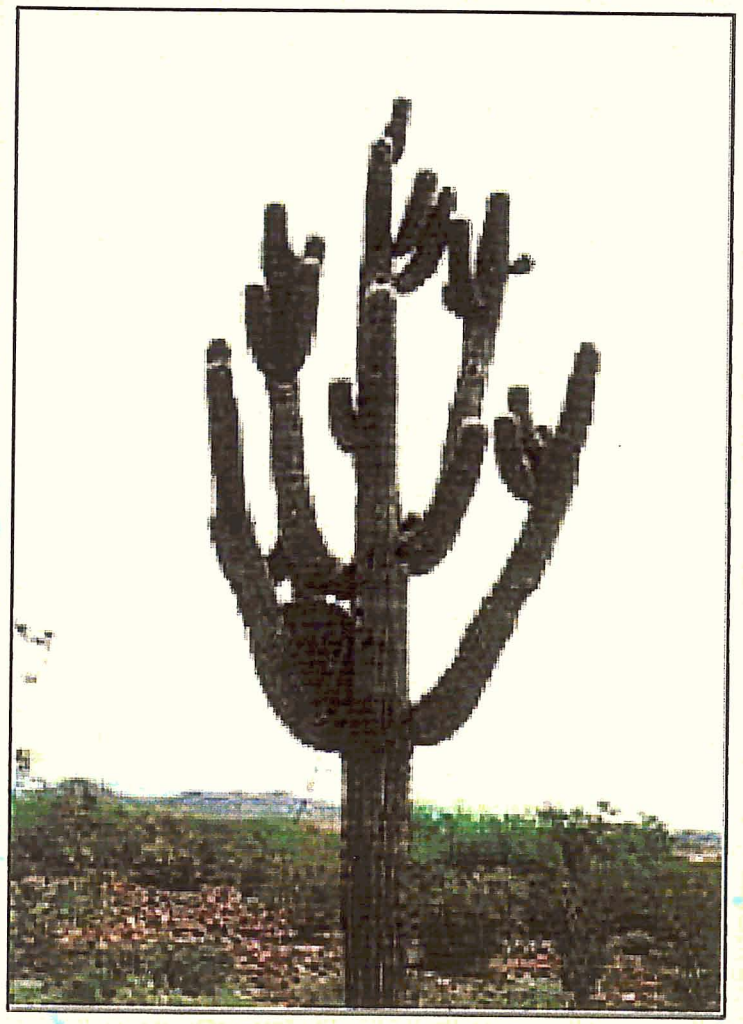

City of Phoenix
Water Services Department
Public Works Department

NORTH GATEWAY North Transfer Station

Access Road
FEMA Forms
Hydraulic Analysis

September 2003

DSWA And Associated Firms

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Flood Control District of MC Library
Please Return to
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NORTH GATEWAY
NORTH TRANSFER STATION
ACCESS ROAD AND BRIDGES

TECHNICAL DATA NOTEBOOK

LETTER OF MAP REVISION (LOMR)
CITY OF PHOENIX, ARIZONA
MARICOPA COUNTY

Prepared for:

Damon S. Williams Associates, L.L.C.
3838 N. Central Avenue, Suite 1700
Phoenix, Arizona 85012

Prepared by:

Tetra Tech, Inc.
Department of Water Resources
33 N. Stone Avenue, Suite 1500
Tucson, Arizona 85701
(Tt Job No. PDAMON4346.2)

September 2003

Registered Professional Engineer (Civil)
CERTIFICATE NO.
25331
LARRY K.
ROBERTS
Date Signed 9-29-03
ARIZONA, U.S.A.

Tetra Tech, Inc.

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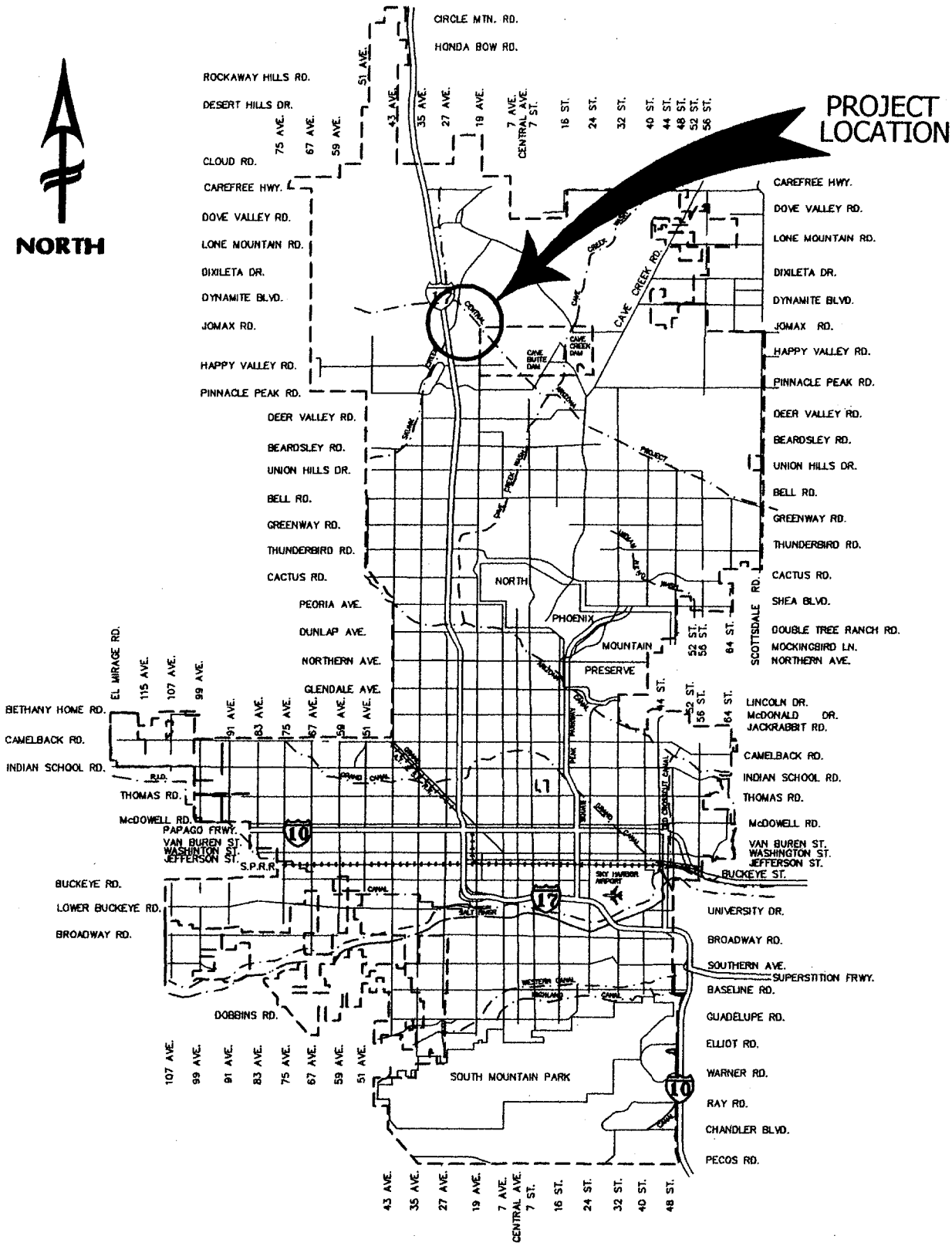
I. INTRODUCTION

This Technical Data Notebook (TDN) was prepared by Tetra Tech, Inc., in accordance with State Standard Attachment 1-97, "Instructions for Organizing and Submitting Technical Documentation for Flood Studies," adopted and effective November 1, 1997. The TDN was prepared by Tetra Tech, Inc., under contract as a subconsultant to Damon S. Williams, for the City of Phoenix.

This TDN presents a summary of the hydraulic and scour analysis that was conducted for the proposed North Gateway Access Road crossing of Skunk Creek. The proposed access road will cross the Skunk Creek floodplain at a location approximately one-half mile north of the existing Central Arizona Project (CAP) overshoot. The roadway will be located along an east-west alignment, from Interstate 17 on the west, to the proposed North Gateway Water Reclamation Plant on the east (see Vicinity Map). The project is located within the City of Phoenix, Maricopa County, Arizona.

Separate engineering plans provide details regarding the proposed access road and bridge crossings. The proposed roadway consists of a cement stabilized alluvium (CSA) elevated structure across the 100-year floodplain of Skunk Creek, with bridges to be installed at the three low-flow channels which are considered to be "Waters of the United States," as defined by Federal permitting criteria. The proposed access road will be elevated above ground elevation in the overbank areas of the 100-year floodplain, such that smaller flows will be diverted by the road to the bridge openings, and larger flow events will overtop and flood the road surface.

A hydraulic analysis was conducted to determine bridge hydraulics, characterize the flow distributions across the width of the 100-year floodplain, and document the effect of the proposed roadway and bridges on the 100-year water surface elevation. Hydraulic parameters were used to predict scour along the roadway and at each individual bridge.



VICINITY MAP

TETRA TECH, INC.

II. ADWR/FEMA FORMS

A. Study Documentation Abstract (2.1)

Subsection	Information Requested	Response
2.1.1	Date Study Accepted:	Not available at this time.
2.1.2	Study Contractor: Contact: Address: Phone: Internal Reference Number:	Tetra Tech,Inc. Larry K. Roberts, P.E. 33 North Stone Avenue, Suite 1500 Tucson, Arizona 85701-1413 520-623-7980 PDAMON4346.2
2.1.3	FEMA Technical Review Contractor: Contact: Address: Phone: Internal Reference Number:	Not available at this time.
2.1.4	FEMA Regional Reviewer: Phone:	Not available at this time.
2.1.5	State Technical Reviewer: Phone:	Not available at this time.
2.1.6	Local Technical Reviewer: Phone:	Hasan Mushtaq, P.E. Floodplain Manager, City of Phoenix 602-262-4026
2.1.7	Reach Descriptions (approximate):	Skunk Creek from 13.28 miles to 14.3 miles above confluence with New River
2.1.8	Topographic Maps	200-scale FEMA Work Study Maps, plus new topography in the vicinity of the new bridges
2.1.9	Unique Conditions and Problems:	The North Transfer Station Access Road required three separate bridges spanning the low flow channels for Skunk Creek.
2.1.10	Coordination of Peak Discharges:	Not Applicable

B. FEMA MT-2 Forms (2.2)

FEMA MT-2 Forms 1, 2, and 3 are included on the following pages.

FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 3067-0148
Expires September 30, 2005

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, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (3067-0148). 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 FEMA

This request is for a (check one):

☐ CLOMR: A letter from 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 FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See Parts 60 & 65 of the NFIP Regulations.)

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
040051	CITY OF PHOENIX	AZ	04013C	0790F	07/19/01
040051	City of Phoenix	AZ	04013C	0770E	07/19/01

2. Flooding Source: Skunk Creek

3. Project Name/Identifier: North Gateway North Transfer Station

4. FEMA zone designations affected: AE (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 ☐ 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 types of flooding and structures (check all that apply)

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

☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

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 FEMA Web site at http://www.fema.gov/fhm/frm_fees.shtm for Fee Amounts and Exemptions.

D. SIGNATURE

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

Name: John H. Matta, P.E., Principal	Company: Damon S. Williams, L.L.C.	
Mailing Address: 3838 N. Central Ave., Suite 1700 Phoenix, AZ 85012	Daytime Telephone No.: 602-265-5400	Fax No.: 602-265-5632
	E-Mail Address: johnmatta@dswa.net	
Signature of Requester (required): John H. Matta		Date: 09/30/03

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: Hasan Mushtaq, P.E., C.F.M.		Telephone No.: 602-262-4026
Community Name: City of Phoenix	Community Official's Signature (required): Hmushtaq	Date: ~~10/01/03~~ 12/16/03

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. 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: Larry K. Roberts, P.E.	License No.: 25331	Expiration Date: current
Company Name: Tetra Tech, Inc.	Telephone No.: 520-623-7980	Fax No.: 520-884-5278
Signature: Larry K. Roberts		Date: 09/29/03

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)

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 3067-0148
Expires September 30, 2005

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3 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, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (3067-0148). 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: Skunk Creek
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 2) ☐ 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.)	FIS (cfs)	Revised (cfs)

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

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model [TR-20, HEC-1, HEC-HMS etc.]
☐ 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. The document, "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at: http://www.fema.gov/fhm/en_modl.shtm.

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	In miles above confluence with New River	13.28	1532.51	1532.5
Upstream Limit	In miles above confluence with New River	14.3	1573.99	1574.15

2. Hydraulic Method Used

Hydraulic Analysis HEC-2 [HEC-2 , HEC-RAS, Other (Attach description)]

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

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 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/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with a message, please attach an explanation of why the message is not valid in this case. Review of your submittal and resolution of valid modeling discrepancies will result in reduced review time.

HEC-2/HEC-RAS models reviewed with CHECK-2/CHECK-RAS? ☒ Yes ☐ No

4. Models Submitted

Duplicate Effective Model*	Natural File Name: skunkcreek.dat	Floodway File Name: skunkcreek.dat
Corrected Effective Model*	Natural File Name: revisedexisting.dat	Floodway File Name: revisedexisting.dat
Existing or Pre-Project Conditions Model	Natural File Name: revisedexisting.dat	Floodway File Name: revisedexisting.dat
Revised or Post-Project Conditions Model	Natural File Name: newb.dat	Floodway File Name: newb.dat
Other - (attach description)	Natural File Name:	Floodway File Name:

*Not required for revisions to approximate 1%-annual-chance floodplains (Zone A) – for details, refer to the corresponding section of the instructions.

The document "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at: http://www.fema.gov/fhm/en_modl.shtm.

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.).

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.

D. COMMON REGULATORY REQUIREMENTS

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

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 BFEs established and would result in increases above 1.00 foot.

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 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.

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B. No. 3067-0148
Expires September 30, 2005

PAPERWORK REDUCTION ACT

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Flooding Source: Skunk Creek
Note: Fill out one form for each flooding source studied

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization.....complete Section B
Bridge/Culvert.....complete Section C
Dam .....complete Section D
Levee/Floodwall .....complete Section E
Sediment Transport.....complete Section F (if required)

Description Of Structure

1. **Name of Structure: North Gateway North Transfer Station Access Road**

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

   Location of Structure: Approximately 13.7 miles above confluence with New River

   Downstream Limit/Cross Section: 13.28

   Upstream Limit/Cross Section: 14.3

2. **Name of Structure:**

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

   Location of Structure:

   Downstream Limit/Cross Section:

   Upstream Limit/Cross Section:

3. **Name of Structure:**

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

   Location of Structure:

   Downstream Limit/Cross Section:

   Upstream Limit/Cross Section:

NOTE: For more structures, attach additional pages as needed.

B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transitions in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

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

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

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

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

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
☐ Other locations (specify):

4. Sediment Transport Considerations

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

C. BRIDGE/CULVERT

Flooding Source: Skunk Creek

Name of Structure: North Gateway North Transfer Station Access Road

1. This revision reflects (check one):

- ☒ New bridge/culvert not modeled in the FIS
- ☐ Modified bridge/culvert previously modeled in the FIS
- ☐ New analysis of bridge/culvert previously modeled in the FIS

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

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

- ☒ Dimensions (height, width, span, radius, length)
- ☐ Shape (culverts only)
- ☒ Material
- ☐ Beveling or Rounding
- ☐ Wing Wall Angle
- ☐ Skew Angle
- ☒ Distances Between Cross Sections
- ☒ Erosion Protection
- ☒ Low Chord Elevations – Upstream and Downstream
- ☒ Top of Road Elevations – Upstream and Downstream
- ☒ Structure Invert Elevations – Upstream and Downstream
- ☒ Stream Invert Elevations – Upstream and Downstream
- ☒ Cross-Section Locations

4. Sediment Transport Considerations

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

D. DAM

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam
2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency

   ☐ Private organization Name of the agency or organization:
3. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).
4. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.
5. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

   Stillwater Elevation Behind the Dam

FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)		
50-year (2%)		
100-year (1%)		
500-year (0.2%)		
Normal Pool Elevation		

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

E. LEVEE/FLOODWALL

1. System Elements

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

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

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

☐ earthen embankment, dike, berm, etc.	Station	to
☐ structural floodwall	Station	to
☐ Other (describe):	Station	to

c. Structural Type (check one):

☐ monolithic cast-in place reinforced concrete
☐ reinforced concrete masonry block
☐ sheet piling
☐ Other (describe):

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

☐ Yes ☐ No

If Yes, by which agency?

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

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

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

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

E. LEVEE/FLOODWALL (CONTINUED)

2. Freeboard (continued)

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

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

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

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

3. Closures

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

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

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

Note: Geotechnical and geologic data

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

4. Embankment Protection

a. The maximum levee slope landside is:

b. The maximum levee slope floodside is:

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

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

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

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

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

4. Embankment Protection (continued)

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

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

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength ϕ = degrees, c = psf

slope: SS = (h) to (v)

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

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

c. Summary of stability analysis results:

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

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

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

If Yes, describe methodology used:

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

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

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

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

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ P_A = psf; P_p = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ P_w = psf

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

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

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

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

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

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)

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

e. Foundation bearing strength for each soil type:

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

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

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

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

b. The computed range of settlement is ft. to ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

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

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

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

b. Relationships Established

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

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

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

e. Which flooding conditions were analyzed?

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

If No for any of the above, attach explanation.

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

If No, attach explanation.

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

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

8. Interior Drainage (continued)

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

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

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

Will the operation be automatic? ☐ Yes ☐ No

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

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

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

9. Other Design Criteria

a. The following items have been addressed as stated:

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

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

Attach supporting documentation

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

Attach supporting documentation

d. Sediment Transport Considerations:

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

E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

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

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

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No

If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No
If No, please attach supporting documentation.

12. Operations and Maintenance Plan

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

F. SEDIMENT TRANSPORT

Flooding Source: Skunk Creek

Name of Structure: North Gateway North Transfer Station Access Road

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

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

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

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport: Review of existing documentation and additional geomorphic assessment

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

Method used to estimate scour and/or deposition: HEC-18

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

Conservative structural toe-downs were used to account for hydraulic uncertainties

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

III. SURVEY AND MAPPING INFORMATION

A. Flood Insurance Study

The existing FEMA Flood Insurance Study (FIS) for the area (FEMA, 2001) provided the base topographic maps for floodplain modeling. The existing Work Study maps, dated July, 1997, were obtained from the Flood Control District of Maricopa County. The annotated maps, showing the existing floodplain, the revised floodplain, and cross section locations, are provided in Section VII of this report.

B. Damon S. Williams and Aztec Engineering

Engineering plans for the proposed roadway and bridges have been prepared by Damon S. Williams and Aztec Engineering. Three pages of the plan set are included in Appendix E.1. These three pages provide plan and profile data for the section of the roadway that spans the Skunk Creek floodplain. The plans were used to obtain proposed bridge parameters, roadway elevations, and existing ground topography immediately adjacent to the proposed roadway and bridges.

IV. HYDROLOGY

Hydrologic data for Skunk Creek were obtained from the FEMA Flood Insurance Study (FIS) for the area (FEMA, 2001). The FIS HEC-2 input file, which formed the base model for the hydraulic analysis, was obtained from the Flood Control District of Maricopa County. The HEC-2 file was revised to incorporate the current revised FIS 100-year discharge (FEMA, 2001).

V. HYDRAULICS

Tetra Tech performed a site-specific hydraulic analysis in order to (1) establish new water surface elevations for both existing and proposed conditions in the vicinity of the proposed roadway, (2) characterize the flow distribution across the width of the 100-year floodplain, and (3) determine hydraulic parameters in the vicinity of the proposed bridges. The base hydraulic model (HEC-2 input file) for Skunk Creek was obtained from the Flood Control District of Maricopa County. The updated 100-year discharge for Skunk Creek was also used (FEMA, 2001). Hydraulic design criteria for the proposed access road and bridge crossings were determined using (1) the existing channel morphology, as defined by slope, cross sectional shape, and channel alignment; and (2) the proposed bridge and roadway configuration, as defined by engineering plans.

A. Hydraulic Input Data

The existing HEC-2 input file was revised in order to establish the existing, before-project hydraulic conditions. A new Cross Section (13.7), located along the proposed roadway alignment, was incorporated into the hydraulic model to replace Cross Section 13.66. Cross Section 13.7 is located 110 feet north (and upstream) of Cross Section 13.66.

Engineering plans for the proposed roadway and bridges have been prepared by Damon S. Williams and Aztec Engineering. Three pages of the plan set are included in Appendix E.1. These three pages provide plan and profile data for the section of the roadway that spans the Skunk Creek floodplain. The plans were used to obtain proposed bridge parameters, roadway elevations, and existing ground topography immediately adjacent to the proposed roadway and bridges for use in the hydraulic modeling.

The three proposed low-flow bridge crossings of Skunk Creek are located at the current locations of the three primary low-flow channels. Each bridge opening is about 90 feet in width, with a single set of 5-foot-diameter piers at the midpoint of the opening. The existing invert of the channel bed was also used for proposed conditions.

These data were then incorporated into the HEC-2 hydraulic model for proposed conditions. Stationing on the plan set, which increases from west to east, had to be converted to HEC-2 stationing, which requires increasing stationing from east (hydraulic left) to west (hydraulic right). Hydraulic left and hydraulic right are defined in terms of looking in a downstream direction.

Because of the multiple bridge configurations, the Normal Bridge Routine was utilized to characterize bridge and channel geometry. Cross Sections 13.73, 13.74, and 13.75 were added to the model to characterize physical properties at the location of the proposed bridges. Manning's roughness coefficients and expansion/contraction coefficients were adjusted per HEC-2 modeling guidelines. In addition, the pier widths were increased by 50% to account for debris.

The proposed access road will be elevated above the ground elevation in the overbank areas of the 100-year floodplain, such that smaller flows will be diverted by the road to the bridge openings, and large flow events will overtop and flood the road surface. The roadway profile across the total width of the 100-year floodplain was incorporated into the HEC-2 model as a weir section for flow, acting in conjunction with the proposed bridges or independently in the overbank areas between the bridges.

B. Hydraulic Modeling

As discussed in the previous section of this report, the existing FEMA HEC-2 input file formed the base model that was modified in the vicinity of the proposed roadway and bridges. The existing FEMA model was revised for (1) new topography in the vicinity of the bridge site, and (2) an updated FEMA 100-year discharge. Hydraulic modeling of the 100-year floodway and 100-year floodplain was performed using the HEC-2 program for (1) revised existing conditions, and (2) proposed conditions with the new bridges. In addition, the HEC-2 modeling was conducted in order to be consistent with the existing FEMA HEC-2 modeling for the area.

Once existing and proposed conditions were defined and modeling completed using the HEC-2 program, the HEC-2 input files were imported into the HEC-RAS program. The HEC-RAS hydraulic modeling software was utilized to determine all of the existing and proposed hydraulic parameters for use in performing the scour analysis. The HEC-RAS was selected for use because of the superior editing and graphical capabilities for performing detailed bridge modeling. The HEC-RAS also provided excellent graphical capabilities for displaying cross sectional geometry and providing output data in a readily useable form.

Three separate bridges along a single cross section location provided challenges both in defining modeling input parameters and in obtaining hydraulic output at each bridge location and at specific points along the width of the cross sections. The main channel bank was defined by designating bank stations at the west edge of the westernmost bridge, and at the eastern edge of the easternmost bridge. The use of flow distribution designations allowed for more specific hydraulic parameters to be reported. In order to properly calculate scour, velocity and depth were needed at each bridge

opening, at locations immediately adjacent to each bridge opening, and at other locations along the roadway profile.

C. Results

1. Water Surface Elevations

Table 1 provides a summary of the HEC-2 100-year water surface elevations in the vicinity of the proposed access road. The HEC-2 input and output files have been provided in Appendix E.2 (hard copy) and Appendix G (digital files). The table provides a comparison of water surface elevations for (1) existing FEMA conditions, (2) revised existing conditions (updated topography at the bridge site and an updated discharge), and (3) conditions with the new bridges in place.

Table 1: Comparison of 100-Year Water Surface Elevations

Section	Existing FEMA WSEL	Revised Existing WSEL	New Bridge WSEL
13.28	1532.51	1532.5	1532.5
13.4	1537.72	1537.86	1537.86
13.55	1543.09	1543.35	1543.35
13.66	1547.65	*n/a*	*n/a*
13.7	*n/a*	1548.18	1548.19
13.73	*n/a*	*n/a*	1547.87
13.74	*n/a*	*n/a*	1549.05
13.75	*n/a*	*n/a*	1549.61
13.86	1555.73	1555.76	1555.32
14.07	1564.42	1564.76	1565.02
14.3	1573.99	1574.16	1574.15

n/a = not applicable

2. Hydraulic Parameters

Hydraulic parameters were obtained for the scour analysis using multiple summary tables from the HEC-RAS software. Standard HEC-RAS tables for (1) bridge hydraulics, (2) cross-section hydraulics, and (3) flow-distribution hydraulics were all necessary to obtain the necessary hydraulic variables for use in calculating the various scour depths. Theses tables are included in Appendix E.3. Three different types of output tables were necessary to accurately characterize the hydraulics along the length of the proposed roadway and the three individual bridges.

