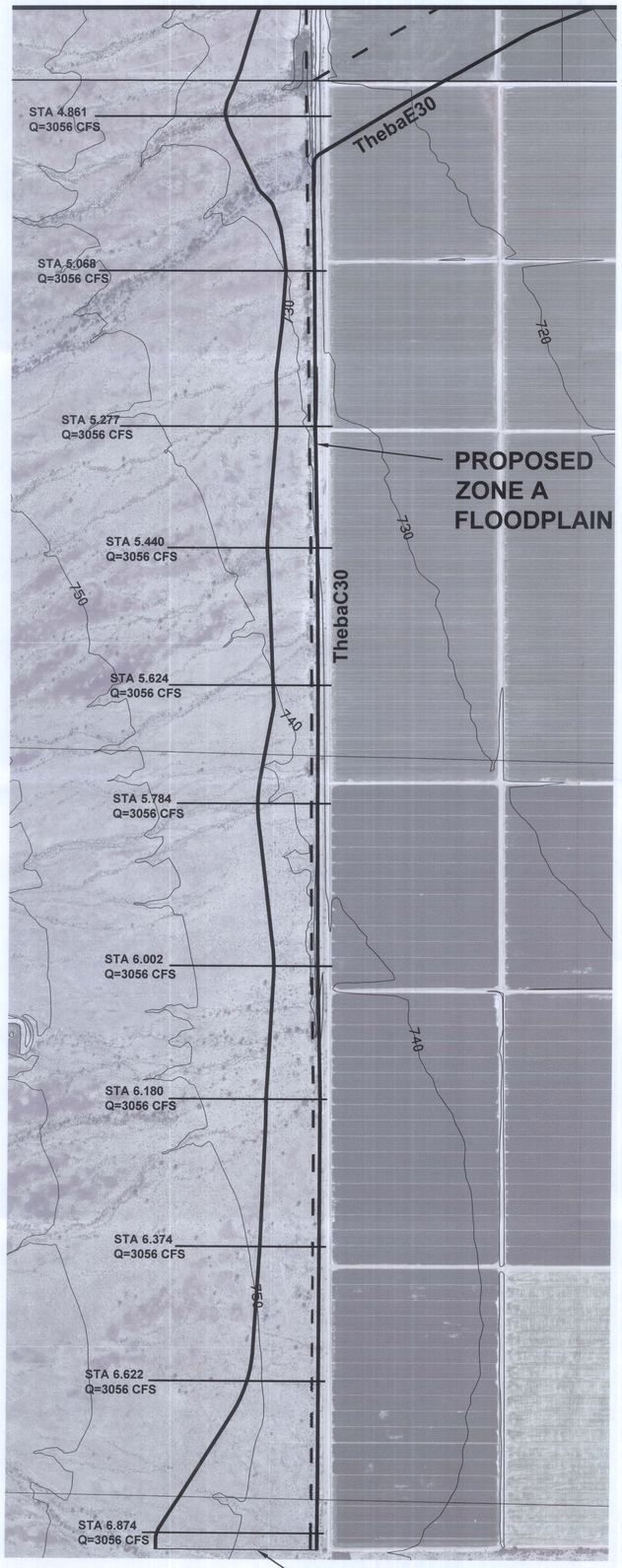
DATE	REVISION	BY

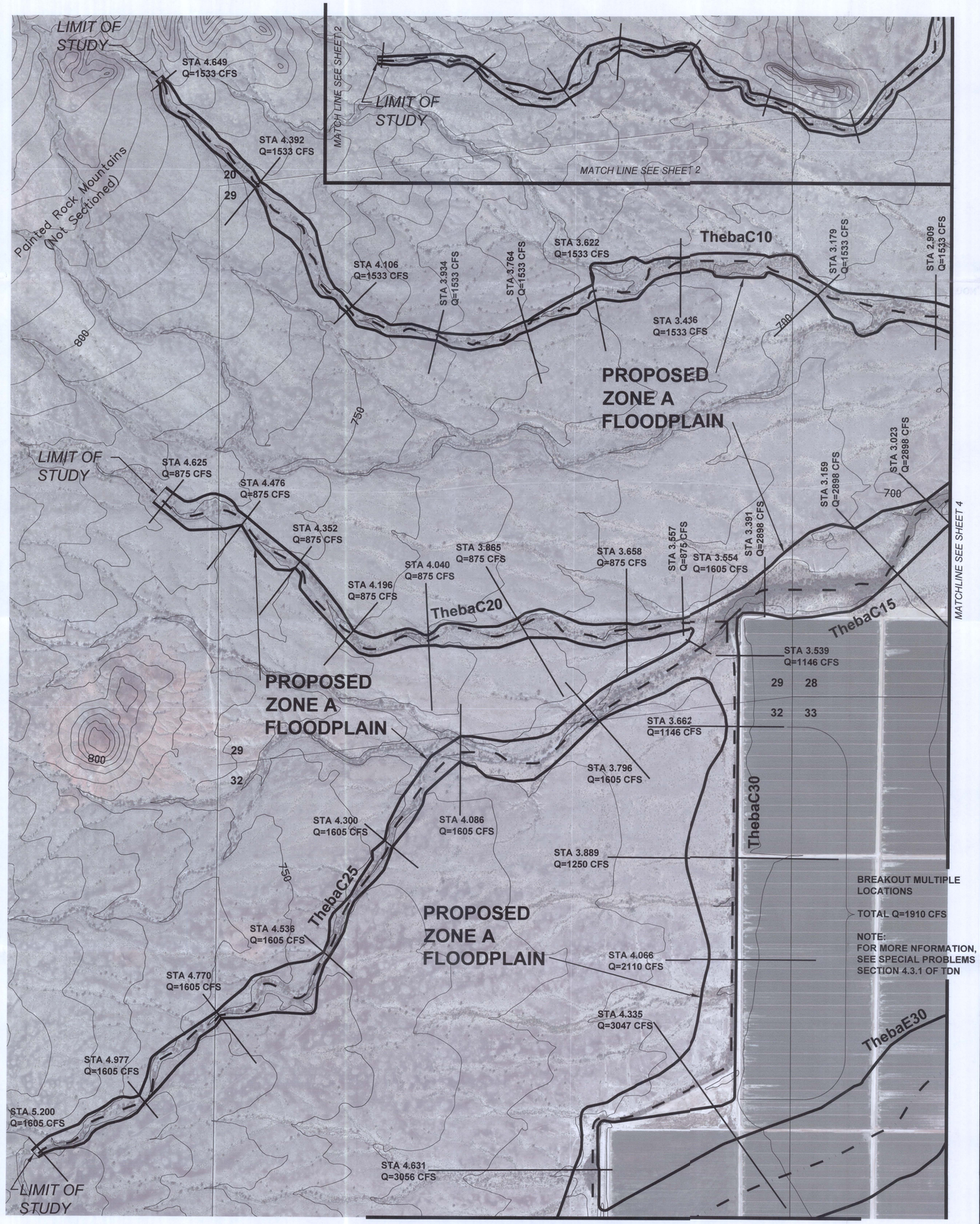
EXPIRES 3-31-13
Registered Professional Engineer (Civil)
CERTIFICATE NO. 25972
MICHAEL D. HEATON
Date Signed 7-10-09
ARIZONA, U.S.A.

PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, STE. 4
PHOENIX, ARIZONA 85021

EXHIBIT F
FLOODPLAIN DELINEATION WORK MAPS

	BY	DATE	
DESIGN	YX	5/10/10	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	MDH	5/10/10	
PLANS	HC	5/10/10	RECOMMENDED BY: DATE
PLANS CHK.	LSM	5/10/10	APPROVED BY: DATE
SUBMITTED BY: DATE:			CHIEF ENGINEER AND GENERAL MANAGER
			SHEET 2 OF 7





FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

THEBA WATERSHED FLOODPLAIN DELINEATION STUDY

CONTRACT FCD 2007C018

LEGEND

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- HYDRAULIC BASE LINE
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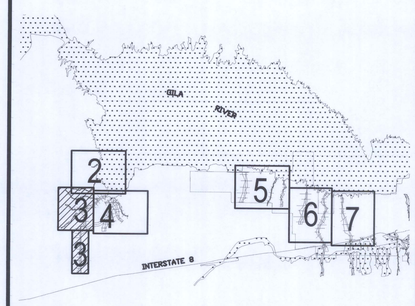

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SUBMITTED BY: DATE:

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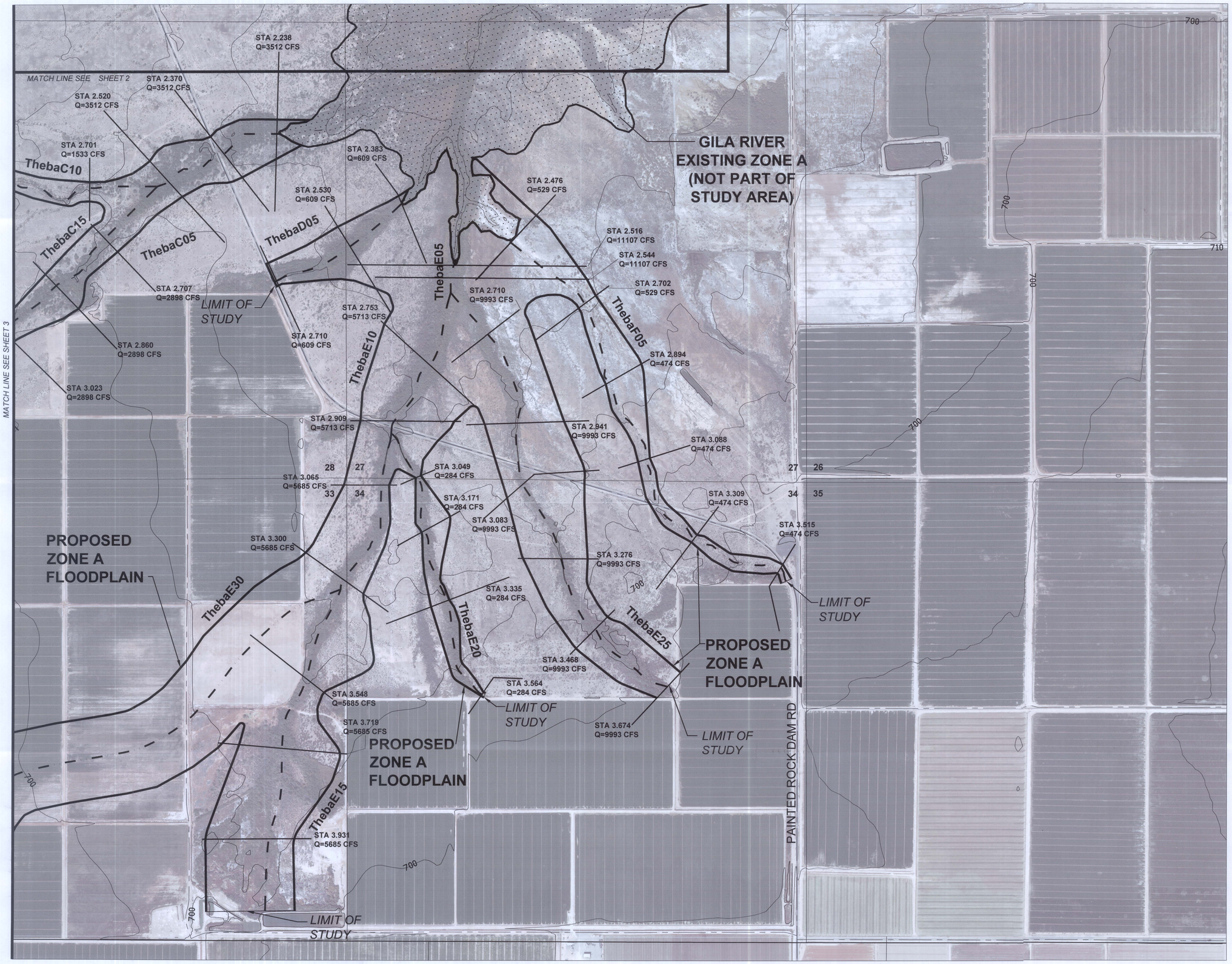
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 7