VI. EROSION AND SEDIMENT TRANSPORT

A. Scour Analysis

A scour analysis was performed to determine scour depths along the proposed roadway and bridges for the 100-year flow event. Hydraulic parameters from the HEC-RAS analysis, along with geometric data obtained from the Damon S. Williams/Aztec plans, were used to perform the analysis. Calculations were performed independently for each of the three proposed bridges because hydraulic conditions vary at each bridge.

The state-of-knowledge and widely accepted methodology for predicting scour at highway bridges is presented within HEC No. 18, "Evaluating Scour at Bridges" (FHWA, 1995). The information presented within this report is the practical application of the HEC-18 methodology to the problem of predicting scour at the proposed North Gateway Access Road bridges. Some of the basic concepts and definitions from HEC-18 are summarized in the following sections of this report. Procedures and equations from HEC-18 are presented within Appendix F. A summary of results is presented both in the following sections and Appendix F.

According to HEC-18, total scour at a roadway bridge crossing is comprised of three components:

(1) Long-term aggradation or degradation,
(2) Contraction scour, and
(3) Local scour.

Local scour is defined as scour at any obstruction to flow, including piers, abutments, spurs, or embankments. Pressure-flow scour can increase contraction or local scour when the water surface elevation exceeds the low chord elevation of the bridge superstructure.

1. Aggradation and Degradation

Aggradation and degradation are long-term streambed elevation changes due to natural or man-induced causes that can affect the reach of the river on which the bridge is located. Aggradation involves the deposition of material eroded from the channel or watershed upstream of the bridge, where degradation involves the lowering or scouring of the streambed due to a deficit in sediment supply from upstream.

Long-term bed elevation changes may be the natural trend of the stream or may be the result of some modification to the stream or watershed. The streambed may be

aggrading, degrading, or in relative equilibrium in the vicinity of the bridge crossing. Long-term aggradation and degradation do not include the localized cutting and filling of the streambed that might occur during a runoff event. A stream may cut and fill at specific locations during a runoff event and also have a long-term trend of an increase or decrease in bed elevation over a longer reach of a stream.

Using the information in the Skunk Creek Watercourse Master Plan (SCWMP) as the primary source of data, site-specific information regarding long-term aggradation and degradation is available for the portion of Skunk Creek where the access road is proposed. Figure 4-84 of the SCWMP (see Appendix A.2) shows the existing longitudinal profile of the Skunk Creek. The profile is "concave up," where the slope is constantly decreasing in a downstream direction. In general, the decrease in slope decreases the sediment transport capacity of the creek, thus promoting sediment deposition. In addition, the overshoot for Skunk Creek at the Central Arizona Project (CAP) canal, located 3400 feet downstream of the proposed bridges, represents a fixed point in the long-term bed profile. According to the SCWMP, the overshoot is undersized and creates backwater conditions upstream of the overshoot. Consequently, velocities will decrease upstream of the CAP canal and will promote additional aggradation within Skunk Creek.

2. Contraction Scour

Contraction of flow, caused by bridge approach embankments encroaching onto the floodplain and/or into the main channel, is the most common cause of contraction scour. Contraction scour results from when the flow area of the approach channel is reduced through a bridge opening, with a resulting increase in velocity and shear stress on the bed of the channel. With an increase in erosive forces, more bed material can be removed which lowers the natural bed elevation. As the bed elevation is lowered, the flow area increases and the velocity and shear stress decrease until relative equilibrium is reached where the quantity of bed material that is transported into the reach is equal to that removed.

Contraction scour was calculated for each of the three bridges. At each bridge, a low-flow channel approaches a 90-foot bridge opening. Flows in excess of the low-flow capacity of each approach channel, which are located outside of the 90-foot opening and below the top-of-road elevation, are blocked by the embankment. These blocked flows are diverted from the overbank area through the bridge opening. Using hydraulic parameters from both the approach channel and the contracted bridge section, contraction scour depths can be calculated at each bridge. Calculations, provided in Appendix E.3, are summarized in Table 2. Results reflect the larger amount of flow blocked and diverted by the roadway embankment at the East Bridge.

Table 2: Contraction Scour			
	West Bridge	Central Bridge	East Bridge
Contraction Scour (ft)	2.8	2.1	8.3

3. Pressure-Flow Scour

Pressure flow, which is also denoted as orifice flow, occurs when the water surface elevation at the upstream face of the bridge is greater than or equal to the low chord of the bridge superstructure. Pressure flow under the bridge results from a pile up of water on the upstream bridge face, and a plunging of the flow downward and under the bridge. At higher approach flow depths, the bridge can be entirely submerged with the resulting flow being a complex combination of the plunging flow under the bridge (orifice flow) and flow over the bridge (weir flow). In many cases, when a bridge is submerged, flow will also overtop adjacent approach embankments.

When bridges are overtopped, flow hydraulics at the bridge are dramatically altered, and contraction and local scour can increase. The hydraulic bridge routines of either HEC-2 or HEC-RAS can be used to determine the roadway embankment overflow, the bridge weir flow, and the orifice flow, provided that the top of the highway is properly included in the input data. These models will also provide average flow depths and velocities for the embankment overflows, bridge weir flows, and pressure flows.

With pressure flow, the local scour depths at a pier or abutment are larger than for free surface flow with similar depths and approach velocities. The increase in local scour at a pier subjected to pressure flow results from the flow being directed downward towards the bed by the superstructure.

As shown on the HEC-RAS Cross Section 13.735 (see Appendix E.3), the 100-year water surface elevation exceeds the low chord elevation of all three bridge superstructures. Following the procedures outlined in HEC-18, scour calculations were performed (see Appendix F). Results are presented in Table 3.

Table 3: Pressure-Flow Scour			
	West Bridge	Central Bridge	East Bridge
Pressure-Flow Scour (ft)	7.5	8.5	8.0

4. Local Scour

Local scour involves removal of material from around piers, abutments, spurs, and embankments. The scour is induced as the flow is accelerated around the nose of the obstruction. Factors that affect the magnitude of local scour at piers and abutments are:

(1) width of the pier,
(2) discharge intercepted by the abutment and returned to the main channel,
(3) length of the pier if skewed to flow,
(4) depth of flow,
(5) velocity of the approach flow,
(6) size and gradation of bed material,
(7) angle of attack of the approach flow to a pier or abutment,
(8) shape of a pier or abutment,
(9) bed configuration,
(10) ice formation or jams, and
(11) debris.

Local scour holes at piers and abutments may overlap one another in some instances. If local scour holes do overlap, the scour is indeterminate and is deeper. The topwidth of a local scour hole ranges from 1.0 to 2.8 times the depth of scour. A topwidth value of 2.0 times the depth of scour is recommended for practical applications.

a. Abutment Scour

Abutment scour was calculated at each the three bridges according to the HEC-18 methodology. Calculations are included in Appendix F. Results are presented in Table 4.

Table 4: Abutment Scour

	West Bridge	Central Bridge	East Bridge
Abutment Scour (ft)	19	23	22

b. Pier Scour

Pier scour was calculated at each the three bridges according to the HEC-18 methodology. Calculations are included in Appendix F. Results are presented in Table 5.

Table 5: Pier Scour			
	West Bridge	Central Bridge	East Bridge
Pier Scour (ft)	9	8	8

5. Total Scour

Total scour at each pier is the sum of pier (local) scour, contraction scour, and pressure-flow scour. Similarly, total scour at each abutment pier is the sum of abutment (local) scour, contraction scour, and pressure-flow scour. Total scour at the piers for each bridge is summarized in Table 6. Total scour at the abutments for each bridge is summarized in Table 7.

Table 6: Total Scour at Piers			
	West Bridge	Central Bridge	East Bridge
Pier Scour (ft)	8.6	8.0	7.7
Contraction Scour (ft)	2.8	2.1	8.3
Pressure-Flow Scour (ft)	7.5	8.5	8.0
Total Scour (ft)	18.9	18.6	24.0

Table 7: Total Scour at Abutments			
	West Bridge	Central Bridge	East Bridge
Abutment Scour (ft)	19.0	23.0	22.0
Contraction Scour (ft)	2.8	2.1	8.3
Pressure-Flow Scour (ft)	7.5	8.5	8.0
Total Scour (ft)	29.3	33.6	38.3

The scour at each pier and abutment forms a predictable geometry that must be considered. The width of the scour hole, measured from the pier or abutment in one opposite direction, is equal to the depth of scour. At each location, the predicted scour hole at each pier and the predicted scour hole at each abutment are very large, and as a result, the scour holes overlap. According to guidelines in HEC-18, the total scour depths for this scenario become indeterminate, and a redesign to increase the spacing between piers and abutments is recommended.

However, using graphical plots of the scour holes and engineering judgment, scour depths can be increased to safely account for the overlapping scour holes. Recommended combined scour depths are summarized in Table 8.

Table 8: Potential Combined Scour at Piers and Abutments

	West Bridge	Central Bridge	East Bridge
Combined Scour (ft)	40	40	50

6. Roadway Scour

The proposed roadway will be elevated above the existing ground elevations across the width of the 100-year floodplain of Skunk Creek. During the 100-year flow event, most of the roadway will be submerged with flow depths of one to three feet. The roadway will act as a submerged weir section. Scour along the downstream edge of the proposed roadway embankment can be determined by using an equation for scour below channel drops (City of Tucson, 1988). Calculations, included in Appendix F, show scour depths of between two to five feet. To provide a safety factor and consider nonuniform flow, scour depths were recalculated after doubling the unit discharge. Eight feet was calculated as a more conservative estimate of scour depths along the downstream edge of the roadway embankment.

The proposed roadway embankment will be protected by soil cement slope protection on both the upstream and downstream slopes. Based on the scour calculations, eight feet is the recommended toe-down along downstream edge of the proposed roadway embankment. To account for localized erosion along the upstream edge, it is recommended that a toe-down of four feet be used along the upstream edge. Toe-downs should be measured from the existing ground elevation adjacent to the toe of the roadway embankment.

B. Engineering-Geomorphic Assessment

1. Data Review and Site Evaluation

The engineering and geomorphic analyses that were completed for the Skunk Creek Watercourse Master Plan (SCWMP) were reviewed as part of a site-specific evaluation of the reach of the river where the North Gateway Access Road is proposed to be located. The purpose of the review and evaluation was to (1) determine the stability of the river, both longitudinally and laterally; (2) evaluate the effectiveness of the proposed bridges and access road; and (3) identify potential long-term problems with the proposed bridges and access road. Included in this report as Appendix A.2 are the referenced materials from the SCWMP.

As part of the SCWMP, detailed reach-by-reach engineering and geomorphic analyses were performed along Skunk Creek. These analyses included qualitative and semi-qualitative geomorphic assessments, hydraulic modeling, floodplain mapping, sediment transport modeling, and river stability assessments. Using the information in the SCWMP as the primary source of data, a more site-specific evaluation was performed for the portion of Skunk Creek where the access road is proposed. This site-specific engineering and geomorphic analyses included both historical conditions and current conditions along the project reach. The project reach, as defined in the Scope of Work, extends from approximately one-half mile upstream to one-half mile downstream of the proposed access road.

The project reach generally corresponds to the limits of the "braided reach" as defined in the SCWMP. *The project reach is one of the most dynamic, unstable reaches of the entire Skunk Creek system.* Channel characteristics can be characterized as follows:

(1) Using two independent qualitative geomorphic channel classification systems, Skunk Creek (1) "exhibits many characteristics that indicate potential for frequent bank erosion and rapid lateral channel movement," and (2) "is characterized by high bank erosion rates, excessive deposition, and annual shifts of the bed locations." This general classification applies more specifically to the project reach as well.

(2) The project reach was classified as "braided." A braided stream is characterized as "one flowing in several dividing and reuniting channels resembling the strands of a braid, the cause of division being the obstruction by sediment deposited by the stream" (Dictionary of Geological Terms, 1976). Obviously, braided streams tend to be laterally unstable.

(3) The position of the channel thalweg, or the deepest point within the channel, was plotted for the years between 1953 and 1999 (SCWMP, Figure 3-1, Appendix A.2). The project reach appears to be the most active reach of Skunk Creek. According to the SCWMP, the thalweg location and channel width varied over 400 feet between the years 1962 and 1971. Further review of Figure 3-1 indicates that the location of the thalweg has varied over a 700 to 900-foot-wide band.

(4) Plots of longitudinal profiles for the years between 1962 and 1999 are inconclusive, given uncertainties in mapping scale and accuracy. The profiles generally indicate channel bed movement of plus or minus 2 feet within the project reach.

(5) Channel width measurements (SCWMP, Table 3.4, Appendix A.2) indicate that the channel has widened from 231 to 414 feet in the vicinity of the proposed access road. These widenings were believed to be the result of channel avulsion, where the existing

low-flow channel becomes overloaded with sediment and erodes a new low-flow channel at a different location.

(6) Figure 4-84 of the SCWMP (Appendix A.2) shows the existing longitudinal profile of the Skunk Creek. The profile is "concave up," where the slope is constantly decreasing in a downstream direction. In general, the decrease in slope decreases the sediment transport capacity of the creek, thus promoting sediment deposition.

(7) The project reach of Skunk Creek is classified as a "braided" channel pattern according to equilibrium slope criteria (SCWMP, Table 4-9, Appendix A.2).

(8) The overshoot for Skunk Creek at the Central Arizona Project (CAP) canal represents a fixed point in the system. According to the SCWMP, the overshoot is undersized and creates backwater conditions upstream of the overshoot. Consequently, velocities will decrease upstream of the CAP canal and will promote additional aggradation within Skunk Creek. The proposed access road is approximately 3400 feet upstream of the CAP canal.

(9) The SCWMP noted that overall there has been a lack of substantial channel movement along Skunk Creek due to the lack of large flows in the last several decades. For the project reach, the maximum channel changes were observed during the period of 1962 to 1971. During that period, there was a 10-year flow event (1967), a 15-year flow event (1970), and a 25-year flow event (1964). More substantial channel movement may occur for larger flow events.

2. Implications for Proposed Road and Bridge

The three proposed bridge crossings of Skunk Creek are located at the current locations of three low-flow channels. The proposed access road will be elevated above ground elevation in the overbank areas of the 100-year floodplain, such that smaller flows will be diverted by the road to the bridge openings, and large flow events will overtop and flow across portions of the road surface. Hydraulic design criteria for the proposed access road and bridge crossings are based on the existing channel morphology, as defined by slope, cross-sectional shape, and channel alignment.

Given the highly unstable nature of Skunk Creek along the project reach, it is very likely that the three existing low-flow channels will change their cross-sectional shape and migrate from their current alignment. Dramatic channel movement, through lateral migration, bank erosion, or channel avulsion, may occur over time as the channel shifts laterally in response to a wide range of flow events. Lateral movement may occur at locations both upstream and downstream of the proposed access road, may increase the scour potential along the access road and at the bridges, and may reduce the hydraulic efficiency of the bridge openings.

In addition, the proposed roadway will act as a fixed point along Skunk Creek that will cause backwater and sedimentation on the upstream side of the roadway. Any flows that exceed that capacity of the low-flow channels will pond along the elevated roadway in the overbank floodplain area, depositing sediment in the process. Over time, sedimentation may quickly reach the top of portions of the upstream edge of elevated roadway. Once sedimentation reaches the upstream edge of the roadway, any flow in the overbank areas will either flow directly over the roadway, or will carve new channels toward the low-flow bridges.

The proposed access road and bridges will not stabilize the potential lateral movement of Skunk Creek. During very large flow events, the potential exists for Skunk Creek to deposit large amounts of sediment along both the roadway and within the bridge openings. With the recommended toe-downs, the roadway and bridges will be stable from any erosion or sedimentation associated with the 100-year flood. However, the existing low-flow channels and corresponding bridge openings might completely fill with sediment, while the elevated portion of the roadway acts as a dam and causes sediment deposition to occur along the roadway. Under this scenario, the low-flow portion of the channel could completely shift to the eastern portion of the floodplain and create a new at-grade river crossing over the proposed access road. Channel avulsion such as this has historically occurred along the project reach and may occur in the future.

To help stabilize channel movement in the vicinity of the proposed roadway, and to minimize scour and help direct low flows to the proposed bridge openings, spur dikes were proposed. However, spur dikes were found to be unacceptable due to right-of-way and environmental concerns. Consequently, channel avulsion and lateral migration may impact the hydraulic efficiency and structural stability of the proposed roadway and bridges.

Given these uncertainties relating to the potential lateral channel movement along this reach of Skunk Creek, bridge and roadway design parameters have been developed to maximize the long-term structural stability and the hydraulic efficiency of the proposed structures. In addition to the proposed design parameters, periodic maintenance and visual inspection of the roadway, bridges, and associated soil cement slope protection are recommended.

C. Design Parameters

A memorandum, summarizing hydraulic and scour design parameters, was prepared for use by Damon S. Williams and Aztec Engineering to facilitate the preparation of the roadway and bridge plans. The memorandum is provided in Appendix E.1. Additional narrative discussions are provided in the following sections.

1. Proposed Bridge

As shown in Table 8, 40 feet is potential scour depth at the west bridge and the central bridge, with 50 feet the potential scour depth at the east bridge. Accordingly, these potential scour depths are the toe-down depths for the piers and abutments at each bridge.

Soil cement slope protection is proposed around the bridge abutments. The proposed abutment slope protection will be constructed with an eight-foot toe-down below the channel bed, then continue around the abutment on both the upstream and downstream side of each bridge. Along the downstream side of the abutment, the eight-foot toe-down will tie into the proposed eight-foot toe-down along the roadway embankment. Along the upstream side of the abutment, the eight-foot toe-down will transition to tie into the proposed four-foot toe-down along the roadway embankment. The transition from eight feet to four feet should occur at a 4H:1V rate.

Since potential scour depths at each bridge are either 40 or 50 feet, riprap blankets are proposed along the channel bed at each bridge to protect the abutment slope protection. The riprap blankets are designed to be twice the thickness of a calculated d_{50} rock diameter, with an underlying filter fabric. A schematic of the proposed riprap blanket is provided in Appendix F. The d_{50} calculations are also included in Appendix F.

2. Proposed Roadway Embankment

The proposed roadway embankment will be protected by soil cement slope protection on both the upstream and downstream slopes. Based on the scour calculations, eight feet is the recommended toe-down along downstream edge of the proposed roadway embankment, and four feet is the recommended toe-down along the upstream edge. The toe-downs should be measured from the existing ground elevation adjacent to the toe of the roadway embankment.

Because portions of the proposed roadway embankment will be inundated by the larger, more infrequent flow events, maintenance of the roadway surface will be important. Maintenance of the roadway surface following flow events will serve to remove any sediment and debris that are deposited from floodwaters. In addition, periodic inspections of the roadway surface and soil cement side slopes are recommended to check for any damage that may need to be repaired.

VII. DRAFT FIS REPORT DATA

A. Summary of Discharges (7.1)

The FEMA discharge of 26,700 cfs (FEMA, 2001) was used for modeling of the 100-year floodplain and floodway for (1) revised existing conditions and (2) new bridge conditions. The only exception was at the initial cross section of 13.28, where the FEMA discharge of 15,700 cfs was used. This was the downstream "match" section, and 15,700 cfs was used in the existing FEMA HEC-2 model.

B. Floodway Data (7.2)

Floodway data are presented in Appendix E.2, as part of the 100-year floodplain model. Increases in water surface elevations due to the floodway encroachment are consistent with the existing FEMA model, with all increases less than one foot. A complete Revised FEMA Floodway Table is provided on the following page. A Floodway Table, showing only the revised data, follows below. A photocopy of the original is also provided.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (feet NGVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (ft)	SECTION AREA (sq. ft.)	MEAN VELOCITY (ft/s)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AV (13.4)	13.38	932	3855	6.9	1537.9	1537.9	1538.8	0.9
AW (13.86)	13.84	1524	2981	9	1555.3	1555.3	1555.5	0.2
AX (14.3)	14.28	950	3049	8.8	1574.1	1574.1	1575	0.9

[1]Miles above confluence with New River

FEDERAL EMERGENCY MANAGEMENT AGENCY	REVISED FLOODWAY DATA
MARICOPA COUNTY, AZ AND INCORPORATED AREAS	SKUNK CREEK

C. Annotated Flood Insurance Rate Maps (7.3)

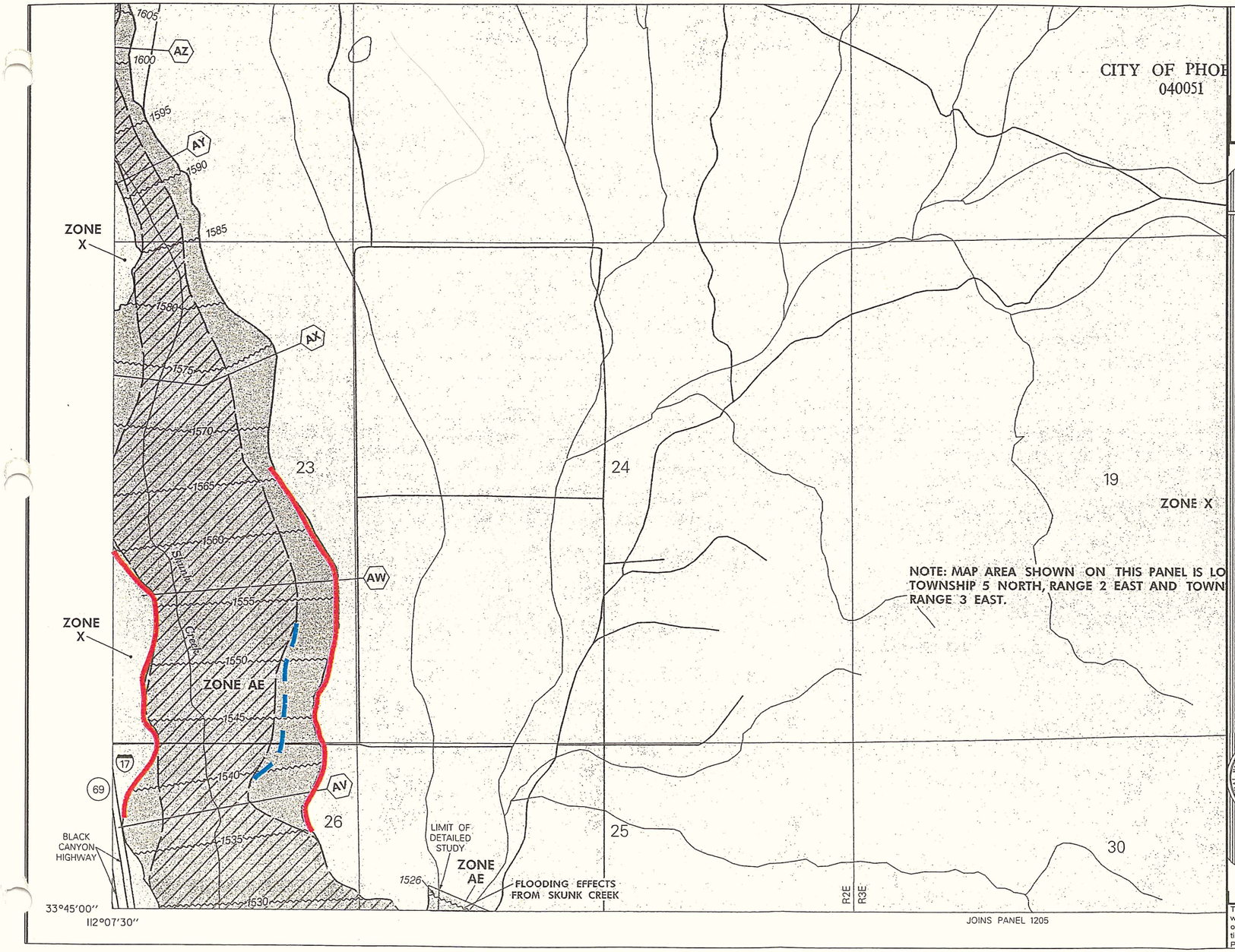
Flood Insurance Rate Maps, Panels 0770E and 0790F, have been annotated with the proposed 100-year floodplain. These two panels are included on the following pages. The annotated Work Study map is included as well.