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

THEBA WATERSHED FLOODPLAIN DELINEATION STUDY

CONTRACT FCD 2007C018

LEGEND

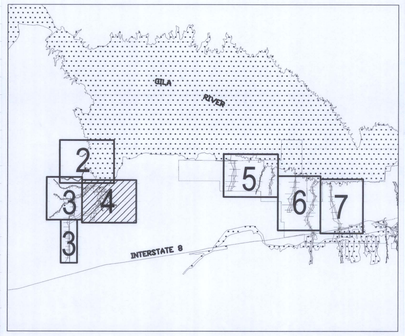
- PROPOSED ZONE A
- HYDRAULIC BASE LINE
- CITY LIMITS
- River Sta. (mi) Discharge (cfs) — CROSS SECTION
- ZONE A — ZONE DESIGNATIONS
- EXISTING FLOODPLAIN
- 16 | 15 / 21 | 22 — SECTION
- ERM101 — ERM LOCATION

N

SCALE: 1" = 500'

0' 500' 1000' 1500'

SHEET INDEX



DATE	REVISION	BY

EXPIRES 3-31-13
Registered Professional Engineer (Civil)
CERTIFICATE NO. 25972
MICHAEL D. HEATON
Date Signed 5-10-10
ARIZONA U.S.A.

PROJECT ENGINEERING CONSULTANTS, LTD.
2310 W. MISSION LANE, STE. 4
PHOENIX, ARIZONA 85021

EXHIBIT F
FLOODPLAIN DELINEATION WORK MAPS

	BY	DATE
DESIGN	YX	5/10/10
DESIGN CHK.	MDH	5/10/10
PLANS	HC	5/10/10
PLANS CHK.	LSM	5/10/10

SUBMITTED BY: DATE:

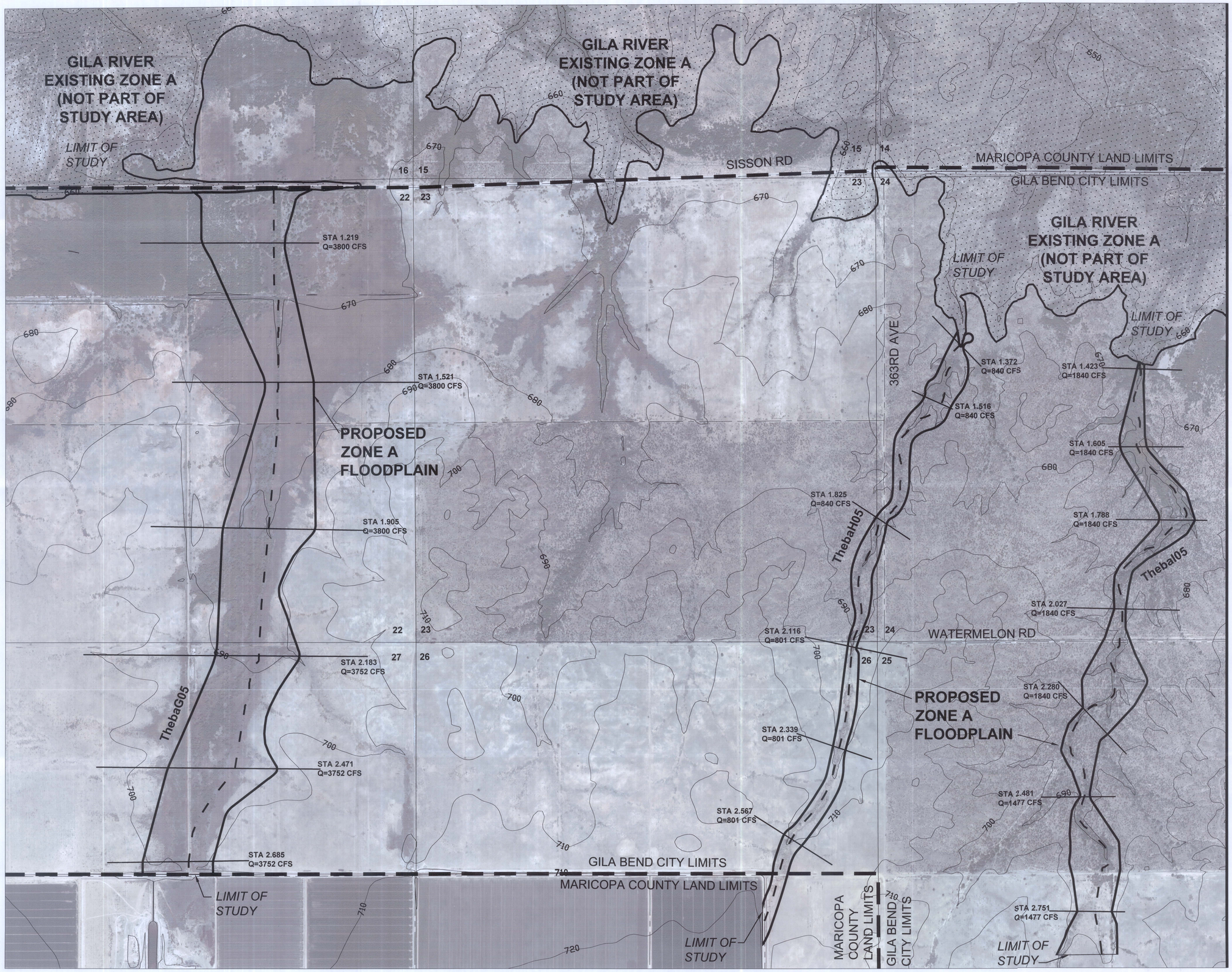
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 4 OF 7



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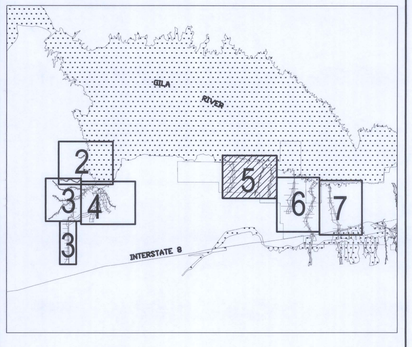