D. Flood Profiles (7.4)

A revised Flood Profile is included.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCRE
					FEET (NGVD)			
Skunk Creek (cont'd)			*(REVISED)*	*(REVISED)*	*(REVISED)*	*(REVISED)*	*(REVISED)*	*(REVISED)*
AV	13.38	932	3659 *(3855)*	6.4 *(6.9)*	1537.7 *(1537.9)*	1537.7 *(1537.9)*	1538.5 *(1538.8)*	0.8 *(0.9)*
AW	13.84	1,524	3993 *(2981)*	5.8 *(9.0)*	1555.7 *(1555.3)*	1555.7 *(1555.3)*	1556.3 *(1555.5)*	0.6 *(0.2)*
AX	14.28	950	2810 *(3049)*	8.3 *(8.8)*	1574 *(1574.1)*	1574 *(1574.1)*	1574.8 *(1575.0)*	0.8 *(0.9)*
AY	14.72	356	2,081	11.2	1,591.1	1,591.1	1,591.2	0.1
AZ	15.04	418	2,352	9.9	1,602.4	1,602.4	1,602.5	0.1
BA	15.39	374	2,264	10.3	1,616.9	1,616.9	1,617.0	0.1
BB	15.73	639	3,750	6.2	1,630.0	1,630.0	1,631.0	1.0
BC	16.05	300	2,140	10.9	1,643.8	1,643.8	1,644.8	1.0
BD	16.25	282	1,666	14.0	1,651.8	1,651.8	1,652.3	0.5
BE	16.66	650	2,992	7.8	1,668.2	1,668.2	1,668.4	0.2
BF	16.94	641	2,211	12.3	1,684.2	1,684.2	1,684.5	0.3
BG	17.16	953	2,912	9.4	1,694.4	1,694.4	1,694.9	0.5
BH	17.37	765	3,086	8.8	1,704.7	1,704.7	1,705.5	0.8
BI	17.63	757	3,353	8.1	1,717.2	1,717.2	1,717.7	0.5
BJ	17.93	750	3,439	7.9	1,729.8	1,729.8	1,730.3	0.5
BK	18.21	700	2,938	9.4	1,741.7	1,741.7	1,741.7	0.0
BL	18.47	643	2,780	10.0	1,750.9	1,750.9	1,751.0	0.1
BM	18.72	745	2,612	10.5	1,760.6	1,760.6	1,760.7	0.1
BN	18.93	841	3,403	8.0	1,771.3	1,771.3	1,771.8	0.5
BO	19.24	635	2,449	11.1	1,784.8	1,784.8	1,784.8	0.0
BP	19.60	746	3,467	7.9	1,800.8	1,800.8	1,800.8	0.0
BQ	19.90	683	3,193	8.5	1,814.8	1,814.8	1,815.0	0.2
BR	20.23	1,205	4,249	6.4	1,831.3	1,831.3	1,831.4	0.1
BS	20.60	885	3,712	7.4	1,848.8	1,848.8	1,849.5	0.7
BT	20.97	670	3,437	7.9	1,866.2	1,866.2	1,866.9	0.7
BU	21.24	745	3,219	8.5	1,880.9	1,880.9	1,881.0	0.1

[1]Miles Above Confluence with New River



FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

REVISED*
FIRM
FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 790 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY, UNINCORPORATED AREAS	040037	0790	F
PHOENIX, CITY OF	040051	0790	F

REVISED FLOODPLAIN

REVISED FLOODWAY

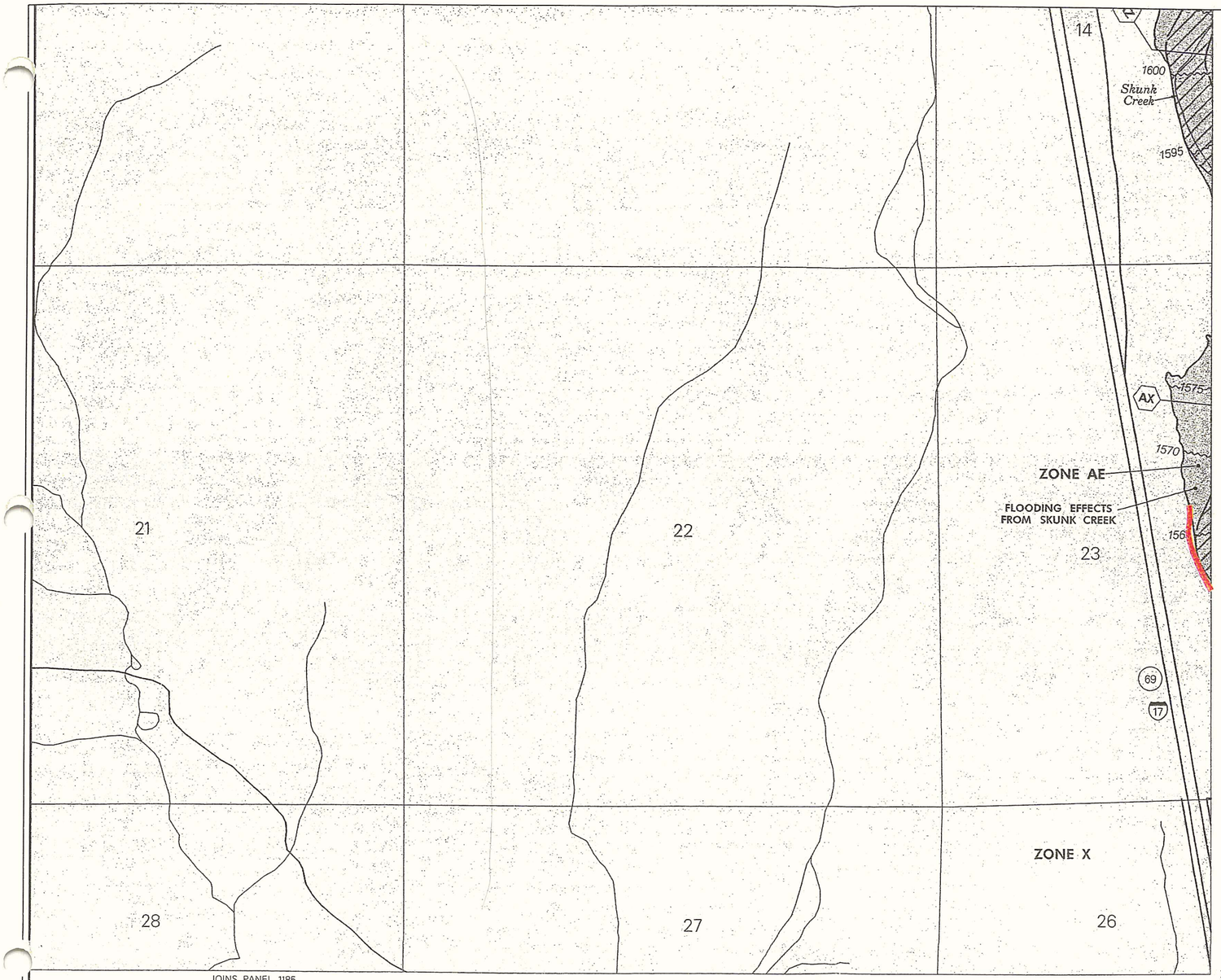
MAP NUMBER
04013C0790 F

MAP REVISED:
JULY 19, 2001

*REVISIONS PER TETREA TECH, INC. 9/29/03

Federal Emergency Management Agency

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



FEET

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NATIONAL FLOOD INSURANCE PROGRAM

REVISED*
FIRM
FLOOD INSURANCE RATE MAP

MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 770 OF 4350

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY, UNINCORPORATED AREAS	040037	0770	E
PHOENIX, CITY OF	040051	0770	E

REVISED FLOODPLAIN

REVISED FLOODWAY

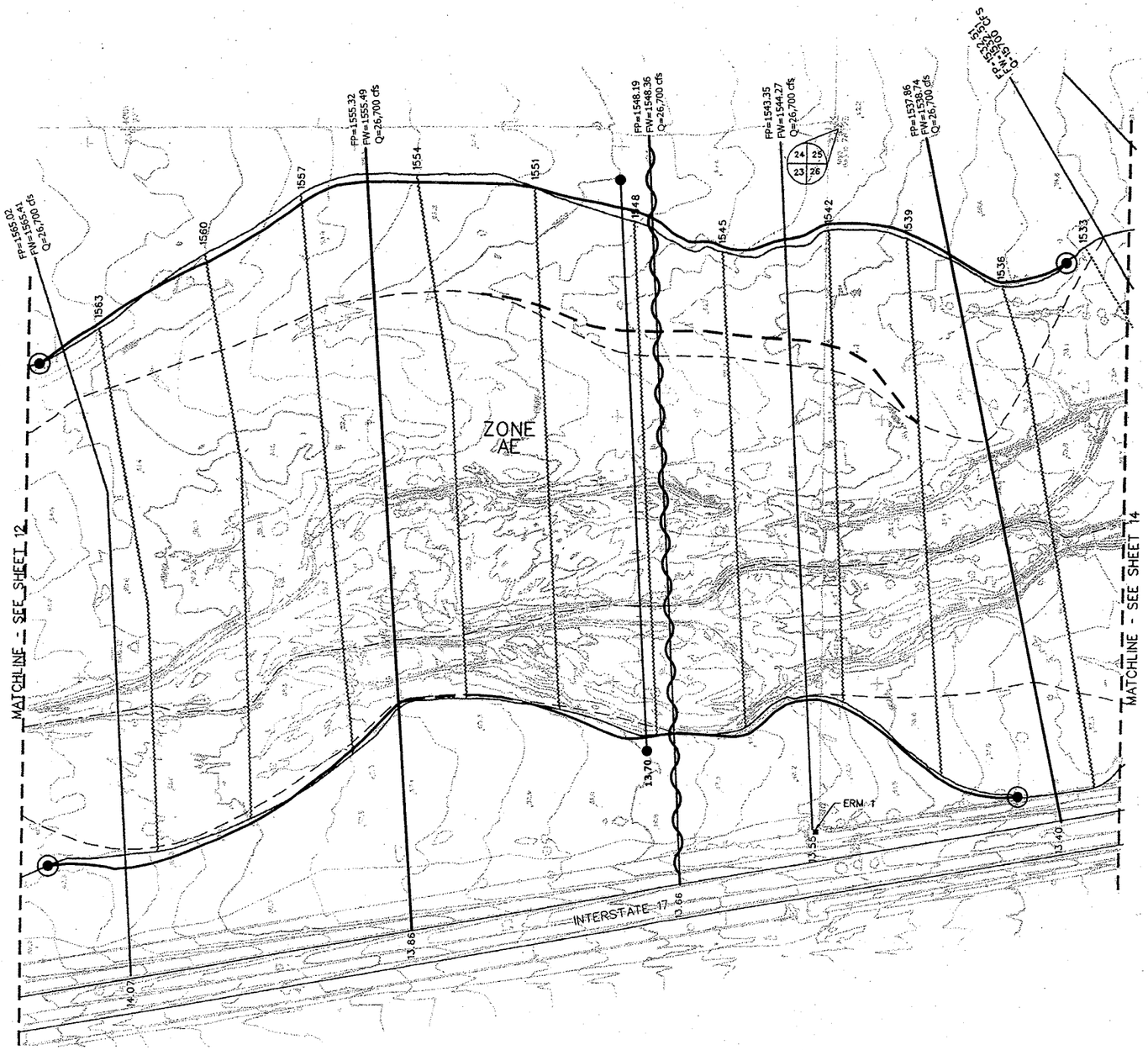
MAP NUMBER
04013C0770 E

MAP REVISED:
JULY 19, 2001

*REVISIONS PER TETREA TECH, INC. 9/29/03

Federal Emergency Management Agency

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



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SKUNK CREEK

F.C.D. CONTRACT NO. 95-16

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
REVISED FLOODPLAIN*	
REVISED FLOODWAY*	
NEW SECTION*	
DELETED*	
CROSS SECTION	25.45 FP-100 Yr WSEL / FW-Floodway WSEL / Q - 100 Year Flow
ELEVATION REFERENCE MARK	ERM3
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary

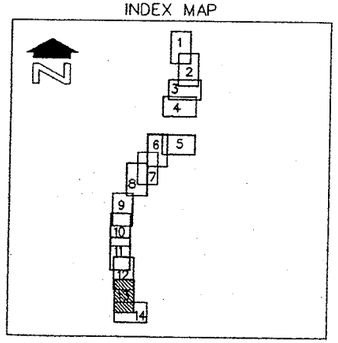
ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
ERM*1	1544.06	3" ALUMINUM CAP ARIZONA HIGHWAY DEPARTMENT, SET IN CONC., NORTH BOUND FRONTAGE ROAD, HWY 17 STA. P.O.S.L. 1061+43.6, 0.3'± ABOVE NORMAL GROUND, EAST OF FRONTAGE ROAD.

*REVISIONS PER TETRA TECH, INC. 9/29/03

INDEX MAP



N

200' 0' 200' 400'

SCALE: 1" = 200'

CONTOUR INTERVAL - 2 FEET

MONTGOMERY WATSON
Phoenix, Arizona

	BY	DATE
DESIGN	CCB	7/97
DESIGN CHK.	FKD	7/97
PLANS	CCB	7/97
PLANS CHK.	FKD	7/97
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

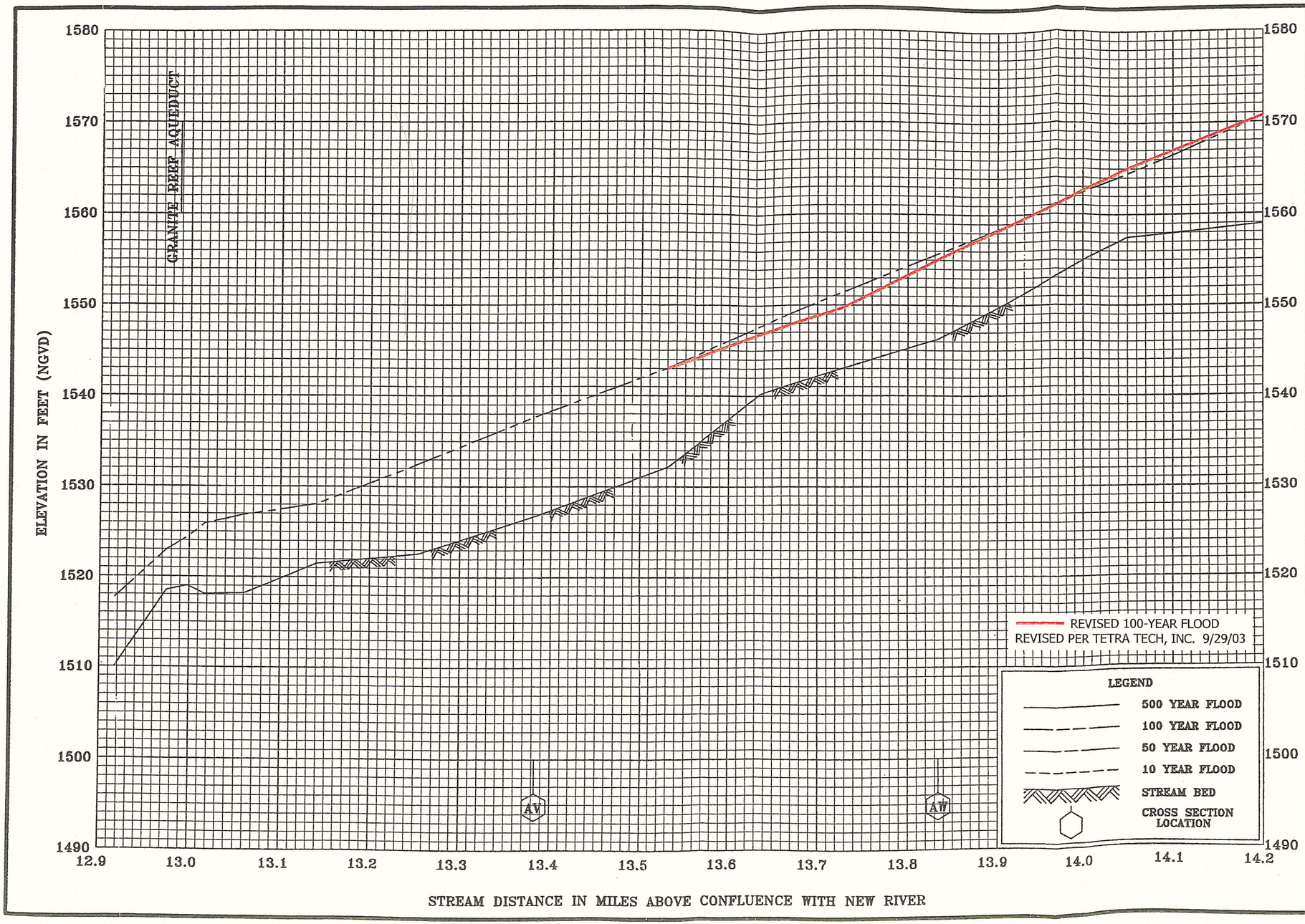
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 13 OF 14

REVISED 5/98 PER FCDMC

KENNEY AERIAL MAPPING COMPANY, INC
PHOTOGRAMMETRY
DECEMBER 1995 AND MAY 1996

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS 1" = 200' HORIZONTAL SCALE AND 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY KENNEY AERIAL MAPPING COMPANY, INC.



FLOOD PROFILES

SKUNK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ

AND INCORPORATED AREAS

315P

Appendix A:

References

Appendix A.1:

Referenced Documents

Referenced Documents

"Access Road Bridges Report, North Gateway Water Reclamation Plant, Phoenix Arizona," AMEC Earth and Environmental, Inc., June 2002.

"City of Tucson Standards Manual for Drainage Design and Floodplain Management," Simons, Li and Associates, Inc., 1988.

"Evaluating Scour at Bridges, HEC-18," Federal Highway Administration, November 1995.

"Flood Insurance Study for Maricopa County, Arizona," Federal Emergency Management Agency, July 2001.

"North Gateway Water Reclamation Plant, Access Road Engineering Plans (100% Preliminary)," Aztec Engineering, March 2003.

"Skunk Creek Watercourse Master Plan," Tetra Tech, Inc., June 2001.

"Skunk Creek Watercourse Master Plan, Attachment 5: Lateral Stability Assessment," JE Fuller, Inc., June 2001.

"Skunk Creek Watercourse Master Plan, Attachment 6: Erosion and Sedimentation Report," Stantech, Inc., June 2001.

Appendix A.2:

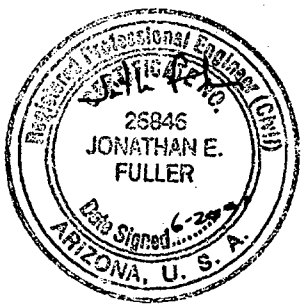
Skunk Creek Watercourse Master Plan Data

Skunk Creek/Sonoran Wash Watercourse Master Plan Report

Attachment 6: Lateral Stability Assessment

June 2001

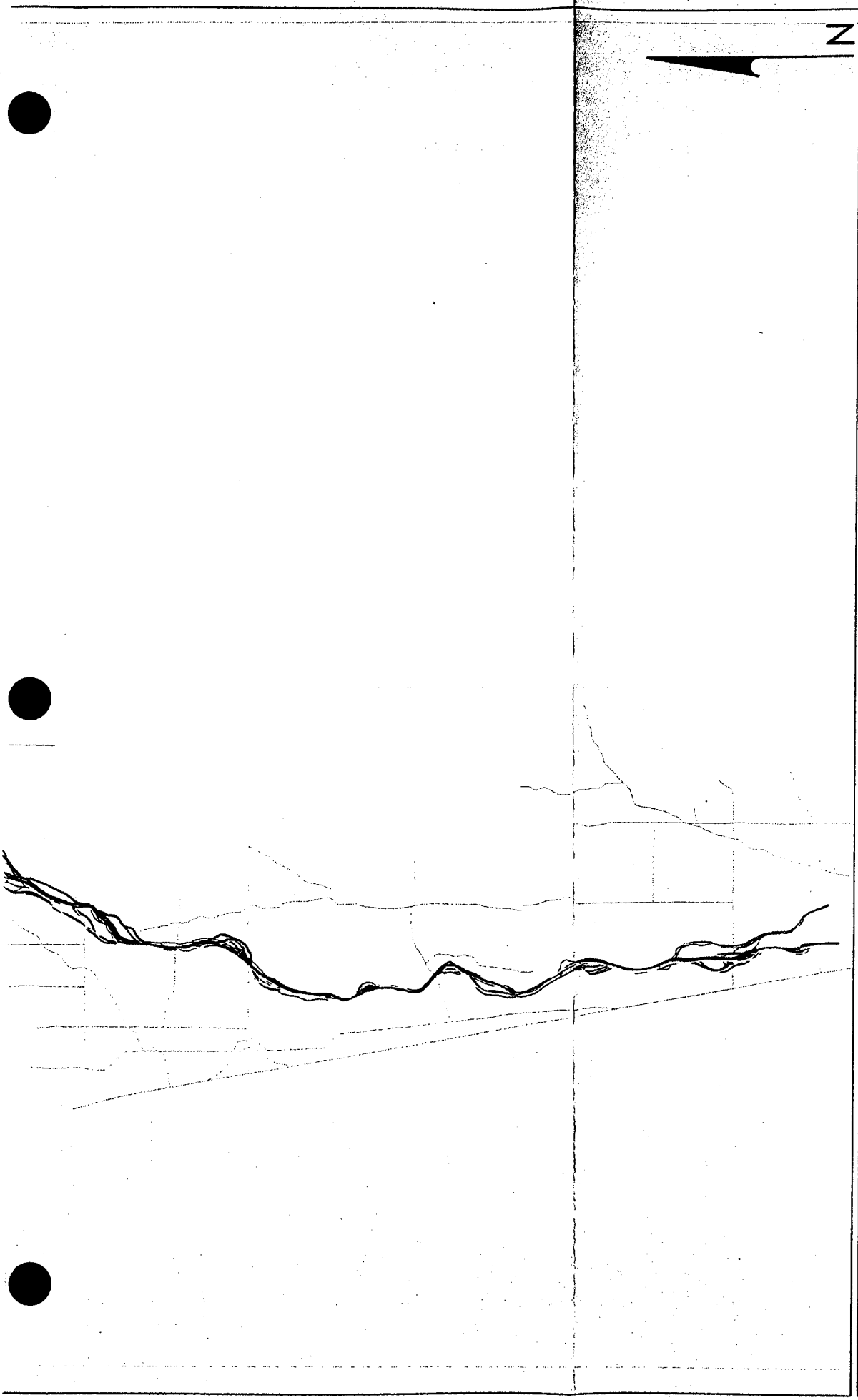
Final Report



Prepared for: **Flood Control District of Maricopa County & Tetra Tech, Inc.**

Prepared by: **JE Fuller/ Hydrology & Geomorphology, Inc. Tempe, AZ**

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.



Skunk Creek WCMF

Figure 3-1
Historical Channel Position

Thalweg	Year
	1953
	1962
	1964
	1971
	1988
	1992
	1995
	1999

ROADS

DRAWING SCALE
1 INCH = 4500 FEE

JE FULLER
HYDROLOGY & GEOMORPHOLOGY

Sheet 1 of

measured channel change between years of coverage may be used as the upper limit of possible single event change during that period, as shown in Table 3-4. Comparison between multiple years of aerial photograph coverage (long-term changes) are discussed in more detail in the next section of this chapter.

Table 3-4. Skunk Creek Watercourse Master Plan
Maximum Channel Width Change & Thalweg Movement – Skunk Creek & Sonoran Wash

Stream Name	Maximum[3] Width Change (ft.)	Average[1] Width Change	Time Period (Dates of Coverage)	Large Floods During Period		
				Date(s)	Peak Discharge	Recurrence Interval
Skunk Creek	414 [4]	30	1962-1971	1964 1967 1970	11,500 cfs 5,900 cfs 9,650 cfs	25 yr < 10 yr 15 yr
Sonoran Wash	32	3	1971-1988	No records available for Sonoran No floods > 10-year on Skunk Ck.[2]		
Stream Name	**Maximum Thalweg Change (ft.)**		**Time Period (Dates of Coverage)**	**Large Floods During Period**		
				Date(s)	**Peak Discharge**	**Recurrence Interval**
Skunk Creek	414 [4]		1962-1971	1964 1967 1970	11,500 cfs 5,900 cfs 9,650 cfs	25 yr < 10 yr 15 yr
Sonoran Wash	Measured thalweg movement within error of measurement.					

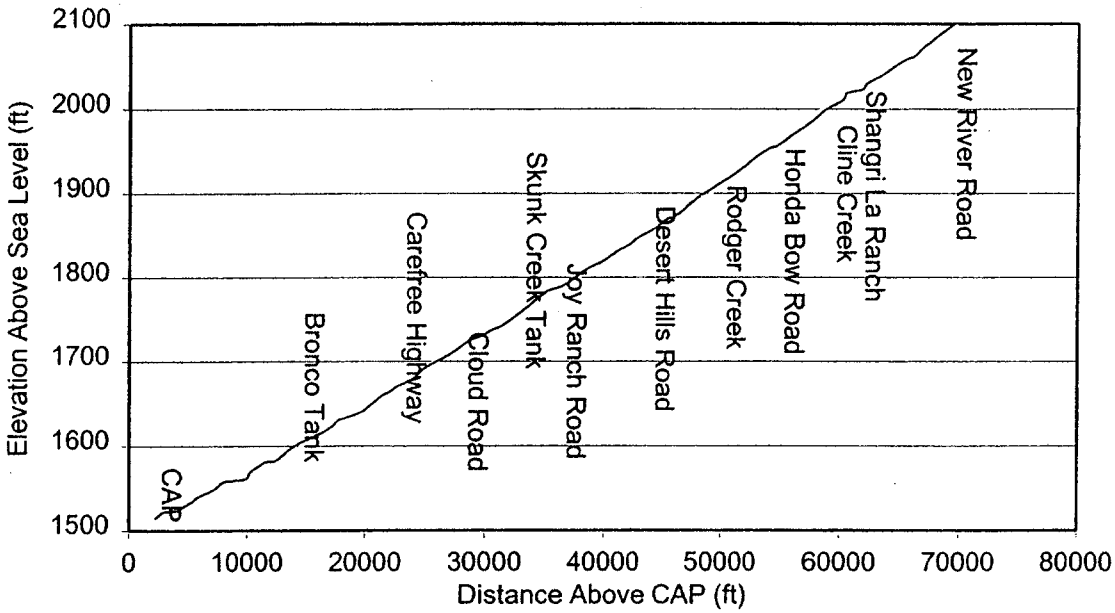
Notes:
1. Average width change during period of maximum width change.
2. Flood record available only for Skunk Creek. No gauge existed on Sonoran Wash.
3. Width measured from furthest left bank to furthest right bank, includes widest braids.
4. 414 ft. estimate width change for Skunk Creek represents probable avulsion.

The August 1964 flood was the largest event during the 40-year period of record, and occurred during the period of greatest measured channel movement on Skunk Creek. The 1964 flood had a recurrence interval equal to about a 25-year flood (4%). In addition, the floods of September 1970 (15-year; 2nd largest in record) and December 1967 (10-year, 7th largest in record) also occurred during the 1962 to 1971 period bracketed by dates of aerial coverage. The October 1959 event, the third largest flood during the period of record, occurred just prior to the period of coverage. During the 1962 to 1971 period, the maximum change in total width as expressed by the distance between the furthest left and furthest right banks or braids was 414 feet on Skunk Creek. This width change was due to development of an avulsion channel in what was an overbank floodplain prior to 1962. Therefore, the upper limit of single event erosion on Skunk Creek was taken to be about 400 feet.

Given that the largest measured width change on Sonoran Wash occurred between 1971 and 1988, it may be assumed that the flood peaks and lateral channel movement are not typically coincident on Skunk Creek and Sonoran Wash. During this period, the maximum measured change in width was 32 feet, which is therefore the assumed upper limit of measured single event channel change. Field evidence suggests that larger avulsive channel changes have occurred in the recent past, but that those larger changes probably occurred prior to the period of coverage by historical aerial photographs.

Table 4-4. Skunk Creek Watercourse Master Plan Topographic Data Used for Skunk Creek Longitudinal Profile Analysis					
Date	**Scale**	**Contour Interval**	**Stream Name**	**Extent**	**Source**
1995	1:2,400	2 ft.	Skunk Creek	CAP to Desert Hills Rd. Honda Bow Rd. to New River Rd.	FCDMC
1996	1:1,200	1 ft.	Skunk Creek	Desert Hills Rd. to Honda Bow Rd.	Erie
1999	1:2,400	2 ft.	Sonoran Wash	CAP to study limit	Tetra Tech

Figure 4-84. Longitudinal Profile of Skunk Creek



Skunk Creek. The following conclusions about lateral stability and erosion hazards can be drawn from the longitudinal profile of Skunk Creek, as shown in Figure 4-84:

- Profile Shape. The longitudinal profile of Skunk Creek has a concave up shape, which is typical of most alluvial streams.[2] The concave profile shape is due to the decrease in channel slope in the downstream direction. Channel slope ranges from 0.0093 ft./ft. from New River Road to Desert Hills Drive, to 0.0089 ft./ft. from Desert Hills Drive to the Carefree Highway, to 0.0075 ft./ft. from Carefree Highway to the CAP overchute. The profile shape indicates that downstream reaches of Skunk Creek will tend to transport less sediment than upstream reaches, and will consequently be subject to deposition of coarse grained sediments during floods.
- Profile Irregularities. The longitudinal profile of Skunk Creek downstream of the Carefree Highway and at the Cline Creek confluence has a jagged, irregular shape which is in contrast to the relatively smooth profile elsewhere within the study reach. A stream which has achieved some level of equilibrium will have a smooth longitudinal profile that indicates water and sediment continuity between cross

[2] Some aggrading streams and channels on some alluvial fans have concave down profiles.

pattern was better adjusted to a less frequent flow event. Tables 4-9 and 4-10 compare the predicted channel pattern (braided, intermediate, meandering, single channel, etc.) with the channel pattern observed in the field and on aerial photographs. The predicted channel pattern was indicated by applying the equations described in the previous paragraphs.

Skunk Creek. As shown in Table 4-9, the channel pattern equations generally predict a straight braided channel pattern for Skunk Creek, with a slight trend toward a less braided pattern with increasing discharge. The coarse bed material in Skunk Creek may inhibit the expression of classic braided channel characteristics. The channel pattern predictions for Skunk Creek are shown graphically in Figures 4-96 to 4-99. Based on the data shown in Table 4-9, slightly less braiding should be expected along Skunk Creek in the future if peak discharges increase, and all other input parameters remain unchanged.

Table 4-9. Skunk Creek/Sonoran Wash Watercourse Master Plan
Predicted Channel Pattern Relationships for Skunk Creek

Name	Predicted Channel Pattern													
	SR		6		5		4		3		2		1	
	Q2	Q10	Q2	Q10	Q2	Q10	Q2	Q10	Q2	Q10	Q2	Q10	Q2	Q10
Lane	B_{67}	B_{67}	B_{56}	I_{75}	B_{59}	I_{41}	B_{55}	I_{62}	IB_{47}	I_{53}	I_{62}	I_{62}	I_{64}	I_{93}
Ackers & Charlton	S_{100}	S_{100}	S_{100}	S_{100}	S_{100}	S_{74}	S_{100}	S_{100}	S_{94}	S_{100}	S_{100}	S_{100}	S_{100}	S_{93}
Leopold & Wolman	B_{67}	B_{100}	B_{94}	B_{69}	B_{96}	B_{59}	B_{93}	B_{100}	B_{62}	B_{97}	B_{92}	B_{100}	B_{79}	B_{64}
Henderson	B_{100}	B_{100}	B_{100}	B_{100}	B_{100}	B_{81}	B_{100}	B_{100}	B_{94}	B_{100}	B_{100}	B_{100}	B_{100}	B_{100}
Observed Pattern	S		S		S						B		B	

Notes: S = Straight Channel I = Intermediate Form B = Braided M = Meandering

1. The subscript number after the pattern code (S, I, B, M) indicates the percent of sections predicted for the given pattern, e.g. B_{87} = 87% braided.
2. Channel patterns are not reported for the bridge reaches due to the historical and expected future disturbance.

Sonoran Wash. As shown in Table 4-10, the channel pattern equations generally predict an intermediate or inconsistent channel pattern for Sonoran Wash, with no clear trend with recurrence interval. This prediction generally conforms to field observations of a relatively narrow single channel that is weakly braided at flow expansions and where overflow channels form. Although field observations suggest that Sonoran Wash becomes more strongly braided in the CAP backwater area (Reach 1), the data in Table 4-10 indicate the long-term equilibrium channel pattern may be meandering for this reach because of the flatter slope. Slight changes in discharge and/or sediment supply could cause significant changes in channel pattern on Sonoran Wash.

- Reach 2. Net long-term degradation is predicted for reach 2. The average equilibrium slope computed using the 2-year discharge is approximately equal to the existing channel slope, a result which indicates overall stability.

- Reach 1. Aggradation during small floods and degradation during large floods is predicted by the equilibrium slope equations for Reach 1. Note that the equilibrium slope equations do not explicitly consider the effects of backwater at the CAP overchute, which is likely to induce deposition during the largest events.

Sonoran Wash. As shown in Table 5-13, the predicted equilibrium slope trends for Sonoran Wash are generally consistent throughout all six study reaches. A strong trend toward aggradation during small and moderate floods is predicted, with a slightly less strong trend toward aggradation during the largest floods. The equilibrium slope equations which assume no sediment inflow uniformly predict long-term degradation, underscoring the importance of watershed management in maintaining channel stability.

Summary. The scour and deposition caused by the channel's adjustment to its equilibrium slope will be limited to a reach length sufficient for the channel to regain a sediment transport balance. In general, long-term aggradation is predicted for the periods dominated by small floods, with long-term degradation more likely to occur during periods dominated by large floods. The greatest amount of expected slope adjustments will occur in the reaches disturbed by bridge construction. In the bridge reaches, the equilibrium slope equations predict long-term aggradation. The actual magnitude of the expected bed elevation changes will be based in part on the potential for armoring, sediment supply, and the magnitude and frequency of the flows experienced in the future.

Table 5-19. Skunk Creek Watercourse Master Plan Comparison of Armoring, Scour, and Equilibrium Slope Estimates – Skunk Creek								
1	2	3	4		5		6	7
Reach	Depth to Armor (ft)	Scour Depth (ft)	Stable Slope		Slope Adjustments		Armor v. Scour	Armor v. Slope
			Regime	Actual	1000 ft.	5000 ft.		
Q100								
SR	2.6	13.3	0.0097	0.0130	-3.3	-16.3	Yes	Yes
NR	1.6	11.7	0.0104	0.0062	4.2	20.8	Yes	N/A
6	5.8	12.1	0.0104	0.0093	1.1	5.6	Yes	N/A
5	15.0	13.7	0.0069	0.0097	-2.8	-13.8	No	No
4	12.7	12.7	0.0066	0.0085	-2.4	-12	No	No
3	7.9	2.3	0.0056	0.0082	-2.6	-12.9	No	No
CFR	26.3	2.9	0.0053	0.0054	-0.1	-0.6	No	No
2	37.1	2.5	0.0055	0.0080	-2.5	-12.6	No	No
1	18.6	13.4	0.0047	0.0057	-1	-4.8	No	No
Q10								
SR	3.0	11.8	0.0107	0.0130	-2.3	-11.3	Yes	Yes
NR	1.0	8.8	0.0105	0.0062	4.3	21.3	Yes	N/A
6	3.9	9.6	0.0106	0.0093	1.3	6.5	Yes	N/A
5	5.3	10.8	0.0067	0.0100	-3.3	-16.5	Yes	N/A
4	8.8	10.2	0.0067	0.0085	-1.8	-9.2	Yes	No
3	6.0	1.7	0.0058	0.0082	-2.4	-11.9	No	No
CFR	5.3	1.6	0.0059	0.0054	0.5	2.3	No	N/A
2	15.2	1.9	0.0056	0.0080	-2.3	-11.7	No	No
1	7.1	11.3	0.0048	0.0057	-0.9	-4.3	Yes	No
Q2								
SR	1.2	3.2	0.0172	0.0130	4.3	21.3	Yes	N/A
NR	0.3	4.4	0.0131	0.0062	6.9	34.7	Yes	N/A
6	0.7	3.2	0.0138	0.0093	4.5	22.4	Yes	N/A
5	1.2	4.0	0.0095	0.0100	-0.5	-2.6	Yes	Yes
4	1.0	3.0	0.0090	0.0085	0.5	2.6	Yes	N/A
3	0.6	0.4	0.0085	0.0082	0.4	1.8	No	N/A
CFR	0.4	0.3	0.0087	0.0054	3.3	16.6	No	N/A
2	0.7	0.5	0.0079	0.0080	0.0	-0.1	No	N/A
1	0.5	3.2	0.0078	0.0057	2.2	10.9	Yes	N/A

Notes:
1. No = scour not limited by armoring
2. Yes = scour limited by formation of armor layer
3. N/A = not applicable, aggradation is predicted (no long-term scour)
4. Armor v. Scour: compare column 3 to 1, i.e. will scour will be limited by armoring?
5. Armor v. Slope: compare column 5 to 1, i.e. will long-term scour be limited by armoring?

Sonoran Wash. As shown in Table 5-20, armoring would have no impact on long-term slope adjustments since aggradation (last column) is predicted for most of Sonoran Wash. In reach 2, where some long-term degradation is predicted for the 10- and 100-year events, armoring would not prevent the possible long-term bed elevation change. Short term scour will be prevented by armoring in reaches 2 to 6 during a 2-year event, in

Appendix B, C, and D not used

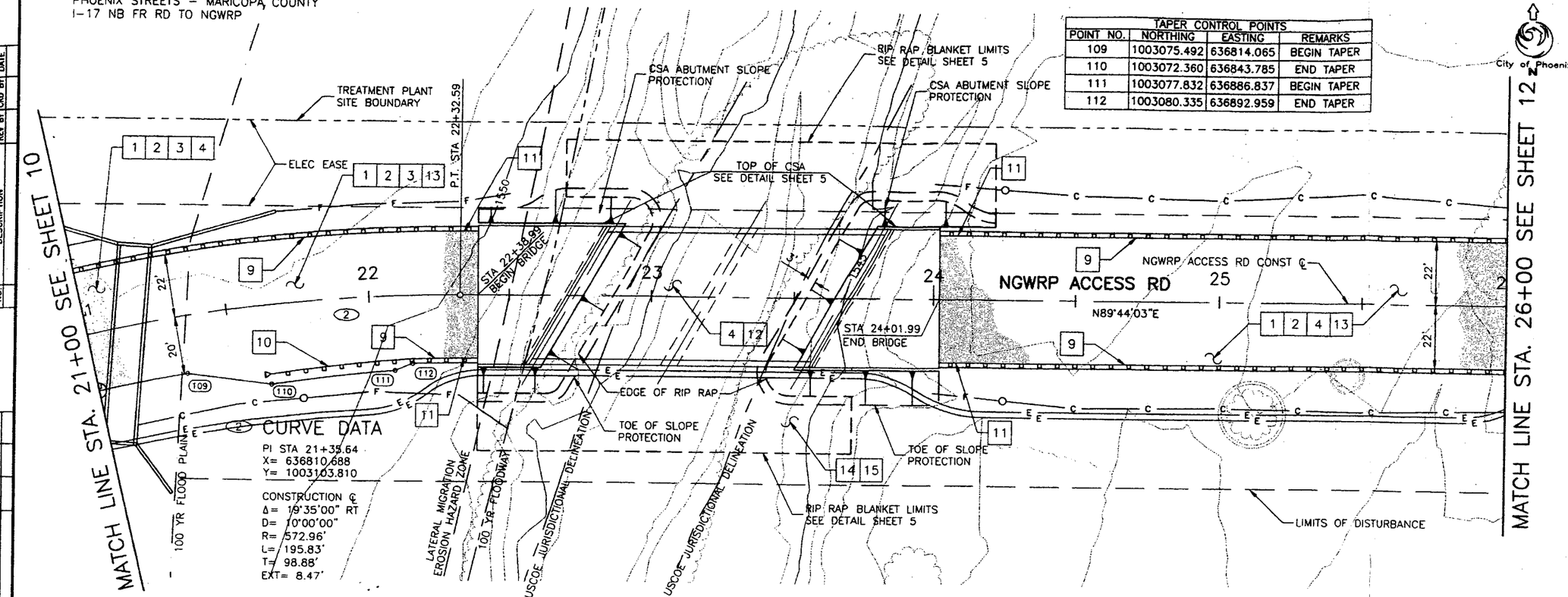
Appendix E:

Hydraulic Analysis Supporting Documentation

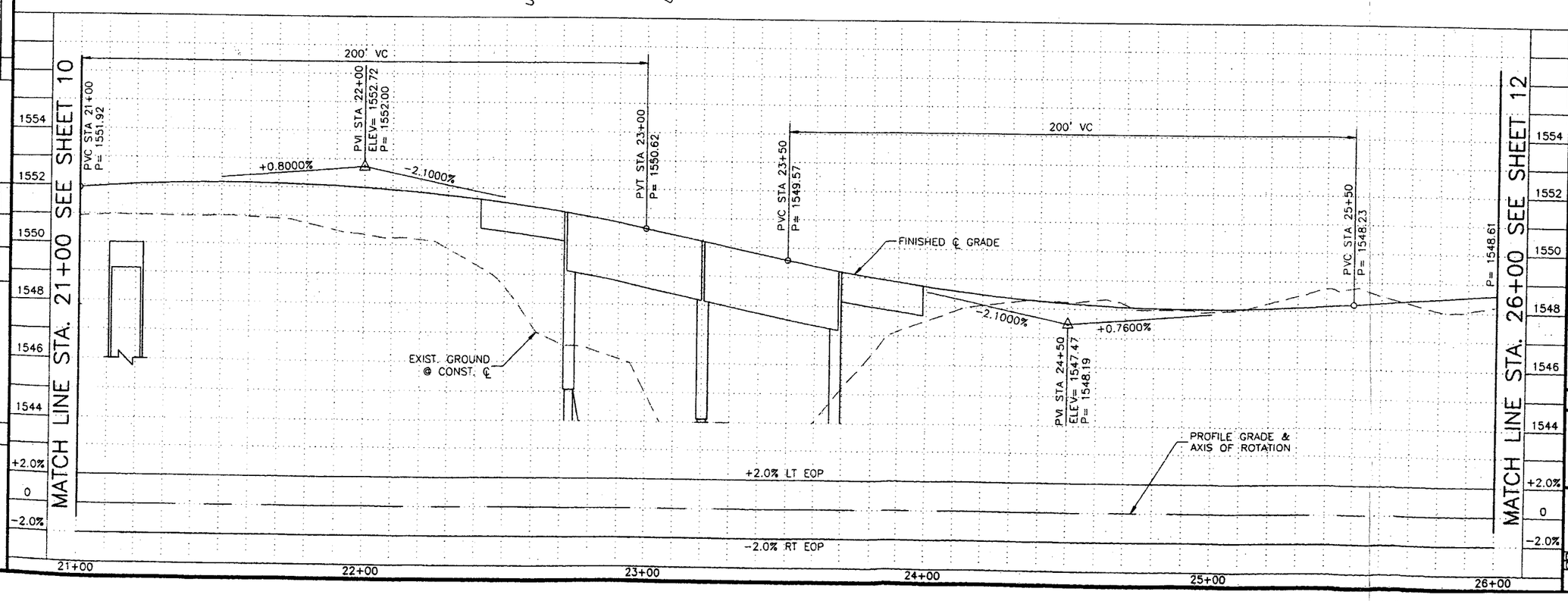
Appendix E.1:

Aztec Roadway Plans

NGWRP ACCESS ROAD
PHOENIX STREETS – MARICOPA COUNTY
I-17 NB FR RD TO NGWRP



TAPER CONTROL POINTS			
POINT NO.	NORTHING	EASTING	REMARKS
109	1003075.492	636814.065	BEGIN TAPER
110	1003072.360	636843.785	END TAPER
111	1003077.832	636886.837	BEGIN TAPER
112	1003080.335	636892.959	END TAPER



F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
9	ARIZ	WS90320006	11	82	

DSWA AZTEC
DR: ASR DES: CCW CK: MDS DATE: 4/03

CONSTRUCTION NOTES

NO	DESCRIPTION	UNIT	QTY
1	SUBGRADE PREPARATION	SY	1772
2	ASPHALT CONCRETE SURFACE COURSE, TYPE C 3/4, 5" THICK	TON	525
3	24" AGGREGATE BASE COURSE STA 21+00 TO 21+30	TON	250
4	EMULSIFIED ASPHALT FOR TACK COAT, TYPE SS-H	TON	1.8
9	GUARD RAIL, W-BEAM SINGLE FACE, TYPE "A" ADOT STD C-10.01 & C-10.20 STA 21+00 TO 22+30.7, 22' LT STA 22+15.1 TO 22+28.1, 22' RT STA 24+15.8 TO 26+00, 22' RT STA 24+18.1 TO 26+00, 22' LT	LF	514
10	GUARD RAIL END TREATMENT, ET-PLUS OR SKT-350 STA 21+63.2 24' RT TO 22+15.1 22' RT	EA	1
11	GUARD RAIL TRANSITION W-BEAM TO THRIE BEAM SEE DETAIL SHT 4 STA 22+30.7 TO 22+36.8, 22' LT STA 22+28.1 TO 22+34.6, 22' RT STA 24+09.6 TO 24+15.8, 22' RT STA 24+11.8 TO 24+18.1, 22' LT	EA	4
12	ASPHALT CONCRETE SURFACE COURSE, TYPE C 3/4, 3" THICK, (FOR BRIDGE & APPROACH SLAB)	TON	146
13	CEMENT STABILIZED ALLUVIUM STA 21+30 TO 22+39 STA 24+02 TO 26+00	CY	2574
14	RIP RAP	CY	745
15	GEOTEXTILE FILTER FABRIC	SY	1400

GENERAL NOTES

NOTES:

1. FOR PAVEMENT LAYOUT @ GUARD RAIL END SECTION – SEE SHEET 4.
2. FOR CSA ABUTMENT SLOPE PROTECTION AND RIPRAP BLANKET – SEE SHEET 5.
3. FOR BRIDGE – SEE SHEET 28–44.
4. FOR BOX CULVERT – SEE SHEETS 22–27.
5. FOR NATIVE PLANT SURVEY – SEE SHEETS 79–81.
6. FOR UTILITIES – SEE SHEET 82.

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1-800-STAKE-IT

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CITY OF PHOENIX, ARIZONA
WATER SERVICES DEPARTMENT
WS90320006
PUBLIC WORKS DEPARTMENT
PW16700002

NGWRP ACCESS ROAD
I-17 NB FR RD TO NGWRP
STA 21+00 TO 26+00

DR: ASR DATE: 4/03	DES: CCW DATE: 4/03	CK: MDS DATE: 4/03	SHEET NO.	TOTAL SHEETS	AS BUILT
SCALE: 1"=20' HORIZONTAL 1"=2' VERTICAL			11	82	—

REVISION BY CITY OF PHOENIX
NO. | DESCRIPTION | REV BY | CKD BY | DATE

Apr 22, 2003 - 12:44pm
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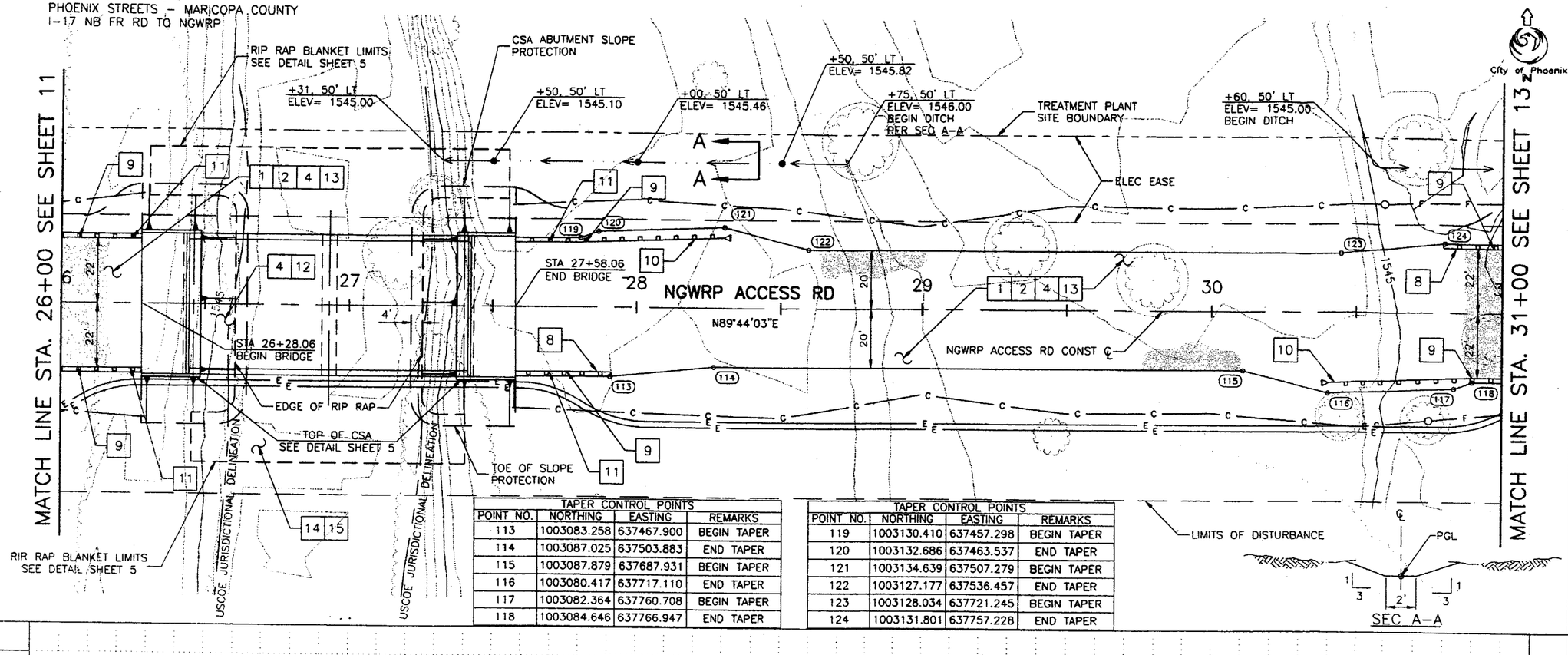
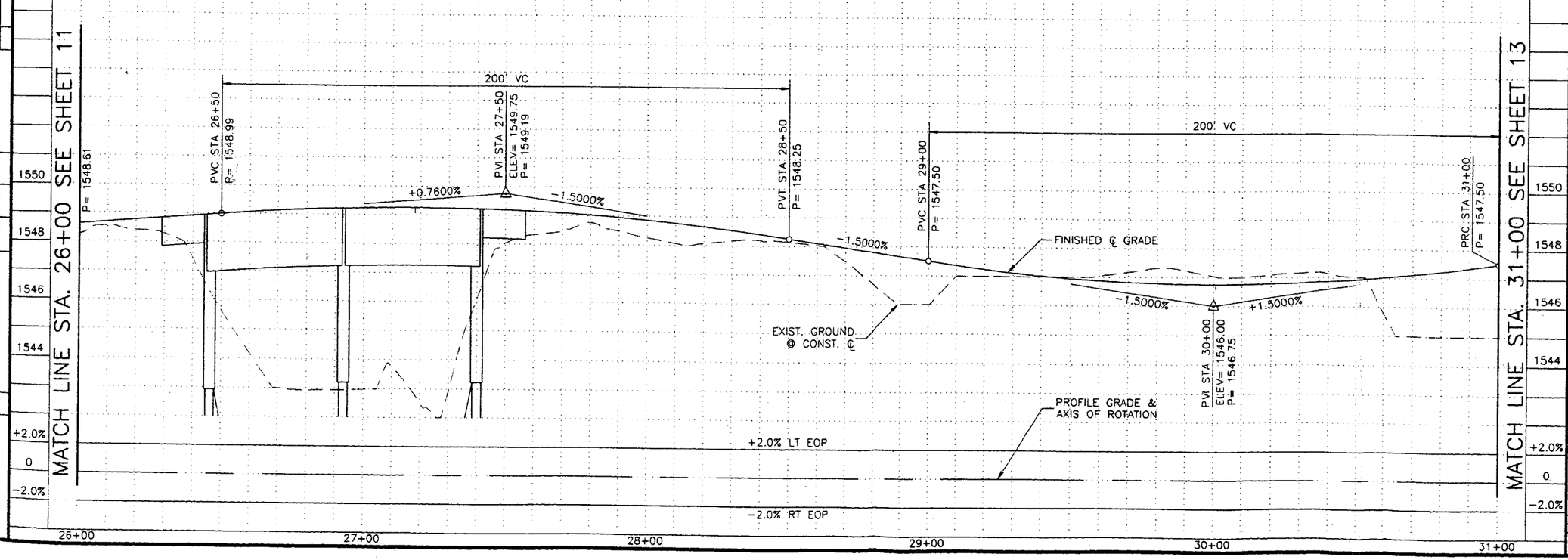
NGWRP ACCESS ROAD
PHOENIX STREETS – MARICOPA COUNTY
I-17 NB FR RD TO NGWRP