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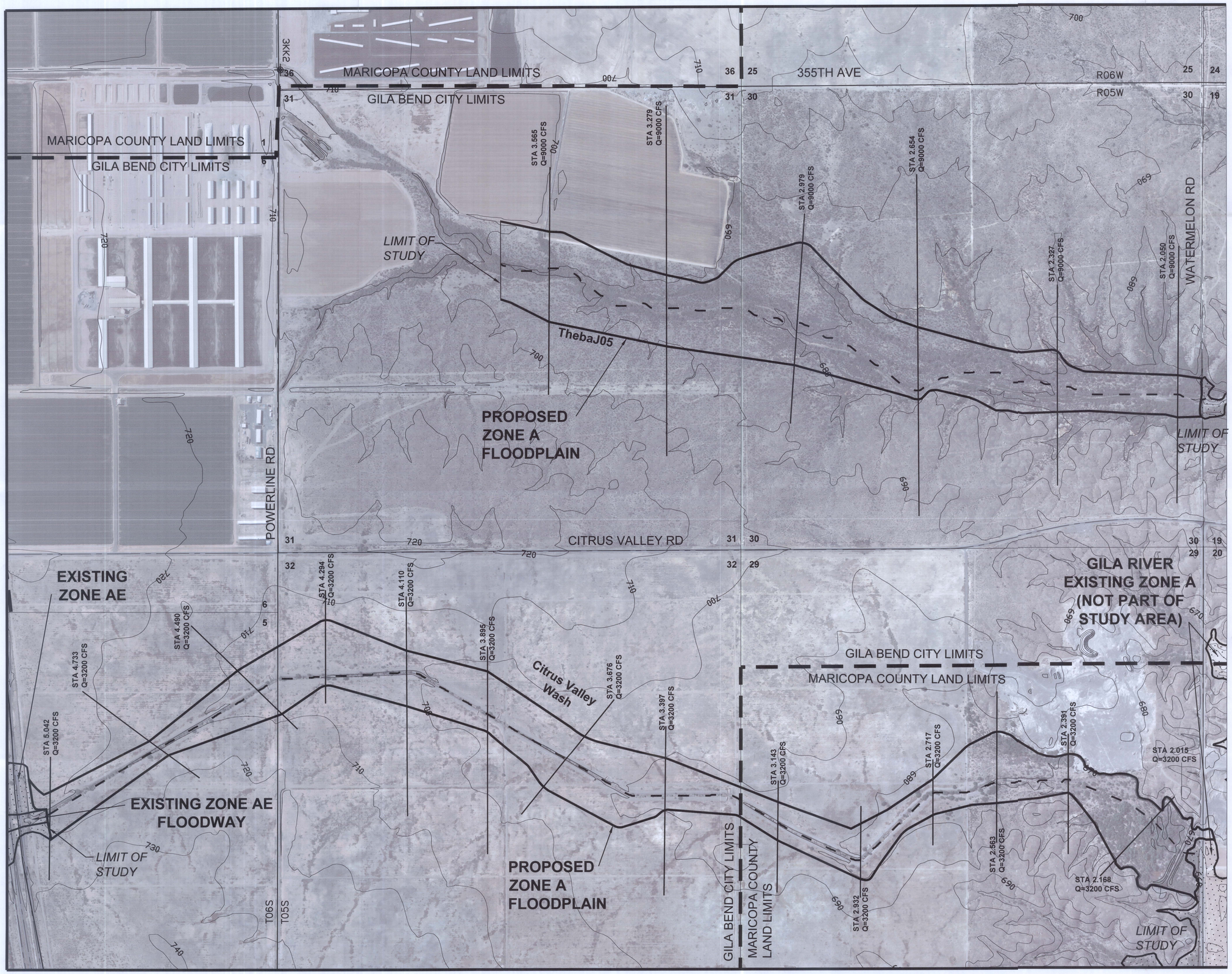
SHEET 5 OF 7

MATCH LINE SEE SHEET 5



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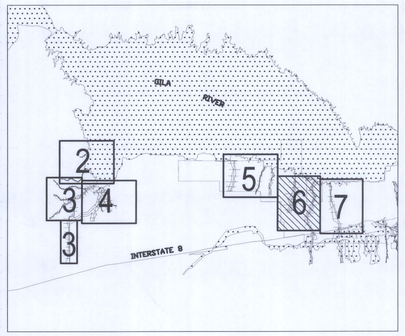