TAPER CONTROL POINTS			
POINT NO.	NORTHING	EASTING	REMARKS
113	1003083.258	637467.900	BEGIN TAPER
114	1003087.025	637503.883	END TAPER
115	1003087.879	637687.931	BEGIN TAPER
116	1003080.417	637717.110	END TAPER
117	1003082.364	637760.708	BEGIN TAPER
118	1003084.646	637766.947	END TAPER

TAPER CONTROL POINTS			
POINT NO.	NORTHING	EASTING	REMARKS
119	1003130.410	637457.298	BEGIN TAPER
120	1003132.686	637463.537	END TAPER
121	1003134.639	637507.279	BEGIN TAPER
122	1003127.177	637536.457	END TAPER
123	1003128.034	637721.245	BEGIN TAPER
124	1003131.801	637757.228	END TAPER



F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
9	ARIZ	WS90320006	12	82	

DSWA AZTEC

DR: ASR DES: CCW CK: MDS DATE: 4/

CONSTRUCTION NOTES

NO	DESCRIPTION	UNIT	QT
1	SUBGRADE PREPARATION	SY	181
2	ASPHALT CONCRETE SURFACE COURSE, TYPE C 3/4, 5" THICK	TON	510
4	EMULSIFIED ASPHALT FOR TACK COAT, TYPE SS-H	TON	1.8
8	GUARD RAIL END TERMINAL ASSEMBLY, ADOT DET C-10.45 STA 27+78.3 TO 27+90.8, 22' RT STA 30+80.4 TO 30+92.9, 22' LT	EA	2
9	GUARD RAIL, W-BEAM SINGLE FACE, TYPE "A" ADOT STD C-10.01 & C-10.20 STA 26+00 TO 26+15.8, 22' RT STA 26+00 TO 26+18.1, 22' LT STA 27+65.8 TO 27+78.3, 22' RT STA 27+68.1 TO 27+80.6, 22' LT STA 30+89.9 TO 31+00, 22' RT STA 30+92.9 TO 31+00, 22' LT	LF	76
10	GUARD RAIL END TREATMENT, ET-PLUS OR SKT-350 STA 27+80.6, 22' LT TO 28+30.6, 24' LT STA 30+39.9, 24' RT TO 30+89.9, 22' RT	EA	2
11	GUARD RAIL TRANSITION W-BEAM TO THRIE BEAM SEE DETAIL SHEET 4 STA 26+15.8 TO 26+22.1, 22' RT STA 26+18.1 TO 26+24.4, 22' LT STA 27+59.6 TO 27+65.8, 22' RT STA 27+61.8 TO 27+68.1, 22' LT	EA	4
12	ASPHALT CONCRETE SURFACE COURSE, TYPE C 3/4, 3" THICK, (FOR BRIDGE & APPROACH SLAB)	TON	117
13	CEMENT STABILIZED ALLUVIUM	CY	2888
14	RIP RAP	CY	950
15	GEOTEXTILE FILTER FABRIC	SY	1100

GENERAL NOTES

NOTES:

1. FOR PAVEMENT LAYOUT & GUARD RAIL END SECTION – SEE SHEET 4.
2. FOR CSA ABUTMENT SLOPE PROTECTION AND RIPRAP BLANKET – SEE SHEET 5.
3. FOR BRIDGE – SEE SHEET 45–61.
4. FOR NATIVE PLANT SURVEY – SEE SHEETS 79–81.
5. FOR UTILITIES – SEE SHEET 82.

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PUBLIC WORKS DEPARTMENT
PW16700002

NGWRP ACCESS ROAD
I-17 NB FR RD TO NGWRP
STA 26+00 TO 31+00

DR: ASR	DES: CCW	CK: MDS	SHEET NO.	TOTAL SHEETS	AS BUILT
DATE: 4/03	DATE: 4/03	DATE: 4/03	12	82	

SCALE: 1"=20' HORIZONTAL, 1"=2' VERTICAL

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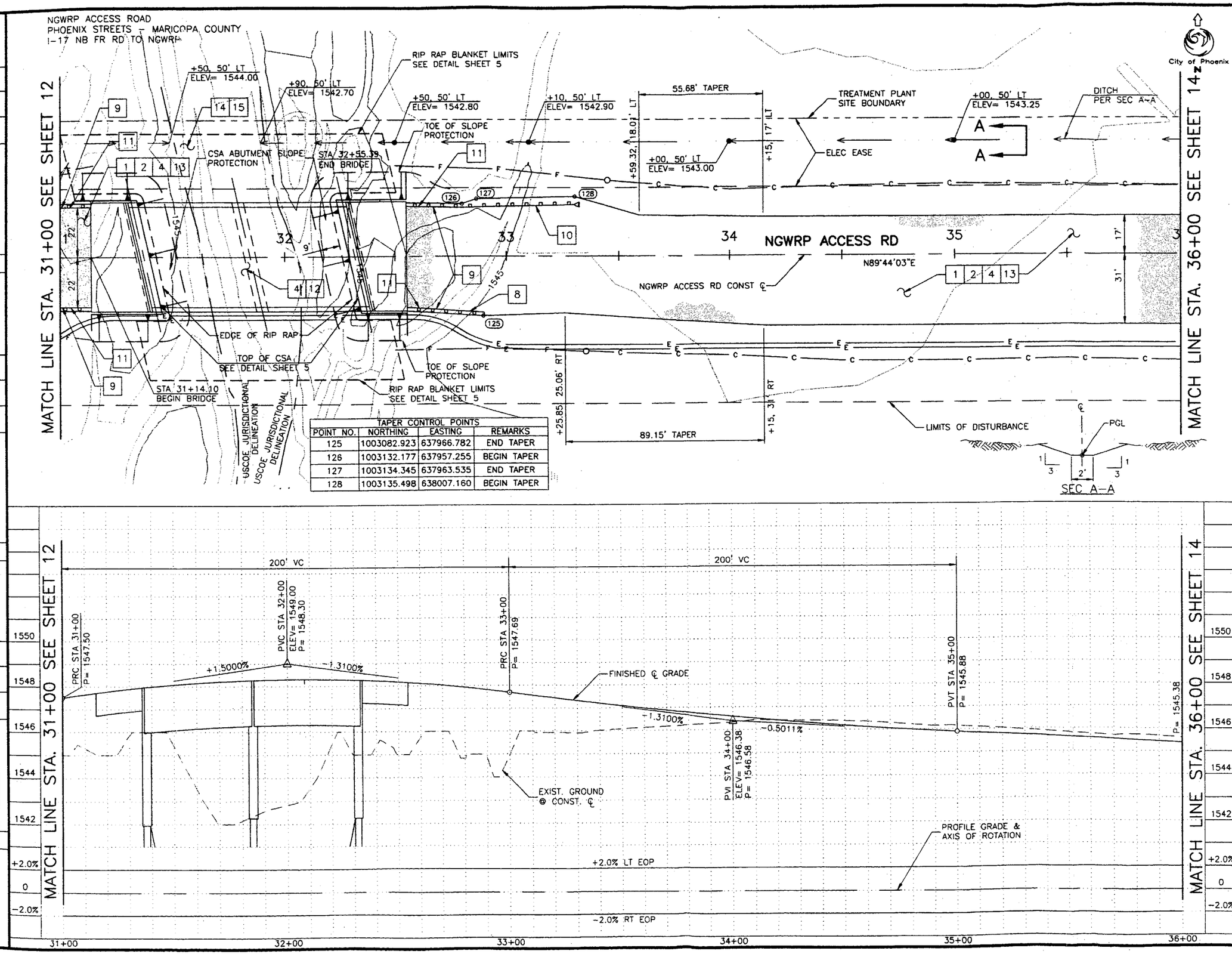
NO.	DESCRIPTION	REV BY	CKD BY	DATE

Apr 22, 2003 – 12:46pm AKordan F:\AZ02070\CAD\ENG\2C009.dwg

NGWRP ACCESS ROAD
PHOENIX STREETS - MARICOPA COUNTY
I-17 NB FR RD TO NGWRP



TAPER CONTROL POINTS			
POINT NO.	NORTHING	EASTING	REMARKS
125	1003082.923	637966.782	END TAPER
126	1003132.177	637957.255	BEGIN TAPER
127	1003134.345	637963.535	END TAPER
128	1003135.498	638007.160	BEGIN TAPER

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
9	ARIZ	WS90320006	13	82	

DSWA — AZTEC

DR: ASR DES: CCW CK: MDS DATE: 4/03

CONSTRUCTION NOTES

NO	DESCRIPTION	UNIT	QTY
1	SUBGRADE PREPARATION	SY	1922
2	ASPHALT CONCRETE SURFACE COURSE, TYPE C 3/4, 5" THICK	TON	540
4	EMULSIFIED ASPHALT FOR TACK COAT, TYPE SS-H	TON	1.9
8	GUARD RAIL END TERMINAL ASSEMBLY, ADOT DET C-10.45 STA 32+77.3 TO 32+89.8 ,22' RT	EA	1
9	GUARD RAIL, W-BEAM SINGLE FACE, TYPE "A" ADOT STD C-10.01 & C-10.20 STA 31+00 TO 31+02.4, 22' RT STA 31+00 TO 31+05.4, 22' LT STA 32+64.9, 23' RT TO 32+77.3, 23.8' RT STA 32+67.9, 21.7' LT TO 32+80.4, 21.4' LT	LF	33
10	GUARD RAIL END TREATMENT, ET-PLUS OR SKT-350 STA 32+80.4, 21.4' LT TO 33+30.4, 22.5' LT	EA	1
11	GUARD RAIL TRANSITION W-BEAM TO THRIE BEAM SEE DETAIL SHEET 4 STA 31+02.4 TO 31+08.6, 22' RT STA 31+05.4 TO 31+11.6, 22' LT STA 32+58.6, 22.6' RT TO 32+64.9, 23' RT STA 32+61.6, 21.8' LT TO 32+67.9, 21.7' LT	EA	4
12	ASPHALT CONCRETE SURFACE COURSE, TYPE C 3/4, 3" THICK, (FOR BRIDGE & APPROACH SLAB)	TON	127
13	CEMENT STABILIZED ALLUVIUM	CY	2877
14	RIP RAP	CY	2604
15	GEOTEXTILE FILTER FABRIC	SY	3000

GENERAL NOTES

NOTES:

1. FOR PAVEMENT LAYOUT @ GUARD RAIL END SECTION - SEE SHEET 4.
2. FOR CSA ABUTMENT SLOPE PROTECTION AND RIP RAP BLANKET - SEE SHEET 5.
3. FOR BRIDGE - SEE SHEET 62-78.
4. FOR NATIVE PLANT SURVEY - SEE SHEETS 79-81.
5. FOR UTILITIES - SEE SHEET 82.

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NGWRP ACCESS ROAD
I-17 NB FR RD TO NGWRP
STA 31+00 TO 36+00

DR: ASR DATE: 4/03	DES: CCW DATE: 4/03	CK: MDS DATE: 4/03	SHEET NO.	TOTAL SHEETS	AS BUILT
SCALE: 1"=20' HORIZONTAL 1"=2' VERTICAL			13	82	

REVISION BY CITY OF PHOENIX
NO. | DESCRIPTION | REV BY | CKD BY | DATE

Apr 22, 2003 - 12:47pm Akiordan
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Appendix E.2:

HEC-2 Input/Output Files
1. Existing FEMA
2. Revised Existing
3. New Bridge

```
1*******************************************
 *  HEC-2 WATER SURFACE PROFILES            *
 *                                          *
 *  Version   4.6.2;  May 1991              *
 *                                          *
 *  RUN DATE    24SEP03    TIME   16:55:27  *
 *******************************************
```

```
*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*          (916) 756-1104           *
*************************************
```

ORIGINAL FEMA FLOOD INSURANCE STUDY INPUT AND OUTPUT FILE
REPRINTED BY TETRA TECH, INC. ON 9/2/03
9.29/03 PRINT FILE EDITED TO DELETE SECTIONS ABOVE 14.3

```
X     X  XXXXXXX   XXXXX             XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
```

1

24SEP03 16:55:27 PAGE 1

THIS RUN EXECUTED 24SEP03 16:55:27

```
************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.2;  May 1991
************************************
```

FILE NAME: SKUNKCK.DAT

COMPLETE HEC-2 MODEL FOR ENTIRE SKUNK CREEK FLOODPLAIN DELINEATION STUDY
HEC ANALYSIS INCLUDES SECTIONS 13.00 TO 17.95 (FLOODPLAIN ANALYSIS ONLY)
MONTGOMERY WATSON ANALYSIS INCLUDES SECTIONS 18.09 TO 20.62 AND 22.96 TO
CASTRO FLEET ANALYSIS (DEL WEBB) INCLUDES SECTIONS 20.64 TO 22.95

SPLIT FLOW BEING PERFORMED

SF SPLIT FLOW FROM SECTIONS 13.02 TO 13.28

TW I-17 SPLIT FLOW

```
        WEIR FLOW OCCURS ALONG I-17 BETWEEN CROSS-SECTIONS 13.02 & 13.28
        FLOW WEIRS OVER THE NORTH BOUND LANES OF I-17 AND ALSO OVER THE
        EMBANKMENT INTO THE CENTRAL ARIZONA PROJECT CANAL
WS    11   13.02   13.28      -1     2.6
WC     0  1527.2     490  1526.1     725    1526     780  1524.5     830    1526
WC   855  1526.7     995    1528    1230    1530    1515    1532    1750    1534
WC  1840  1534.5
1
   24SEP03      16:55:27                                                                                    PAGE    2


T1      SKUNK CREEK FLOODPLAIN AND FLOODWAY DELINEATION (METHOD 1)
T2      100-YEAR FREQUENCY           DATE:  FEBRUARY 1998
T2      RUN INCORPORATING FCDMC'S AND FEMA'S REVISIONS AT NEW RIVER ROAD BRIDGE
T3      MONT. WAT. AND HEC

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                                                                  1522.96

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     1                  -1


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38         43          1          8         42          3          2         26          5         39
     53          4         54        110        115        150        200
        SPLIT FLOW ANALYSES AT CAP CANAL & CAREFREE HWY
        NO FLOODWAY ANALYSIS PERFORMED FOR CROSS SECTIONS 13.00 TO 13.28
        DUE TO WEIR FLOW AND PONDING OF WATER UPSTREAM OF THE CAP CANAL BERM.
        THE FLOODWAY CONCEPT IS NOT APPLICABLE FOR THIS REACH.

QT        2      15700      15700
NC     .025       .025       .025         .3          .5
ET                 9.1        9.1                                                                   9820       10065
        DOWNSTREAM OF BRINK OF CAP OVERCHUTE NO.1 (BOR STA 470+80)
        OVERFLOW DISCHARGE HAS BEEN ADJUSTED TO ACCOUNT FOR SPLIT FLOW TO CAP
        OVERCHUTE NO.2 (BOR STA 492+04)
X1    13.00          8       9820      10065
GR   1527.0       7780     1518.5     7780.5      1518.5      7939.5      1527.0        7940      1527.0        9820
GR   1518.5     9820.5     1518.5    10064.5      1527.0       10065

ET                 9.1        9.1                                                                   9820       10065
        UPSTREAM ENTRANCE TO CAP OVERCUTE NO.1
X1    13.02          8       9820      10065         120         120         120
GR   1527.0       7780       1519     7780.5        1519      7939.5      1527.0        7940      1527.0        9820
GR     1519     9820.5       1519    10064.5      1527.0       10065

NC      .04        .04        .04         .3          .5
ET                 9.1        9.1                                                                   9537       10350
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X1    13.04        77      9721     10130       100       100       100
GR   1531.2      7311    1526.9      7365    1526.6      7377    1527.8      7428      1527      7475
GR   1526.6      7516    1520.1      7540    1519.5      7577    1519.3      7631    1519.6      7648
GR   1518.7      7682      1519      7704    1518.1      7758    1518.4      7790    1520.6      7803
GR   1526.7      7829    1527.1      7840    1526.9      7898    1526.2      7917      1531      7961
GR   1532.2      7999      1532      8035    1532.1      8067    1532.4      8106    1537.1      8125
GR   1532.3      8139    1533.8      8206    1533.4      8257    1532.9      8297    1532.3      8355
GR   1532.9      8404    1533.1      8450    1533.5      8518    1533.5      8547    1533.9      8592
GR   1534.2      8649    1533.7      8711    1532.6      8807    1532.4      8944    1532.6      8993
GR     1533      9051    1532.4      9144    1533.9      9163    1536.3      9206    1537.1      9230
GR   1536.6      9261    1535.6      9288    1533.9      9315    1532.8      9358    1532.3      9408
GR   1532.3      9438    1532.1      9481    1529.4      9537    1527.9      9567    1527.1      9596
1
   24SEP03      16:55:27                                                                          PAGE     3

GR   1527.1      9632    1527.7      9669    1527.5      9710      1528      9721    1522.3      9749
GR   1520.2      9797    1519.6      9890    1520.1      9931    1521.2      9949    1520.1      9966
GR   1518.8      9976    1519.8     10027    1520.7     10082    1521.2     10108    1527.1     10130
GR   1526.8     10162    1526.5     10210      1527     10249    1527.4     10274    1527.5     10325
GR   1528.4     10355    1528.1     10398

NC     .069      .044      .050        .1        .3
ET                9.1       9.1                                                      9550     10679
X1    13.08        57      9615     10182       230       230       230
GR     1532      7732      1530      7863      1528      7933      1526      8065      1525      8114
GR   1524.5      8264      1524      8409    1522.2      8469    1522.5      8605    1522.2      8621
GR   1522.8      8775    1522.9      8828      1523      8862    1522.5      8926    1521.9      8955
GR   1520.4      8966    1522.5      9024    1524.4      9127      1524      9197    1524.1      9265
GR   1524.4      9305      1524      9386    1524.3      9436    1523.7      9447    1523.6      9533
GR   1524.2      9615    1523.4      9651    1522.6      9720    1520.4      9740    1522.2      9755
GR   1522.9      9781    1524.6      9805    1520.9      9821      1521      9836    1522.2      9847
GR     1523      9886    1522.2      9978    1518.5      9992    1518.2     10002    1518.8     10008
GR   1522.4     10023      1522     10070    1521.1     10078      1522     10090      1522     10106
GR     1520     10131    1521.5     10160    1523.5     10182    1523.9     10210    1524.3     10274
GR   1524.7     10346      1526     10460    1525.8     10512    1524.4     10555    1524.5     10575
GR     1526     10616      1528     10679

NC     .038      .042      .052        .1        .3
ET                9.1       9.1                                                      9421     10816
        NEW CROSS SECTION:  GR CARD DATA DEVELOPED FROM TOPOGRAPHIC MAPS
X1    13.16        53      9953     10288       420       425       421
GR     1534      7863      1532      8128      1530      8316      1528      8551    1526.5      8641
GR     1528      8791    1528.3      8868      1528      8888      1526      8946      1525      9139
GR     1526      9169    1526.2      9219      1526      9255    1525.3      9389      1526      9405
GR   1526.5      9421      1526      9442    1525.5      9459      1526      9481    1526.4      9632
GR     1526      9721      1525      9736      1526      9751      1528      9929    1528.3      9936
GR     1528      9943      1526      9953      1524      9963      1522      9981    1521.5      9991
GR     1522     10001      1524     10043    1524.5     10093      1524     10148      1523     10163
GR     1524     10215      1523     10220      1524     10225      1525     10235      1524     10245
GR   1523.2     10250      1524     10255      1526     10273    1526.2     10288      1526     10303
GR   1525.8     10323      1526     10349      1528     10689    1528.4     10744      1528     10774
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GR   1527.5      10784       1528      10793      1529.8       10816
        CROSS-SECTION AT WHICH FLOWS TO CAP OVERCHUTES 1 AND 2 RECOMBINE.
        WSEL MATCHES AT THIS CROSS-SECTION

ET                 9.1        9.1                                                                  9537       10802
X1    13.28         65       9671      10110        390        610        600
GR     1536       8217     1534.9       8297     1534.2       8552     1534.3       8677       1534       8812
GR     1532       8979       1530       9107     1529.3       9165       1530       9205       1532       9255
GR   1532.2       9337     1531.5       9390     1531.5       9439     1530.1       9484     1525.7       9507
GR   1526.0       9523     1529.8       9537     1530.1       9605     1530.9       9671     1530.2       9682
GR   1530.4       9709     1531.2       9726     1531.3       9776     1530.4       9840     1529.7       9851
GR   1530.9       9901     1531.6       9962     1530.6       9975     1522.9       9991     1522.6      10000
GR   1522.9      10034     1530.4      10052     1530.6      10083     1527.4      10097     1531.2      10110
GR   1531.0      10143     1531.2      10169     1532.3      10193     1532.9      10222     1532.2      10250
GR   1532.2      10302     1532.2      10347     1531.6      10363     1532.0      10389     1531.1      10421
GR   1531.1      10475     1531.1      10529     1529.7      10581     1530.3      10594     1530.6      10634
GR   1530.0      10654     1530.5      10667     1529.9      10697     1531.7      10727     1532.2      10771
GR   1532.9      10840     1533.5      10884     1533.9      10956     1533.3      10961     1534.6      10969
1
   24SEP03      16:55:27                                                                                    PAGE    4


GR   1534.9      10995     1534.0      11002     1533.5      11019     1534.9      11025     1535.4      11065

QT         2     23300      23300
ET                            7.1                                       9670      10602
X1    13.40         73       9670      10319        650        590      678.6
GR     1540       8520       1538       8940       1536       9105       1535       9155       1536       9197
GR   1536.2       9202       1536       9212     1535.9     9214.5       1536       9217     1536.5       9287
GR     1536       9359     1535.5       9414       1536       9474     1537.5       9641     1537.6       9670
GR   1536.4       9692     1534.6       9719     1527.4       9732     1530.8       9748     1532.1       9770
GR   1530.0       9782     1534.1       9800     1533.9       9820     1535.3       9840     1534.9       9849
GR   1535.8       9866     1536.5       9908     1537.1       9939     1536.9       9968     1535.2       9980
GR   1529.0       9994     1528.7      10000     1529.7      10010     1534.5      10033     1534.1      10063
GR   1534.3      10084     1534.3      10102     1536.0      10133     1536.4      10164     1535.0      10177
GR   1535.9      10194     1535.2      10209     1526.8      10246     1528.5      10252     1529.1      10269
GR   1537.1      10289     1537.5      10319     1536.6      10361     1535.1      10379     1535.3      10395
GR   1536.0      10422     1535.1      10447     1535.7      10465     1535.8      10514     1535.1      10539
GR   1535.0      10600     1535.4      10653     1535.5      10687     1535.0      10726     1534.3      10744
GR   1534.4      10772     1535.1      10797     1534.7      10833     1535.5      10874     1535.5      10910
GR   1535.1      10944     1534.7      11001     1535.1      11027     1539.0      11043     1538.8      11070

ET                            7.1                                       9236      10494
X1    13.55         79       9688      10494        740        850      787.3
GR   1544.6       8416     1544.5       8496     1543.9       8598     1543.5       8689     1542.8       8797
GR   1542.2       8877     1541.9       8929     1541.3       8950     1540.3       8963     1539.6       8985
GR   1540.1       8993     1540.1       9040     1539.8       9081     1540.4       9104     1540.0       9157
GR   1540.8       9241     1541.2       9311     1540.5       9346     1541.0       9443     1540.2       9451
GR   1541.2       9464     1541.0       9477     1541.9       9510     1542.7       9558     1543.1       9592
GR   1543.3       9645     1543.1       9688     1541.9       9715     1539.8       9736     1540.1       9742
GR   1538.2       9757     1537.4       9776     1532.2       9787     1535.6       9804     1540.7       9828
GR   1539.7       9836     1541.7       9855     1541.6       9877     1542.0       9897     1541.4       9930
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GR   1541.8      9965     1535.8      9988     1535.2     10000     1538.4     10010     1540.8     10031
GR   1540.9     10045     1540.5     10054     1541.3     10065     1541.2     10098     1541.8     10123
GR   1541.3     10132     1542.7     10150     1541.1     10176     1539.5     10191     1538.7     10208
GR   1537.7     10219     1539.2     10233     1541.4     10262     1541.1     10270     1542.0     10283
GR   1542.3     10307     1541.4     10349     1537.3     10370     1537.9     10380     1537.0     10394
GR   1538.6     10403     1541.0     10432     1542.6     10456     1543.0     10494     1544.4     10550
GR   1544.5     10623     1545.0     10680     1545.2     10743     1544.8     10802     1544.6     10856
GR   1544.2     10907     1544.1     10973     1545.1     10985     1545.3     10993

ET               9.1       7.1                                     9055     10482      8335     10646
X1    13.66       92      9477     10486       500       540     549.1
GR   1548.4      8244     1548.9      8287     1549.0      8335     1548.3      8352     1548.2      8399
GR   1548.3      8462     1548.0      8514     1547.5      8594     1546.9      8663     1546.0      8720
GR   1545.8      8738     1544.9      8780     1544.1      8828     1543.6      8914     1543.1      8917
GR   1543.7      8921     1544.0      8985     1544.6      9048     1545.1      9086     1545.3      9138
GR   1546.1      9173     1546.5      9234     1546.3      9275     1546.0      9318     1545.7      9360
GR   1545.3      9383     1545.1      9436     1544.5      9449     1545.0      9457     1544.1      9467
GR   1545.4      9477     1544.9      9492     1543.5      9512     1540.2      9528     1540.5      9540
GR   1542.2      9550     1546.6      9572     1546.4      9585     1542.7      9600     1542.8      9619
GR   1543.3      9627     1542.4      9643     1543.1      9655     1546.0      9667     1546.6      9689
GR   1546.7      9709     1546.1      9717     1546.0      9736     1544.6      9744     1546.0      9753
GR   1545.3      9775     1546.1      9791     1546.1      9829     1547.5      9852     1547.5      9878
GR   1546.7      9894     1546.7      9941     1545.9      9956     1544.6      9988     1542.1     10000
1
   24SEP03      16:55:27                                                                              PAGE     5


GR   1542.3     10006     1543.9     10015     1543.0     10055     1543.5     10063     1546.5     10083
GR   1546.6     10108     1546.0     10119     1547.2     10133     1546.3     10145     1547.2     10160
GR   1546.2     10177     1546.6     10193     1546.1     10207     1546.4     10246     1546.8     10280
GR   1547.3     10324     1547.3     10357     1546.7     10379     1545.6     10392     1543.2     10408
GR   1543.9     10430     1542.9     10442     1542.6     10465     1548.6     10486     1549.3     10509
GR   1549.5     10557     1549.8     10592     1549.9     10646     1549.4     10686     1549.5     10727
GR   1549.4     10784     1549.5     10846

ET               9.1       7.1                                      8708     10232      8212     10433
         CROSS-SECTION PROVIDED BY AERIAL MAPPER SKEWED TO CONTAIN FLOW
X1    13.86       90      9330     10042      1060      1050     1049.1
GR   1556.0      8212     1554.0      8550     1553.0      8600     1553.4      8617     1552.4      8685
GR   1551.6      8708     1551.5      8749     1550.6      8759     1551.7      8767     1552.1      8788
GR   1551.5      8817     1554.3      8863     1555.1      8895     1555.4      8908     1555.1      8935
GR   1555.0      8975     1555.5      9022     1556.1      9072     1556.9      9125     1557.1      9165
GR   1557.3      9223     1556.6      9242     1557.3      9263     1557.4      9298     1557.0      9319
GR   1556.1      9330     1553.5      9344     1552.5      9379     1551.4      9393     1552.9      9404
GR   1552.7      9416     1551.9      9420     1553.3      9429     1553.2      9446     1549.8      9464
GR   1549.3      9472     1549.8      9494     1553.0      9513     1553.6      9535     1553.4      9596
GR   1552.9      9605     1553.3      9613     1553.5      9634     1553.4      9666     1553.2      9716
GR   1552.5      9727     1553.4      9739     1552.6      9770     1553.6      9784     1553.4      9803
GR   1551.8      9819     1551.2      9831     1552.5      9842     1551.1      9855     1553.3      9864
GR   1553.3      9885     1551.8      9919     1549.0      9936     1549.0      9948     1551.6      9970
GR   1550.4      9983     1547.6      9991     1546.3     10000     1551.6     10009     1554.6     10023
GR   1555.7     10042     1555.6     10083     1554.3     10149     1550.9     10159     1552.6     10171
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GR   1554.4      10197     1554.7      10232      1556.0      10271      1557.0      10327      1557.5      10379
GR   1557.7      10433     1557.5      10477      1557.5      10546      1557.7      10596      1557.6      10656
GR   1557.4      10695     1557.1      10752      1556.8      10820      1556.5      10873      1556.1      10945
GR   1555.9      10962     1555.7      11006      1558.1      11035      1561.0      11054      1561.7      11092

ET                 9.1        7.1                                        8805       10529       8530       10608
        CROSS-SECTION PROVIDED BY AERIAL MAPPER SKEWED TO CONTAIN FLOW
X1    14.07         65       9879      10059       1050        1100      1134.1
GR   1565.4       8530       1564       8652       1562        8685      1560.7       8705      1560.7       8805
GR     1562       8920     1562.4       9043     1562.8        9116      1563.1       9185      1562.8       9201
GR   1562.8       9250     1563.3       9286     1563.7        9321      1563.4       9353      1562.5       9394
GR   1561.5       9417     1561.4       9462     1562.3        9530      1562.4       9554      1562.0       9566
GR   1562.0       9614     1562.3       9680     1563.1        9746      1563.6       9814      1564.0       9855
GR   1564.3       9879     1560.9       9898     1561.4        9904      1558.5       9924      1558.9       9938
GR   1558.9       9959     1557.5       9972     1557.5        9978      1558.5      10000      1562.0      10020
GR   1562.6      10040     1564.5      10059     1564.0       10077      1563.5      10125      1563.1      10151
GR   1562.6      10166     1562.7      10176     1562.2       10201      1563.1      10217      1563.0      10249
GR   1563.1      10300     1563.0      10338     1563.2       10381      1563.1      10396      1562.3      10404
GR   1563.1      10408     1563.1      10454     1563.1       10499      1564.1      10516      1565.5      10571
GR   1566.0      10608     1565.9      10656     1565.8       10710      1565.6      10758      1564.7      10813
GR   1564.3      10848     1564.8      10873     1565.1       10923      1570.0      10950      1570.8      10989
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The following GR record has been modified as per discussion with the FEMA technical evaluator. From station 8450 to station 9500, the elevations are read from the topographic map. From station 9563 to station 11361, the elevations remain the same as provided by the Aerial Mapping Company, Inc (AMCI) (March 17, 1998).


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ET                           7.1                                        9210       10160
X1    14.30         73       9923      10027       1010        1210      1213.6
GR   1576.2       8450     1575.9       8550     1574.1        8650      1573.7       8750      1573.5       8850
GR   1573.4       8950     1573.3       9050     1572.5        9150      1572.5       9250      1571.9       9350
GR   1571.9       9450     1573.5       9500     1573.8        9563      1574.2       9626      1573.5       9652
GR   1573.1       9672     1573.8       9707     1573.7        9731      1573.8       9769      1573.2       9788
GR   1573.2       9836     1572.9       9878     1572.4        9906      1571.6       9923      1570.4       9941
GR   1565.1       9961     1565.2       9967     1560.0        9973      1560.3       9983      1559.6      10000
GR   1566.5      10011     1570.0      10027     1570.1       10045      1569.4      10052      1570.1      10062
GR   1571.0      10097     1571.2      10131     1571.1       10157      1572.5      10191      1572.9      10211
GR   1572.6      10251     1572.3      10297     1572.5       10351      1572.2      10386      1571.8      10410
GR   1572.1      10417     1571.7      10437     1571.7       10448      1571.5      10480      1571.6      10515
GR   1572.7      10552     1572.9      10571     1572.7       10608      1572.4      10642      1571.4      10681
GR   1571.6      10735     1571.9      10765     1572.0       10792      1571.2      10804      1571.8      10811
GR   1573.2      10852     1575.9      10899     1577.1       10931      1577.9      10967      1578.4      10992
GR   1578.7      11034     1578.6      11096     1578.4       11179      1578.2      11233      1577.7      11273
GR   1582.1      11295     1582.8      11336     1577.8       11361
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    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*PROF 1
0

CCHV=     .300 CEHV=     .500
*SECNO 13.000
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     9820.0   10065.0  TYPE=      1  TARGET=      245.000
    13.000      4.48   1522.98   1522.98   1522.98   1525.23      2.25       .00       .00   1527.00
   13163.1        .0   13163.1        .0        .0    1093.2        .0        .0        .0 100000.00
       .00       .00     12.04       .00      .000      .025      .000      .000   1518.50   9820.24
   .005829        0.        0.        0.         0         4         0       .00    244.53  10064.76


*SECNO 13.020

3301 HV CHANGED MORE THAN HVINS


3470 ENCROACHMENT STATIONS=     9820.0   10065.0  TYPE=      1  TARGET=      245.000
    13.020      5.39   1524.39   1523.47   1524.39   1525.94      1.55       .50       .21   1527.00
   13163.1        .0   13163.1        .0        .0    1316.1        .0       3.3        .7 100000.00
       .00       .00     10.00       .00      .000      .025      .000      .000   1519.00   9820.16
   .003171      120.      120.      120.        19         5         0       .00    244.67  10064.84


CCHV=     .300 CEHV=     .500
*SECNO 13.040

3301 HV CHANGED MORE THAN HVINS


3470 ENCROACHMENT STATIONS=     9537.0   10350.0  TYPE=      1  TARGET=      813.000
    13.040      7.85   1525.95       .00   1525.95   1526.53       .58       .30       .29   1528.00
   13163.1        .0   13163.1        .0        .0    2145.5        .0       7.3       1.4   1527.10
       .01       .00      6.14       .00      .000      .040      .000      .000   1518.10   9731.08
   .002864      100.      100.      100.         5         0         0       .00    394.62  10125.70


CCHV=     .100 CEHV=     .300
*SECNO 13.080

3470 ENCROACHMENT STATIONS=     9550.0   10679.0  TYPE=      1  TARGET=     1129.000
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    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

    13.080      8.73    1526.93        .00    1526.93    1527.13        .20        .56        .04    1524.20
   13163.1     382.5    10462.2     2318.3      193.3     2709.9      893.6       23.0        5.3    1523.50
       .03      1.98       3.86       2.59       .069       .050       .044       .000    1518.20    9550.00
   .002106      230.       230.       230.          2          0          0        .00    1095.47   10645.47

CCHV=     .100 CEHV=     .300
*SECNO 13.160

3265 DIVIDED FLOW

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .64

3470 ENCROACHMENT STATIONS=     9421.0   10816.0  TYPE=      1  TARGET=     1395.000
    13.160      6.64    1528.14        .00    1528.14    1528.50        .36       1.32        .05    1526.00
   13163.1    3734.2     7775.9     1652.9      891.0     1437.7      529.6       55.2       17.0    1526.20
       .05      4.19       5.41       3.12       .038       .052       .042       .000    1521.50    9421.00
   .005155      420.       421.       425.          3          0          0        .00    1310.31   10794.75

*SECNO 13.280

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS=     9537.0   10802.0  TYPE=      1  TARGET=     1265.000
    13.280      9.91    1532.51    1532.24    1532.51    1533.21        .70       4.61        .10    1530.90
   15700.0    2428.2     8742.6     4529.2      306.9     1283.2      794.6       88.6       33.0    1531.20
       .07      7.91       6.81       5.70       .038       .052       .042       .000    1522.60    9537.00
   .013778      390.       600.       610.         11         12          0        .00    1230.26   10801.64

*SECNO 13.400

3265 DIVIDED FLOW

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.38

    13.400     10.92    1537.72        .00    1537.72    1538.06        .34       4.82        .04    1537.60
```

```
   23300.0    3696.3   11361.7    8241.9     960.9    2330.8    1720.4     143.2      57.1   1537.50
       .11      3.85      4.87      4.79      .038      .052      .042      .000   1526.80   8963.18
  .005377      650.      679.      590.         7         0         0       .00   2079.32  11082.48
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1


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    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*SECNO 13.550

3265 DIVIDED FLOW

    13.550     10.89   1543.09       .00   1543.09   1543.69       .60       5.55       .08   1543.10
   23300.0   11067.7   12232.2        .1    1609.1    2216.4        .2      222.9      90.5   1543.00
       .15      6.88      5.52       .45      .038      .052      .042      .000   1532.20   8752.06
  .009761      740.      787.      850.         2         0         0       .00   1648.66  10497.65

*SECNO 13.660

3470 ENCROACHMENT STATIONS=     8335.0   10646.0  TYPE=      1  TARGET=     2311.000
    13.660      7.45   1547.65       .00   1547.65   1548.17       .52       4.47       .01   1545.40
   23300.0   13742.7    9557.3        .0    2066.5    2253.0        .0      272.2     112.0   1548.60
       .17      6.65      4.24       .00      .038      .052      .000      .000   1540.20   8570.05
  .007557      500.      549.      540.         3         0         0       .00   1912.62  10482.67

*SECNO 13.860

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS=     8212.0   10433.0  TYPE=      1  TARGET=     2221.000
    13.860      9.43   1555.73       .00   1555.73   1556.28       .55       8.10       .01   1556.10
   23300.0    8959.8   13139.5    1200.7    1371.1    2351.5     249.6      372.5     155.9   1555.70
       .22      6.53      5.59      4.81      .038      .052      .042      .000   1546.30   8257.22
  .007811     1060.     1049.     1050.         5         0         0       .00   1715.14  10262.97

*SECNO 14.070

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS=     8530.0   10608.0  TYPE=      1  TARGET=     2078.000
```

14.070	6.92	1564.42	.00	1564.42	1565.01	.60	8.72	.01	1564.30
23300.0	16022.4	4983.9	2293.7	2542.7	745.2	580.6	470.4	200.8	1564.50
.27	6.30	6.69	3.95	.038	.052	.042	.000	1557.50	8615.59
.008252	1050.	1134.	1100.	5	0	0	.00	1909.12	10528.49

1

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 14.300

3265 DIVIDED FLOW

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

14.300	14.39	1573.99	1573.99	1573.99	1574.90	.91	9.15	.09	1571.60
23300.0	4606.0	9236.3	9457.8	1110.2	889.1	1723.4	567.5	251.5	1570.00
.31	4.15	10.39	5.49	.038	.052	.042	.000	1559.60	8677.95
.008053	1010.	1214.	1210.	10	22	0	.00	2146.54	10865.72

TW I-17 SPLIT FLOW

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
2536.95	2538.56	.06	2536.95	2538.56	.06	5	1524.387	1532.511	13.020	13.280

1

T1 Floodway Run - Method 1
T2 Date: 4-25-97
T3 Floodway Run - Method 1

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	-10	3							1522.96	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2		-1							

```
 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
 Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST

*PROF 2
0

CCHV=     .300 CEHV=     .500
*SECNO 13.000
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     9820.0   10065.0  TYPE=      1  TARGET=      245.000
    13.000      4.48   1522.98   1522.98   1522.98   1525.23      2.25       .00       .00   1527.00
   13163.1        .0   13163.1       .0        .0    1093.2        .0        .0        .0 100000.00
       .00       .00     12.04       .00      .000      .025      .000      .000   1518.50   9820.24
   .005829        0.        0.        0.         0         4         0       .00    244.53  10064.76

*SECNO 13.020

3301 HV CHANGED MORE THAN HVINS

3470 ENCROACHMENT STATIONS=     9820.0   10065.0  TYPE=      1  TARGET=      245.000
    13.020      5.39   1524.39   1523.47   1524.39   1525.94      1.55       .50       .21   1527.00
   13163.1        .0   13163.1       .0        .0    1316.1        .0       3.3        .7 100000.00
       .00       .00     10.00       .00      .000      .025      .000      .000   1519.00   9820.16
   .003171      120.      120.      120.        19         5         0       .00    244.67  10064.84

CCHV=     .300 CEHV=     .500
*SECNO 13.040

3301 HV CHANGED MORE THAN HVINS

3470 ENCROACHMENT STATIONS=     9537.0   10350.0  TYPE=      1  TARGET=      813.000
    13.040      7.85   1525.95       .00   1525.95   1526.53       .58       .30       .29   1528.00
   13163.1        .0   13163.1       .0        .0    2145.5        .0       7.3       1.4   1527.10
       .01       .00      6.14       .00      .000      .040      .000      .000   1518.10   9731.08
   .002864      100.      100.      100.         5         0         0       .00    394.62  10125.70

CCHV=     .100 CEHV=     .300
*SECNO 13.080
```

3470 ENCROACHMENT STATIONS= 9550.0 10679.0 TYPE= 1 TARGET= 1129.000

1

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
13.080	8.73	1526.93	.00	1526.93	1527.13	.20	.56	.04	1524.20
13163.1	382.5	10462.2	2318.3	193.3	2709.9	893.6	23.0	5.3	1523.50
.03	1.98	3.86	2.59	.069	.050	.044	.000	1518.20	9550.00
.002106	230.	230.	230.	2	0	0	.00	1095.47	10645.47

CCHV= .100 CEHV= .300
*SECNO 13.160

3265 DIVIDED FLOW

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .64

3470 ENCROACHMENT STATIONS= 9421.0 10816.0 TYPE= 1 TARGET= 1395.000

13.160	6.64	1528.14	.00	1528.14	1528.50	.36	1.32	.05	1526.00
13163.1	3734.2	7775.9	1652.9	891.0	1437.7	529.6	55.2	17.0	1526.20
.05	4.19	5.41	3.12	.038	.052	.042	.000	1521.50	9421.00
.005155	420.	421.	425.	3	0	0	.00	1310.31	10794.75

*SECNO 13.280

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= 9537.0 10802.0 TYPE= 1 TARGET= 1265.000

13.280	9.91	1532.51	1532.24	1532.51	1533.21	.70	4.61	.10	1530.90
15700.0	2428.2	8742.6	4529.2	306.9	1283.2	794.6	88.6	33.0	1531.20
.07	7.91	6.81	5.70	.038	.052	.042	.000	1522.60	9537.00
.013778	390.	600.	610.	11	12	0	.00	1230.26	10801.64

*SECNO 13.400
3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.06

3470 ENCROACHMENT STATIONS= 9670.0 10602.0 TYPE= 1 TARGET= 932.000

13.400	11.73	1538.53	.00	1538.53	1539.16	.63	5.94	.01	1537.60

```
   23300.0        .0   18362.9    4937.1        .0    2855.2     804.0     133.9      48.9   1537.50
       .10       .00      6.43      6.14      .000      .052      .042      .000   1526.80   9670.00
   .007154      650.      679.      590.         7         0         0       .00    932.00  10602.00


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   24SEP03      16:55:27                                                                          PAGE   79

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 *SECNO 13.550

 3470 ENCROACHMENT STATIONS=     9236.0   10494.0  TYPE=      1  TARGET=     1258.000
    13.550     11.86   1544.06       .00   1544.06   1544.57       .51      5.40       .01   1543.10
   23300.0    6635.7   16664.3        .0    1070.2    3003.7        .0     203.8      68.6 100000.00
       .14      6.20      5.55       .00      .038      .052      .000      .000   1532.20   9236.00
   .006590      740.      787.      850.         2         0         0       .00   1258.00  10494.00


 *SECNO 13.660

 3470 ENCROACHMENT STATIONS=     9055.0   10482.0  TYPE=      1  TARGET=     1427.000
    13.660      7.99   1548.19       .00   1548.19   1548.78       .59      4.19       .02   1545.40
   23300.0    7899.8   15400.2        .0    1084.4    2801.5        .0     252.8      85.1 100000.00
       .16      7.28      5.50       .00      .038      .052      .000      .000   1540.20   9055.00
   .009491      500.      549.      540.         4         0         0       .00   1427.00  10482.00


 *SECNO 13.860

 3265 DIVIDED FLOW


 3470 ENCROACHMENT STATIONS=     8708.0   10232.0  TYPE=      1  TARGET=     1524.000
    13.860     10.01   1556.31       .00   1556.31   1556.86       .55      8.07       .00   1556.10
   23300.0    6204.5   15415.5    1680.1     889.7    2760.6     342.8     347.9     117.8   1555.70
       .21      6.97      5.58      4.90      .038      .052      .042      .000   1546.30   8708.00
   .006323     1060.     1049.     1050.         6         0         0       .00   1282.28  10232.00


 *SECNO 14.070

 3470 ENCROACHMENT STATIONS=     8805.0   10529.0  TYPE=      1  TARGET=     1724.000
    14.070      7.08   1564.58       .00   1564.58   1565.25       .67      8.36       .04   1564.30
   23300.0   14668.2    5662.9    2968.8    2230.0     774.5     657.0     444.1     155.3   1564.50
       .26      6.58      7.31      4.52      .038      .052      .042      .000   1557.50   8805.00
   .009427     1050.     1134.     1100.         5         0         0       .00   1724.00  10529.00
```

*SECNO 14.300

3301 HV CHANGED MORE THAN HVINS

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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 9210.0 10160.0 TYPE= 1 TARGET= 950.000

14.300	15.16	1574.76	1574.76	1574.76	1576.12	1.36	10.07	.21	1571.60
23300.0	7609.7	11066.6	4623.8	1293.7	969.7	546.9	526.0	188.3	1570.00
.29	5.88	11.41	8.46	.038	.052	.042	.000	1559.60	9210.00
.008656	1010.	1214.	1210.	10	14	0	.00	950.00	10160.00

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TW I-17 SPLIT FLOW

ASQ	QCOMP	ERRAC	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
2536.95	2538.56	.06	2536.95	2538.56	.06	5	1524.387	1532.511	13.020	13.280

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24SEP03 16:55:27 PAGE 116

THIS RUN EXECUTED 24SEP03 16:55:32

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

MONT. WAT. AND HEC

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	ELMIN	EG	CRIWS	VCH	10*KS	XLCH	SSTA	TOPWID	ENDST
*	13.000	13163.05	1522.98	4.48	1518.50	1525.23	1522.98	12.04	58.29	.00	9820.24	244.53	10064.76
*	13.000	13163.05	1522.98	4.48	1518.50	1525.23	1522.98	12.04	58.29	.00	9820.24	244.53	10064.76
	13.020	13163.05	1524.39	5.39	1519.00	1525.94	1523.47	10.00	31.71	120.00	9820.16	244.67	10064.84
	13.020	13163.05	1524.39	5.39	1519.00	1525.94	1523.47	10.00	31.71	120.00	9820.16	244.67	10064.84
	13.040	13163.05	1525.95	7.85	1518.10	1526.53	.00	6.14	28.64	100.00	9731.08	394.62	10125.70
	13.040	13163.05	1525.95	7.85	1518.10	1526.53	.00	6.14	28.64	100.00	9731.08	394.62	10125.70
	13.080	13163.05	1526.93	8.73	1518.20	1527.13	.00	3.86	21.06	230.00	9550.00	1095.47	10645.47
	13.080	13163.05	1526.93	8.73	1518.20	1527.13	.00	3.86	21.06	230.00	9550.00	1095.47	10645.47
*	13.160	13163.05	1528.14	6.64	1521.50	1528.50	.00	5.41	51.55	421.00	9421.00	1310.31	10794.75
*	13.160	13163.05	1528.14	6.64	1521.50	1528.50	.00	5.41	51.55	421.00	9421.00	1310.31	10794.75
	13.280	15700.00	1532.51	9.91	1522.60	1533.21	1532.24	6.81	137.78	600.00	9537.00	1230.26	10801.64
	13.280	15700.00	1532.51	9.91	1522.60	1533.21	1532.24	6.81	137.78	600.00	9537.00	1230.26	10801.64
*	13.400	23300.00	1537.72	10.92	1526.80	1538.06	.00	4.87	53.77	678.60	8963.18	2079.32	11082.48
*	13.400	23300.00	1538.53	11.73	1526.80	1539.16	.00	6.43	71.54	678.60	9670.00	932.00	10602.00
	13.550	23300.00	1543.09	10.89	1532.20	1543.69	.00	5.52	97.61	787.30	8752.06	1648.66	10497.65
	13.550	23300.00	1544.06	11.86	1532.20	1544.57	.00	5.55	65.90	787.30	9236.00	1258.00	10494.00
	13.660	23300.00	1547.65	7.45	1540.20	1548.17	.00	4.24	75.57	549.10	8570.05	1912.62	10482.67
	13.660	23300.00	1548.19	7.99	1540.20	1548.78	.00	5.50	94.91	549.10	9055.00	1427.00	10482.00
	13.860	23300.00	1555.73	9.43	1546.30	1556.28	.00	5.59	78.11	1049.10	8257.22	1715.14	10262.97
	13.860	23300.00	1556.31	10.01	1546.30	1556.86	.00	5.58	63.23	1049.10	8708.00	1282.28	10232.00
	14.070	23300.00	1564.42	6.92	1557.50	1565.01	.00	6.69	82.52	1134.10	8615.59	1909.12	10528.49
	14.070	23300.00	1564.58	7.08	1557.50	1565.25	.00	7.31	94.27	1134.10	8805.00	1724.00	10529.00