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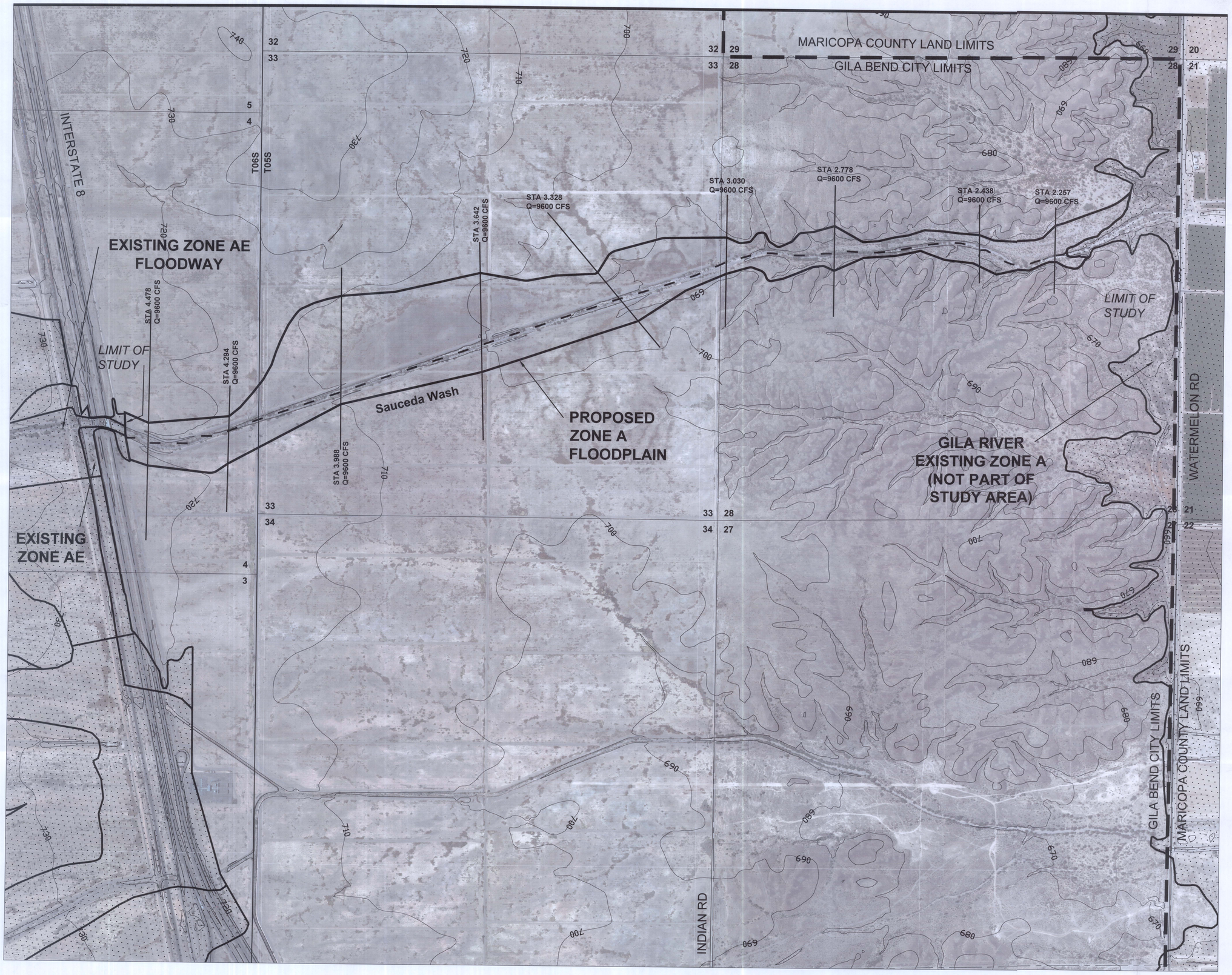
SHEET 6 OF 7

MATCH LINE SEE SHEET 6



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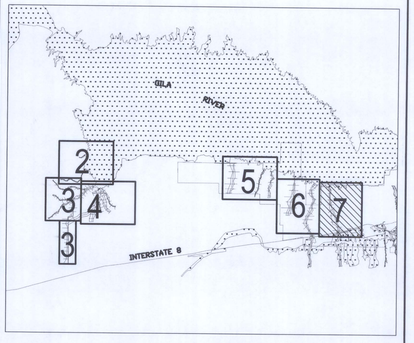

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SHEET 7 OF 7