1

	SECNO	Q	CWSEL	DEPTH	ELMIN	EG	CRIWS	VCH	10*KS	XLCH	SSTA	TOPWID	ENDST
*	14.300	23300.00	1573.99	14.39	1559.60	1574.90	1573.99	10.39	80.53	1213.60	8677.95	2146.54	10865.72
*	14.300	23300.00	1574.76	15.16	1559.60	1576.12	1574.76	11.41	86.56	1213.60	9210.00	950.00	10160.00

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MONT. WAT. AND HEC

SUMMARY PRINTOUT TABLE 110

	SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
*	13.000	1522.98	-.01	1525.23	244.53	.00	13163.05	.00	245.00	9820.00	9820.00	10065.00	10065.00
	13.020	1524.39	.00	1525.94	244.67	.00	13163.05	.00	245.00	9820.00	9820.00	10065.00	10065.00
	13.020	1524.39	.00	1525.94	244.67	.00	13163.05	.00	245.00	9820.00	9820.00	10065.00	10065.00
	13.040	1525.95	-.01	1526.53	394.62	.00	13163.05	.00	813.00	9537.00	9721.00	10130.00	10350.00
	13.040	1525.95	-.01	1526.53	394.62	.00	13163.05	.00	813.00	9537.00	9721.00	10130.00	10350.00
	13.080	1526.93	-.01	1527.13	1095.47	382.50	10462.22	2318.33	1129.00	9550.00	9615.00	10182.00	10679.00
	13.080	1526.93	-.01	1527.13	1095.47	382.50	10462.22	2318.33	1129.00	9550.00	9615.00	10182.00	10679.00
*	13.160	1528.14	.00	1528.50	1310.31	3734.22	7775.94	1652.89	1395.00	9421.00	9953.00	10288.00	10816.00
*	13.160	1528.14	.00	1528.50	1310.31	3734.22	7775.94	1652.89	1395.00	9421.00	9953.00	10288.00	10816.00
	13.280	1532.51	.00	1533.21	1230.26	2428.25	8742.59	4529.16	1265.00	9537.00	9671.00	10110.00	10802.00
	13.280	1532.51	.00	1533.21	1230.26	2428.25	8742.59	4529.16	1265.00	9537.00	9671.00	10110.00	10802.00
*	13.400	1537.72	.00	1538.06	2079.32	3696.35	11361.71	8241.94	.00	.00	9670.00	10319.00	.00
*	13.400	1538.53	.00	1539.16	932.00	.00	18362.90	4937.10	932.00	9670.00	9670.00	10319.00	10602.00
	13.550	1543.09	.00	1543.69	1648.66	11067.74	12232.19	.07	.00	.00	9688.00	10494.00	.00
	13.550	1544.06	.00	1544.57	1258.00	6635.72	16664.28	.00	1258.00	9236.00	9688.00	10494.00	10494.00
	13.660	1547.65	.00	1548.17	1912.62	13742.68	9557.32	.00	2311.00	8335.00	9477.00	10486.00	10646.00
	13.660	1548.19	.00	1548.78	1427.00	7899.81	15400.19	.00	1427.00	9055.00	9477.00	10486.00	10482.00
	13.860	1555.73	.00	1556.28	1715.14	8959.83	13139.49	1200.68	2221.00	8212.00	9330.00	10042.00	10433.00
	13.860	1556.31	.00	1556.86	1282.28	6204.46	15415.46	1680.08	1524.00	8708.00	9330.00	10042.00	10232.00
	14.070	1564.42	.00	1565.01	1909.12	16022.38	4983.93	2293.70	2078.00	8530.00	9879.00	10059.00	10608.00
	14.070	1564.58	.00	1565.25	1724.00	14668.25	5662.93	2968.83	1724.00	8805.00	9879.00	10059.00	10529.00
*	14.300	1573.99	.00	1574.90	2146.54	4605.95	9236.27	9457.78	.00	.00	9923.00	10027.00	.00
*	14.300	1574.76	.00	1576.12	950.00	7609.69	11066.56	4623.76	950.00	9210.00	9923.00	10027.00	10160.00

MONT. WAT. AND HEC

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	13.000	.00	.00	.00	1518.50	13163.05	1522.98	1522.98	1525.23	58.29	12.04	1093.19	1724.06
*	13.000	.00	.00	.00	1518.50	13163.05	1522.98	1522.98	1525.23	58.29	12.04	1093.19	1724.06
	13.020	120.00	.00	.00	1519.00	13163.05	1524.39	1523.47	1525.94	31.71	10.00	1316.08	2337.66
	13.020	120.00	.00	.00	1519.00	13163.05	1524.39	1523.47	1525.94	31.71	10.00	1316.08	2337.66
	13.040	100.00	.00	.00	1518.10	13163.05	1525.95	.00	1526.53	28.64	6.14	2145.45	2459.42
	13.040	100.00	.00	.00	1518.10	13163.05	1525.95	.00	1526.53	28.64	6.14	2145.45	2459.42
	13.080	230.00	.00	.00	1518.20	13163.05	1526.93	.00	1527.13	21.06	3.86	3796.82	2868.37
	13.080	230.00	.00	.00	1518.20	13163.05	1526.93	.00	1527.13	21.06	3.86	3796.82	2868.37
*	13.160	421.00	.00	.00	1521.50	13163.05	1528.14	.00	1528.50	51.55	5.41	2858.32	1833.29
*	13.160	421.00	.00	.00	1521.50	13163.05	1528.14	.00	1528.50	51.55	5.41	2858.32	1833.29
	13.280	600.00	.00	.00	1522.60	15700.00	1532.51	1532.24	1533.21	137.78	6.81	2384.62	1337.52
	13.280	600.00	.00	.00	1522.60	15700.00	1532.51	1532.24	1533.21	137.78	6.81	2384.62	1337.52
*	13.400	678.60	.00	.00	1526.80	23300.00	1537.72	.00	1538.06	53.77	4.87	5012.18	3177.59
*	13.400	678.60	.00	.00	1526.80	23300.00	1538.53	.00	1539.16	71.54	6.43	3659.17	2754.70
	13.550	787.30	.00	.00	1532.20	23300.00	1543.09	.00	1543.69	97.61	5.52	3825.70	2358.41
	13.660	549.10	.00	.00	1540.20	23300.00	1547.65	.00	1548.17	75.57	4.24	4319.53	2680.34
	13.660	549.10	.00	.00	1540.20	23300.00	1548.19	.00	1548.78	94.91	5.50	3885.92	2391.60
	13.860	1049.10	.00	.00	1546.30	23300.00	1555.73	.00	1556.28	78.11	5.59	3972.16	2636.31
	13.860	1049.10	.00	.00	1546.30	23300.00	1556.31	.00	1556.86	63.23	5.58	3993.17	2930.21
	14.070	1134.10	.00	.00	1557.50	23300.00	1564.42	.00	1565.01	82.52	6.69	3868.46	2564.91
	14.070	1134.10	.00	.00	1557.50	23300.00	1564.58	.00	1565.25	94.27	7.31	3661.50	2399.79
*	14.300	1213.60	.00	.00	1559.60	23300.00	1573.99	1573.99	1574.90	80.53	10.39	3722.61	2596.40
*	14.300	1213.60	.00	.00	1559.60	23300.00	1574.76	1574.76	1576.12	86.56	11.41	2810.28	2504.38

MONT. WAT. AND HEC

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	13.000	13163.05	1522.98	.00	.00	-.01	244.53	.00
*	13.000	13163.05	1522.98	.00	.00	-.01	244.53	.00
	13.020	13163.05	1524.39	.00	1.41	.00	244.67	120.00

	13.020	13163.05	1524.39	.00	1.41	.00	244.67	120.00
	13.040	13163.05	1525.95	.00	1.56	-.01	394.62	100.00
	13.040	13163.05	1525.95	.00	1.56	-.01	394.62	100.00
	13.080	13163.05	1526.93	.00	.98	-.01	1095.47	230.00
	13.080	13163.05	1526.93	.00	.98	-.01	1095.47	230.00
*	13.160	13163.05	1528.14	.00	1.21	.00	1310.31	421.00
*	13.160	13163.05	1528.14	.00	1.21	.00	1310.31	421.00
	13.280	15700.00	1532.51	.00	4.37	.00	1230.26	600.00
	13.280	15700.00	1532.51	.00	4.37	.00	1230.26	600.00
*	13.400	23300.00	1537.72	.00	5.21	.00	2079.32	678.60
*	13.400	23300.00	1538.53	.81	6.02	.00	932.00	678.60
	13.550	23300.00	1543.09	.00	5.37	.00	1648.66	787.30
	13.550	23300.00	1544.06	.97	5.53	.00	1258.00	787.30
	13.660	23300.00	1547.65	.00	4.56	.00	1912.62	549.10
	13.660	23300.00	1548.19	.54	4.13	.00	1427.00	549.10
	13.860	23300.00	1555.73	.00	8.08	.00	1715.14	1049.10
	13.860	23300.00	1556.31	.58	8.11	.00	1282.28	1049.10
	14.070	23300.00	1564.42	.00	8.69	.00	1909.12	1134.10
	14.070	23300.00	1564.58	.16	8.27	.00	1724.00	1134.10
*	14.300	23300.00	1573.99	.00	9.57	.00	2146.54	1213.60
*	14.300	23300.00	1574.76	.78	10.18	.00	950.00	1213.60

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=     13.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     13.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

WARNING SECNO=     13.160  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     13.160  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     13.400  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     13.400  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     14.300  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     14.300  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     14.300  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     14.300  PROFILE=  2  MINIMUM SPECIFIC ENERGY
```

Floodway width summary: MONT. WAT. AND HEC
Profile No. 2

Section Number	Elevation Increase	Top Width	Left Encroach Station	Left Sta Distance From Center	Center Station	Right Sta Distance From Center	Right Encroach Station
13.000	.00	245.00	9820.00	122.50	9942.50	122.50	10065.00
13.020	.00	245.00	9820.00	122.50	9942.50	122.50	10065.00
13.040	.00	813.00	9537.00	388.50	9925.50	424.50	10350.00
13.080	.00	1129.00	9550.00	348.50	9898.50	780.50	10679.00
13.160	.00	1395.00	9421.00	699.50	10120.50	695.50	10816.00
13.280	.00	1265.00	9537.00	353.50	9890.50	911.50	10802.00
13.400	.81	932.00	9670.00	324.50	9994.50	607.50	10602.00
13.550	.97	1258.00	9236.00	855.00	10091.00	403.00	10494.00
13.660	.54	1427.00	9055.00	926.50	9981.50	500.50	10482.00
13.860	.58	1524.00	8708.00	978.00	9686.00	546.00	10232.00
14.070	.16	1724.00	8805.00	1164.00	9969.00	560.00	10529.00
14.300	.78	950.00	9210.00	765.00	9975.00	185.00	10160.00

FLOODWAY DATA, MONT. WAT. AND HEC
PROFILE NO. 2

STATION	FLOODWAY WIDTH	FLOODWAY SECTION AREA	FLOODWAY MEAN VELOCITY	WATER SURFACE ELEVATION WITH FLOODWAY	WATER SURFACE ELEVATION WITHOUT FLOODWAY	DIFFERENCE
13.000	245.	1093.	12.0	1523.0	1523.0	.0
13.020	245.	1316.	10.0	1524.4	1524.4	.0
13.040	395.	2145.	6.1	1525.9	1525.9	.0
13.080	1095.	3797.	3.5	1526.9	1526.9	.0
13.160	1374.	2858.	4.6	1528.1	1528.1	.0
13.280	1265.	2385.	6.6	1532.5	1532.5	.0
13.400	932.	3659.	6.4	1538.5	1537.7	.8
13.550	1258.	4074.	5.7	1544.1	1543.1	1.0
13.660	1427.	3886.	6.0	1548.1	1547.6	.5
13.860	1524.	3993.	5.8	1556.3	1555.7	.6
14.070	1724.	3662.	6.4	1564.6	1564.4	.2
14.300	950.	2810.	8.3	1574.8	1574.0	.8

```
1*****************************************
 *  HEC-2 WATER SURFACE PROFILES          *
 *                                        *
 *  Version   4.6.2;  May 1991            *
 *                                        *
 *  RUN DATE    23SEP03    TIME   15:25:58 *
 *****************************************
```

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*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  HYDROLOGIC ENGINEERING CENTER    *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616-4687     *
*          (916) 756-1104           *
*************************************
```

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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

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23SEP03 15:25:58 PAGE 1

REVISED EXISTING CONDITIONS

THIS RUN EXECUTED 23SEP03 15:25:58

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*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.2;  May 1991
*************************************


  REVISED EXISTING CONDITIONS
  SEPTEMBER 2003 SUBMITTAL TO FEMA FOR LOMR
          REVISE EXISTING CONDITIONS FOR 2001 DISCHARGE
          REVISE EXISTING CONDITIONS FOR NEW TOPOGRAPHY
            Replace section 13.66 with 13.7 (updated topo at new bridge site)
            Adjust reach lengths (13.7 is 129' more upstream than 13.66)
            fix starting water surface at 13.28 as downstream match section
            use FIS HEC-2 discharge of 15,700 at 13.28
            starting at 13.4 use updated 100-year discharge of 26,700
            correct ET stationing for 13.7 (old-7400=new)
T1 SKUNK CREEK HYDRAULIC ANALYSIS FOR PROPOSED NORTH GATEWAY ACCESS ROAD
T2 100-YEAR FLOODPLAIN AND FLOODWAY
T3      REVISED EXISTING CONDITIONS

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                                                         1532.5
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J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1		-1							

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

	38	43	1	8	42	3	2	26	5	39
	53	4	54	110	115	150	200			
QT	2	15700	15700							
NC	.038	.042	.052							
ET		9.1	9.1						9537	10802
X1	13.28	65	9671	10110	390	610	600			
GR	1536	8217	1534.9	8297	1534.2	8552	1534.3	8677	1534	8812
GR	1532	8979	1530	9107	1529.3	9165	1530	9205	1532	9255
GR	1532.2	9337	1531.5	9390	1531.5	9439	1530.1	9484	1525.7	9507
GR	1526.0	9523	1529.8	9537	1530.1	9605	1530.9	9671	1530.2	9682
GR	1530.4	9709	1531.2	9726	1531.3	9776	1530.4	9840	1529.7	9851
GR	1530.9	9901	1531.6	9962	1530.6	9975	1522.9	9991	1522.6	10000
GR	1522.9	10034	1530.4	10052	1530.6	10083	1527.4	10097	1531.2	10110
GR	1531.0	10143	1531.2	10169	1532.3	10193	1532.9	10222	1532.2	10250
GR	1532.2	10302	1532.2	10347	1531.6	10363	1532.0	10389	1531.1	10421
GR	1531.1	10475	1531.1	10529	1529.7	10581	1530.3	10594	1530.6	10634
GR	1530.0	10654	1530.5	10667	1529.9	10697	1531.7	10727	1532.2	10771
GR	1532.9	10840	1533.5	10884	1533.9	10956	1533.3	10961	1534.6	10969
GR	1534.9	10995	1534.0	11002	1533.5	11019	1534.9	11025	1535.4	11065

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QT	2	26700	26700							
ET			7.1				9670	10602		
X1	13.40	73	9670	10319	650	590	678.6			
GR	1540	8520	1538	8940	1536	9105	1535	9155	1536	9197
GR	1536.2	9202	1536	9212	1535.9	9214.5	1536	9217	1536.5	9287
GR	1536	9359	1535.5	9414	1536	9474	1537.5	9641	1537.6	9670
GR	1536.4	9692	1534.6	9719	1527.4	9732	1530.8	9748	1532.1	9770
GR	1530.0	9782	1534.1	9800	1533.9	9820	1535.3	9840	1534.9	9849
GR	1535.8	9866	1536.5	9908	1537.1	9939	1536.9	9968	1535.2	9980
GR	1529.0	9994	1528.7	10000	1529.7	10010	1534.5	10033	1534.1	10063
GR	1534.3	10084	1534.3	10102	1536.0	10133	1536.4	10164	1535.0	10177
GR	1535.9	10194	1535.2	10209	1526.8	10246	1528.5	10252	1529.1	10269
GR	1537.1	10289	1537.5	10319	1536.6	10361	1535.1	10379	1535.3	10395
GR	1536.0	10422	1535.1	10447	1535.7	10465	1535.8	10514	1535.1	10539
GR	1535.0	10600	1535.4	10653	1535.5	10687	1535.0	10726	1534.3	10744
GR	1534.4	10772	1535.1	10797	1534.7	10833	1535.5	10874	1535.5	10910
GR	1535.1	10944	1534.7	11001	1535.1	11027	1539.0	11043	1538.8	11070
GR	1537.4	11080	1540.1	11101	1539.6	11142				

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ET                          7.1                                     9236      10494
X1    13.55        79      9688     10494       740       850     787.3
GR   1544.6      8416    1544.5      8496    1543.9      8598    1543.5      8689    1542.8      8797
GR   1542.2      8877    1541.9      8929    1541.3      8950    1540.3      8963    1539.6      8985
GR   1540.1      8993    1540.1      9040    1539.8      9081    1540.4      9104    1540.0      9157
GR   1540.8      9241    1541.2      9311    1540.5      9346    1541.0      9443    1540.2      9451
GR   1541.2      9464    1541.0      9477    1541.9      9510    1542.7      9558    1543.1      9592
GR   1543.3      9645    1543.1      9688    1541.9      9715    1539.8      9736    1540.1      9742
GR   1538.2      9757    1537.4      9776    1532.2      9787    1535.6      9804    1540.7      9828
GR   1539.7      9836    1541.7      9855    1541.6      9877    1542.0      9897    1541.4      9930
GR   1541.8      9965    1535.8      9988    1535.2     10000    1538.4     10010    1540.8     10031
GR   1540.9     10045    1540.5     10054    1541.3     10065    1541.2     10098    1541.8     10123
GR   1541.3     10132    1542.7     10150    1541.1     10176    1539.5     10191    1538.7     10208
GR   1537.7     10219    1539.2     10233    1541.4     10262    1541.1     10270    1542.0     10283
GR   1542.3     10307    1541.4     10349    1537.3     10370    1537.9     10380    1537.0     10394
GR   1538.6     10403    1541.0     10432    1542.6     10456    1543.0     10494    1544.4     10550
GR   1544.5     10623    1545.0     10680    1545.2     10743    1544.8     10802    1544.6     10856
GR   1544.2     10907    1544.1     10973    1545.1     10985    1545.3     10993

NC     .038      .042      .025
ET                9.1       7.1                                     1655      3063       935      3063
X1    13.7        58      2133      3027       610       650       659
GR    1549      1000      1548      1155      1547      1333      1545      1417      1544      1521
GR  1543.3      1527      1544      1533      1545      1629      1546      1780    1546.6      1907
GR    1546      2021      1545      2024    1544.5      2027      1545      2030      1546      2070
GR    1545      2097      1546      2108      1544      2120      1545      2126      1544      2133
GR    1543      2137      1543      2150      1542      2162    1541.6      2165      1542      2167
GR    1543      2173      1546      2185      1546      2200      1545      2208      1546      2215
GR    1545      2228      1545      2271      1547      2280      1547      2424      1546      2434
GR  1545.7      2441      1546      2447      1548      2471      1548      2520      1549      2555
GR    1548      2585      1543      2603      1542      2606      1543      2614      1543      2665
GR    1544      2673      1548      2697      1548      2919      1544      2968      1543      2981
GR  1542.6      2983      1543      2985      1544      2992      1544      3014      1546      3027
GR    1547      3060      1550      3089      1551      3135
1
   23SEP03      15:25:58                                                                    PAGE    3


NC     .038      .042      .052
         CROSS-SECTION PROVIDED BY AERIAL MAPPER SKEWED TO CONTAIN FLOW
ET                9.1       7.1                                     8708     10232      8212     10433
X1    13.86        90      9330     10042       950       940       939
GR   1556.0      8212    1554.0      8550    1553.0      8600    1553.4      8617    1552.4      8685
GR   1551.6      8708    1551.5      8749    1550.6      8759    1551.7      8767    1552.1      8788
GR   1551.5      8817    1554.3      8863    1555.1      8895    1555.4      8908    1555.1      8935
GR   1555.0      8975    1555.5      9022    1556.1      9072    1556.9      9125    1557.1      9165
GR   1557.3      9223    1556.6      9242    1557.3      9263    1557.4      9298    1557.0      9319
GR   1556.1      9330    1553.5      9344    1552.5      9379    1551.4      9393    1552.9      9404
GR   1552.7      9416    1551.9      9420    1553.3      9429    1553.2      9446    1549.8      9464
GR   1549.3      9472    1549.8      9494    1553.0      9513    1553.6      9535    1553.4      9596
GR   1552.9      9605    1553.3      9613    1553.5      9634    1553.4      9666    1553.2      9716
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GR   1552.5       9727     1553.4       9739      1552.6       9770      1553.6       9784      1553.4       9803
GR   1551.8       9819     1551.2       9831      1552.5       9842      1551.1       9855      1553.3       9864
GR   1553.3       9885     1551.8       9919      1549.0       9936      1549.0       9948      1551.6       9970
GR   1550.4       9983     1547.6       9991      1546.3      10000      1551.6      10009      1554.6      10023
GR   1555.7      10042     1555.6      10083      1554.3      10149      1550.9      10159      1552.6      10171
GR   1554.4      10197     1554.7      10232      1556.0      10271      1557.0      10327      1557.5      10379
GR   1557.7      10433     1557.5      10477      1557.5      10546      1557.7      10596      1557.6      10656
GR   1557.4      10695     1557.1      10752      1556.8      10820      1556.5      10873      1556.1      10945
GR   1555.9      10962     1555.7      11006      1558.1      11035      1561.0      11054      1561.7      11092
        CROSS-SECTION PROVIDED BY AERIAL MAPPER SKEWED TO CONTAIN FLOW

ET                 9.1        7.1                                   8805      10529       8530      10608
X1    14.07         65       9879      10059       1050       1100      1134.1
GR   1565.4       8530       1564       8652       1562       8685      1560.7       8705      1560.7       8805
GR     1562       8920     1562.4       9043     1562.8       9116      1563.1       9185      1562.8       9201
GR   1562.8       9250     1563.3       9286     1563.7       9321      1563.4       9353      1562.5       9394
GR   1561.5       9417     1561.4       9462     1562.3       9530      1562.4       9554      1562.0       9566
GR   1562.0       9614     1562.3       9680     1563.1       9746      1563.6       9814      1564.0       9855
GR   1564.3       9879     1560.9       9898     1561.4       9904      1558.5       9924      1558.9       9938
GR   1558.9       9959     1557.5       9972     1557.5       9978      1558.5      10000      1562.0      10020
GR   1562.6      10040     1564.5      10059     1564.0      10077      1563.5      10125      1563.1      10151
GR   1562.6      10166     1562.7      10176     1562.2      10201      1563.1      10217      1563.0      10249
GR   1563.1      10300     1563.0      10338     1563.2      10381      1563.1      10396      1562.3      10404
GR   1563.1      10408     1563.1      10454     1563.1      10499      1564.1      10516      1565.5      10571
GR   1566.0      10608     1565.9      10656     1565.8      10710      1565.6      10758      1564.7      10813
GR   1564.3      10848     1564.8      10873     1565.1      10923      1570.0      10950      1570.8      10989

        The following GR record has been modified as per discussion with the
        FEMA technical evaluator. From station 8450 to station 9500, the
        elevations are read from the topographic map. From station 9563 to
        station 11361, the elevations remain the same as provided by the
        Aerial Mapping Company, Inc (AMCI) (March 17, 1998).

ET                            7.1                                   9210      10160
X1    14.30         73       9923      10027       1010       1210      1213.6
GR   1576.2       8450     1575.9       8550     1574.1       8650      1573.7       8750      1573.5       8850
GR   1573.4       8950     1573.3       9050     1572.5       9150      1572.5       9250      1571.9       9350
GR   1571.9       9450     1573.5       9500     1573.8       9563      1574.2       9626      1573.5       9652
GR   1573.1       9672     1573.8       9707     1573.7       9731      1573.8       9769      1573.2       9788
1
   23SEP03      15:25:58                                                                                   PAGE     4

GR   1573.2       9836     1572.9       9878     1572.4       9906      1571.6       9923      1570.4       9941
GR   1565.1       9961     1565.2       9967     1560.0       9973      1560.3       9983      1559.6      10000
GR   1566.5      10011     1570.0      10027     1570.1      10045      1569.4      10052      1570.1      10062
GR   1571.0      10097     1571.2      10131     1571.1      10157      1572.5      10191      1572.9      10211
GR   1572.6      10251     1572.3      10297     1572.5      10351      1572.2      10386      1571.8      10410
GR   1572.1      10417     1571.7      10437     1571.7      10448      1571.5      10480      1571.6      10515
GR   1572.7      10552     1572.9      10571     1572.7      10608      1572.4      10642      1571.4      10681
GR   1571.6      10735     1571.9      10765     1572.0      10792      1571.2      10804      1571.8      10811
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GR   1573.2      10852     1575.9      10899      1577.1      10931      1577.9      10967      1578.4      10992
GR   1578.7      11034     1578.6      11096      1578.4      11179      1578.2      11233      1577.7      11273
GR   1582.1      11295     1582.8      11336      1577.8      11361
1
   23SEP03      15:25:58                                                                                    PAGE    5

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 *PROF 1
0

 *SECNO 13.280

 3265 DIVIDED FLOW


 3470 ENCROACHMENT STATIONS=     9537.0   10802.0  TYPE=      1  TARGET=     1265.000
    13.280      9.90   1532.50       .00        .00   1533.21       .71        .00        .00   1530.90
   15700.0    2428.8    8758.7    4512.5      305.4    1278.4     787.5         .0         .0   1531.20
       .00      7.95      6.85      5.73       .038      .052      .042       .000    1522.60   9537.00
   .014002      390.      600.      610.          0         0         0        .00    1228.23  10800.57


 *SECNO 13.400

 3265 DIVIDED FLOW


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.61

    13.400     11.06   1537.86       .00        .00   1538.26       .40       5.05        .00   1537.60
   26700.0    4486.1   12725.6    9488.4     1060.9    2421.9    1822.1       56.7       24.2   1537.50
       .04      4.23      5.25      5.21       .038      .052      .042       .000    1526.80   8951.61
   .005936      650.      679.      590.          5         0         0        .00    2093.56  11083.57


 *SECNO 13.550
    13.550     11.15   1543.35       .00        .00   1543.98       .62       5.72        .00   1543.10
   26700.0   12889.3   13808.1       2.6     1847.5    2426.2       2.5      143.0       59.0   1543.00
       .07      6.98      5.69      1.06       .038      .052      .042       .000    1532.20   8711.90
   .009204      740.      787.      850.          4         0         0        .00    1796.16  10508.06


 *SECNO 13.700

 3265 DIVIDED FLOW
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3470 ENCROACHMENT STATIONS=      935.0    3063.0  TYPE=      1  TARGET=     2128.000
    13.700       6.58   1548.18       .00       .00   1548.90       .73      4.92       .00   1544.00
   26700.0    14093.5   12374.1     232.4    2274.2    1640.0      58.4     203.1      85.7   1546.00
       .10       6.20      7.55      3.98      .038      .025      .042      .000   1541.60   1127.75
   .006640       610.      659.      650.         2         0         0       .00   1881.67   3063.00
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    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

*SECNO 13.860

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS=     8212.0   10433.0  TYPE=      1  TARGET=     2221.000
    13.860       9.46   1555.76       .00       .00   1556.46       .70      7.56       .00   1556.10
   26700.0    10294.4   15012.2    1393.4    1399.7    2377.3     257.6     289.8     124.8   1555.70
       .14       7.35      6.31      5.41      .038      .052      .042      .000   1546.30   8251.09
   .009837       950.      939.      940.         2         0         0       .00   1725.57  10264.06

*SECNO 14.070

3470 ENCROACHMENT STATIONS=     8530.0   10608.0  TYPE=      1  TARGET=     2078.000
    14.070       7.26   1564.76       .00       .00   1565.32       .57      8.87       .00   1564.30
   26700.0    18460.6    5176.5    3062.9    2977.9     806.4     742.6     396.7     170.4   1564.50
       .19       6.20      6.42      4.12      .038      .052      .042      .000   1557.50   8585.92
   .006883      1050.     1134.     1100.         2         0         0       .00   1955.94  10541.86

*SECNO 14.300

3265 DIVIDED FLOW

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    14.300      14.56   1574.16   1574.16       .00   1575.11       .96      8.54       .00   1571.60
   26700.0     5911.9    9803.7   10984.5    1321.1     906.8    1866.4     506.6     222.4   1570.00
       .23       4.47     10.81      5.89      .038      .052      .042      .000   1559.60   8646.76
   .008496      1010.     1214.     1210.         4        18         0       .00   2213.82  10868.68
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T1      Floodway Run - Method 1
T2      Updated:  9-2-03
T3      Floodway Run - Method 1

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

     -10        3                                                          1532.5

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

      2                 -1

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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST

 *PROF 2
0

 *SECNO 13.280

 3265 DIVIDED FLOW


 3470 ENCROACHMENT STATIONS=     9537.0   10802.0  TYPE=      1  TARGET=     1265.000
    13.280      9.90   1532.50       .00   1532.50   1533.21       .71       .00       .00   1530.90
   15700.0    2428.8    8758.7    4512.5     305.4    1278.4     787.5        .0        .0   1531.20
       .00      7.95      6.85      5.73      .038      .052      .042      .000   1522.60   9537.00
   .014002      390.      600.      610.         0         0         0       .00   1228.23  10800.57


 *SECNO 13.400

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.26


 3470 ENCROACHMENT STATIONS=     9670.0   10602.0  TYPE=      1  TARGET=      932.000
    13.400     11.94   1538.74       .00   1537.86   1539.48       .75      6.28       .00   1537.60
   26700.0        .0   20872.9    5827.1        .0    2991.6     863.5      46.7      15.8   1537.50
       .03       .00      6.98      6.75      .000      .052      .042      .000   1526.80   9670.00
   .007915      650.      679.      590.         5         0         0       .00    932.00  10602.00
```

*SECNO 13.550

3470 ENCROACHMENT STATIONS= 9236.0 10494.0 TYPE= 1 TARGET= 1258.000

13.550	12.22	1544.42	.00	1543.35	1544.97	.55	5.49	.00	1543.10
26700.0	7919.2	18780.8	.0	1230.3	3289.2	.0	122.4	35.6	100000.00
.06	6.44	5.71	.00	.038	.052	.000	.000	1532.20	9236.00
.006188	740.	787.	850.	4	0	0	.00	1258.00	10494.00

*SECNO 13.700

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3470 ENCROACHMENT STATIONS= 1655.0 3063.0 TYPE= 1 TARGET= 1408.000

13.700	6.88	1548.48	1548.39	1548.18	1549.62	1.14	4.65	.00	1544.00
26700.0	8638.2	17710.8	351.0	1246.5	1902.4	69.5	179.5	55.0	1546.00
.08	6.93	9.31	5.05	.038	.025	.042	.000	1541.60	1655.00
.008557	610.	659.	650.	6	14	0	.00	1374.48	3063.00

*SECNO 13.860

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= 8708.0 10232.0 TYPE= 1 TARGET= 1524.000

13.860	10.13	1556.43	.00	1555.76	1557.09	.66	7.47	.00	1556.10
26700.0	7145.3	17563.1	1991.6	939.2	2852.1	367.2	259.3	83.8	1555.70
.12	7.61	6.16	5.42	.038	.052	.042	.000	1546.30	8708.00
.007363	950.	939.	940.	4	0	0	.00	1292.36	10232.00

*SECNO 14.070

3470 ENCROACHMENT STATIONS= 8805.0 10529.0 TYPE= 1 TARGET= 1724.000

14.070	7.39	1564.89	.00	1564.76	1565.55	.66	8.46	.00	1564.30
26700.0	16972.7	5922.9	3804.3	2567.4	831.0	804.6	364.3	121.4	1564.50
.17	6.61	7.13	4.73	.038	.052	.042	.000	1557.50	8805.00

.008154	1050.	1134.	1100.	4	0	0	.00	1724.00	10529.00

*SECNO 14.300

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 9210.0 10160.0 TYPE= 1 TARGET= 950.000

14.300	15.45	1575.05	1575.05	1574.16	1576.49	1.44	9.47	.00	1571.60
26700.0	9651.6	11807.3	5241.1	1498.7	999.6	585.1	456.2	154.5	1570.00
.20	6.44	11.81	8.96	.038	.052	.042	.000	1559.60	9210.00
.008905	1010.	1214.	1210.	3	14	0	.00	950.00	10160.00

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THIS RUN EXECUTED 23SEP03 15:25:58

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HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

REVISED EXISTING CONDITI

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	ELMIN	EG	CRIWS	VCH	10*KS	XLCH	SSTA	TOPWID	ENDST
	13.280	15700.00	1532.50	9.90	1522.60	1533.21	.00	6.85	140.02	.00	9537.00	1228.23	10800.57
	13.280	15700.00	1532.50	9.90	1522.60	1533.21	.00	6.85	140.02	.00	9537.00	1228.23	10800.57
*	13.400	26700.00	1537.86	11.06	1526.80	1538.26	.00	5.25	59.36	678.60	8951.61	2093.56	11083.57
*	13.400	26700.00	1538.74	11.94	1526.80	1539.48	.00	6.98	79.15	678.60	9670.00	932.00	10602.00
	13.550	26700.00	1543.35	11.15	1532.20	1543.98	.00	5.69	92.04	787.30	8711.90	1796.16	10508.06
	13.550	26700.00	1544.42	12.22	1532.20	1544.97	.00	5.71	61.88	787.30	9236.00	1258.00	10494.00
	13.700	26700.00	1548.18	6.58	1541.60	1548.90	.00	7.55	66.40	659.00	1127.75	1881.67	3063.00
	13.700	26700.00	1548.48	6.88	1541.60	1549.62	1548.39	9.31	85.57	659.00	1655.00	1374.48	3063.00

	13.860	26700.00	1555.76	9.46	1546.30	1556.46	.00	6.31	98.37	939.00	8251.09	1725.57	10264.06
	13.860	26700.00	1556.43	10.13	1546.30	1557.09	.00	6.16	73.63	939.00	8708.00	1292.36	10232.00
	14.070	26700.00	1564.76	7.26	1557.50	1565.32	.00	6.42	68.83	1134.10	8585.92	1955.94	10541.86
	14.070	26700.00	1564.89	7.39	1557.50	1565.55	.00	7.13	81.54	1134.10	8805.00	1724.00	10529.00
*	14.300	26700.00	1574.16	14.56	1559.60	1575.11	1574.16	10.81	84.96	1213.60	8646.76	2213.82	10868.68
*	14.300	26700.00	1575.05	15.45	1559.60	1576.49	1575.05	11.81	89.05	1213.60	9210.00	950.00	10160.00

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REVISED EXISTING CONDITI

SUMMARY PRINTOUT TABLE 110

	SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
	13.280	1532.50	.00	1533.21	1228.23	2428.84	8758.70	4512.46	1265.00	9537.00	9671.00	10110.00	10802.00
	13.280	1532.50	.00	1533.21	1228.23	2428.84	8758.70	4512.46	1265.00	9537.00	9671.00	10110.00	10802.00
*	13.400	1537.86	.00	1538.26	2093.56	4486.06	12725.58	9488.36	.00	.00	9670.00	10319.00	.00
*	13.400	1538.74	.88	1539.48	932.00	.00	20872.87	5827.13	932.00	9670.00	9670.00	10319.00	10602.00
	13.550	1543.35	.00	1543.98	1796.16	12889.30	13808.06	2.63	.00	.00	9688.00	10494.00	.00
	13.550	1544.42	1.07	1544.97	1258.00	7919.23	18780.77	.00	1258.00	9236.00	9688.00	10494.00	10494.00
	13.700	1548.18	.00	1548.90	1881.67	14093.52	12374.08	232.40	2128.00	935.00	2133.00	3027.00	3063.00
	13.700	1548.48	.31	1549.62	1374.48	8638.20	17710.84	350.96	1408.00	1655.00	2133.00	3027.00	3063.00
	13.860	1555.76	.00	1556.46	1725.57	10294.38	15012.21	1393.41	2221.00	8212.00	9330.00	10042.00	10433.00
	13.860	1556.43	.67	1557.09	1292.36	7145.35	17563.07	1991.58	1524.00	8708.00	9330.00	10042.00	10232.00
	14.070	1564.76	.00	1565.32	1955.94	18460.63	5176.48	3062.89	2078.00	8530.00	9879.00	10059.00	10608.00
	14.070	1564.89	.14	1565.55	1724.00	16972.74	5922.95	3804.31	1724.00	8805.00	9879.00	10059.00	10529.00
*	14.300	1574.16	.00	1575.11	2213.82	5911.86	9803.67	10984.46	.00	.00	9923.00	10027.00	.00
*	14.300	1575.05	.89	1576.49	950.00	9651.63	11807.28	5241.09	950.00	9210.00	9923.00	10027.00	10160.00

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REVISED EXISTING CONDITI

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K

	13.280	.00	.00	.00	1522.60	15700.00	1532.50	.00	1533.21	140.02	6.85	2371.26	1326.80
	13.280	.00	.00	.00	1522.60	15700.00	1532.50	.00	1533.21	140.02	6.85	2371.26	1326.80
*	13.400	678.60	.00	.00	1526.80	26700.00	1537.86	.00	1538.26	59.36	5.25	5304.82	3465.37
*	13.400	678.60	.00	.00	1526.80	26700.00	1538.74	.00	1539.48	79.15	6.98	3855.08	3001.10
	13.550	787.30	.00	.00	1532.20	26700.00	1543.35	.00	1543.98	92.04	5.69	4276.14	2783.11
	13.550	787.30	.00	.00	1532.20	26700.00	1544.42	.00	1544.97	61.88	5.71	4519.50	3394.20
	13.700	659.00	.00	.00	1541.60	26700.00	1548.18	.00	1548.90	66.40	7.55	3972.55	3276.74
	13.700	659.00	.00	.00	1541.60	26700.00	1548.48	1548.39	1549.62	85.57	9.31	3218.36	2886.41
	13.860	939.00	.00	.00	1546.30	26700.00	1555.76	.00	1556.46	98.37	6.31	4034.53	2692.08
	13.860	939.00	.00	.00	1546.30	26700.00	1556.43	.00	1557.09	73.63	6.16	4158.49	3111.69
	14.070	1134.10	.00	.00	1557.50	26700.00	1564.76	.00	1565.32	68.83	6.42	4526.89	3218.21
	14.070	1134.10	.00	.00	1557.50	26700.00	1564.89	.00	1565.55	81.54	7.13	4202.99	2956.87
*	14.300	1213.60	.00	.00	1559.60	26700.00	1574.16	1574.16	1575.11	84.96	10.81	4094.24	2896.69
*	14.300	1213.60	.00	.00	1559.60	26700.00	1575.05	1575.05	1576.49	89.05	11.81	3083.38	2829.43

REVISED EXISTING CONDITI

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	13.280	15700.00	1532.50	.00	.00	.00	1228.23	.00
	13.280	15700.00	1532.50	.00	.00	.00	1228.23	.00
*	13.400	26700.00	1537.86	.00	5.36	.00	2093.56	678.60
*	13.400	26700.00	1538.74	.88	6.24	.88	932.00	678.60
	13.550	26700.00	1543.35	.00	5.49	.00	1796.16	787.30
	13.550	26700.00	1544.42	1.07	5.69	1.07	1258.00	787.30
	13.700	26700.00	1548.18	.00	4.82	.00	1881.67	659.00
	13.700	26700.00	1548.48	.31	4.06	.31	1374.48	659.00
	13.860	26700.00	1555.76	.00	7.59	.00	1725.57	939.00
	13.860	26700.00	1556.43	.67	7.95	.67	1292.36	939.00
	14.070	26700.00	1564.76	.00	8.99	.00	1955.94	1134.10
	14.070	26700.00	1564.89	.14	8.46	.14	1724.00	1134.10
*	14.300	26700.00	1574.16	.00	9.40	.00	2213.82	1213.60

```
*     14.300  26700.00   1575.05       .89     10.16       .89    950.00   1213.60
```


SUMMARY OF ERRORS AND SPECIAL NOTES

```
WARNING SECNO=     13.400  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     13.400  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     14.300  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     14.300  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     14.300  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     14.300  PROFILE=  2  MINIMUM SPECIFIC ENERGY
```


Floodway width summary: REVISED EXISTING CONDITI
Profile No. 2

Section Number	Elevation Increase	Top Width	Left Encroach Station	Left Sta Distance From Center	Center Station	Right Sta Distance From Center	Right Encroach Station
13.280	.00	1265.00	9537.00	353.50	9890.50	911.50	10802.00
13.400	.88	932.00	9670.00	324.50	9994.50	607.50	10602.00
13.550	1.07	1258.00	9236.00	855.00	10091.00	403.00	10494.00
13.700	.31	1408.00	1655.00	925.00	2580.00	483.00	3063.00
13.860	.67	1524.00	8708.00	978.00	9686.00	546.00	10232.00
14.070	.14	1724.00	8805.00	1164.00	9969.00	560.00	10529.00
14.300	.89	950.00	9210.00	765.00	9975.00	185.00	10160.00

FLOODWAY DATA, REVISED EXISTING CONDITI
PROFILE NO. 2

STATION	FLOODWAY WIDTH	FLOODWAY SECTION AREA	FLOODWAY MEAN VELOCITY	WATER SURFACE ELEVATION WITH FLOODWAY	WITHOUT FLOODWAY	DIFFERENCE

13.280	1264.	2371.	6.6	1532.5	1532.5	.0
13.400	932.	3855.	6.9	1538.8	1537.9	.9
13.550	1258.	4520.	5.9	1544.5	1543.4	1.1
13.700	1408.	3218.	8.3	1548.5	1548.2	.3
13.860	1524.	4158.	6.4	1556.5	1555.8	.7
14.070	1724.	4203.	6.4	1564.9	1564.8	.1
14.300	950.	3083.	8.7	1575.1	1574.2	.9

```
1*****************************************
 *  HEC-2 WATER SURFACE PROFILES           *
 *                                         *
 *  Version   4.6.2;  May 1991             *
 *                                         *
 *  RUN DATE    24SEP03    TIME   17:29:52 *
 *****************************************
```

```
****************************************
*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
****************************************
```

NEW BRIDGES

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

1

24SEP03 17:29:52 PAGE 1

THIS RUN EXECUTED 24SEP03 17:29:52

```
*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.2;  May 1991
*************************************
```

```
    September 2003 Final Modifications for LOMR Submittal
    Proposed New Bridges along North Gateway Access Road
    Use Normal Bridge Routine to model low-flow bridges at section 13.7
       fix starting water surface at 13.28 as downstream match section
       use FIS HEC-2 discharge of 15,700 at 13.28
       starting at 13.4 use updated 100-year discharge of 26,700
       correct ET stationing for new sections at bridge (old-7400=new)
T1 SKUNK CREEK HYDRAULIC ANALYSIS FOR PROPOSED NORTH GATEWAY ACCESS ROAD
T2 100-YEAR FLOODPLAIN AND FLOODWAY
T3      PROPOSED LOW FLOW BRIDGES AT SECTION 13.7

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

                2                                                                  1532.5

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE
```

1 -1

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

	38	43	1	8	42	3	2	26	5	39
	53	4	54	110	115	150	200			
QT	2	15700	15700							
NC	.038	.042	.052							
ET		9.1	9.1						9537	10802
X1	13.28	65	9671	10110	390	610	600			
GR	1536	8217	1534.9	8297	1534.2	8552	1534.3	8677	1534	8812
GR	1532	8979	1530	9107	1529.3	9165	1530	9205	1532	9255
GR	1532.2	9337	1531.5	9390	1531.5	9439	1530.1	9484	1525.7	9507
GR	1526.0	9523	1529.8	9537	1530.1	9605	1530.9	9671	1530.2	9682
GR	1530.4	9709	1531.2	9726	1531.3	9776	1530.4	9840	1529.7	9851
GR	1530.9	9901	1531.6	9962	1530.6	9975	1522.9	9991	1522.6	10000
GR	1522.9	10034	1530.4	10052	1530.6	10083	1527.4	10097	1531.2	10110
GR	1531.0	10143	1531.2	10169	1532.3	10193	1532.9	10222	1532.2	10250
GR	1532.2	10302	1532.2	10347	1531.6	10363	1532.0	10389	1531.1	10421
GR	1531.1	10475	1531.1	10529	1529.7	10581	1530.3	10594	1530.6	10634
GR	1530.0	10654	1530.5	10667	1529.9	10697	1531.7	10727	1532.2	10771
GR	1532.9	10840	1533.5	10884	1533.9	10956	1533.3	10961	1534.6	10969
GR	1534.9	10995	1534.0	11002	1533.5	11019	1534.9	11025	1535.4	11065

1

QT	2	26700	26700							
ET			7.1				9670	10602		
X1	13.40	73	9670	10319	650	590	678.6			
GR	1540	8520	1538	8940	1536	9105	1535	9155	1536	9197
GR	1536.2	9202	1536	9212	1535.9	9214.5	1536	9217	1536.5	9287
GR	1536	9359	1535.5	9414	1536	9474	1537.5	9641	1537.6	9670
GR	1536.4	9692	1534.6	9719	1527.4	9732	1530.8	9748	1532.1	9770
GR	1530.0	9782	1534.1	9800	1533.9	9820	1535.3	9840	1534.9	9849
GR	1535.8	9866	1536.5	9908	1537.1	9939	1536.9	9968	1535.2	9980
GR	1529.0	9994	1528.7	10000	1529.7	10010	1534.5	10033	1534.1	10063
GR	1534.3	10084	1534.3	10102	1536.0	10133	1536.4	10164	1535.0	10177
GR	1535.9	10194	1535.2	10209	1526.8	10246	1528.5	10252	1529.1	10269
GR	1537.1	10289	1537.5	10319	1536.6	10361	1535.1	10379	1535.3	10395
GR	1536.0	10422	1535.1	10447	1535.7	10465	1535.8	10514	1535.1	10539
GR	1535.0	10600	1535.4	10653	1535.5	10687	1535.0	10726	1534.3	10744
GR	1534.4	10772	1535.1	10797	1534.7	10833	1535.5	10874	1535.5	10910
GR	1535.1	10944	1534.7	11001	1535.1	11027	1539.0	11043	1538.8	11070
GR	1537.4	11080	1540.1	11101	1539.6	11142				
ET			7.1				9150	10494		
X1	13.55	79	9688	10494	740	850	787.3			
GR	1544.6	8416	1544.5	8496	1543.9	8598	1543.5	8689	1542.8	8797

```
GR   1542.2      8877    1541.9      8929    1541.3      8950    1540.3      8963    1539.6      8985
GR   1540.1      8993    1540.1      9040    1539.8      9081    1540.4      9104    1540.0      9157
GR   1540.8      9241    1541.2      9311    1540.5      9346    1541.0      9443    1540.2      9451
GR   1541.2      9464    1541.0      9477    1541.9      9510    1542.7      9558    1543.1      9592
GR   1543.3      9645    1543.1      9688    1541.9      9715    1539.8      9736    1540.1      9742
GR   1538.2      9757    1537.4      9776    1532.2      9787    1535.6      9804    1540.7      9828
GR   1539.7      9836    1541.7      9855    1541.6      9877    1542.0      9897    1541.4      9930
GR   1541.8      9965    1535.8      9988    1535.2     10000    1538.4     10010    1540.8     10031
GR   1540.9     10045    1540.5     10054    1541.3     10065    1541.2     10098    1541.8     10123
GR   1541.3     10132    1542.7     10150    1541.1     10176    1539.5     10191    1538.7     10208
GR   1537.7     10219    1539.2     10233    1541.4     10262    1541.1     10270    1542.0     10283
GR   1542.3     10307    1541.4     10349    1537.3     10370    1537.9     10380    1537.0     10394
GR   1538.6     10403    1541.0     10432    1542.6     10456    1543.0     10494    1544.4     10550
GR   1544.5     10623    1545.0     10680    1545.2     10743    1544.8     10802    1544.6     10856
GR   1544.2     10907    1544.1     10973    1545.1     10985    1545.3     10993
```

Normal Bridge Routine, sections 13.7, 13.73, 13.74, 13.75
Increase expansion/contraction coefficients for 4 bridge sections
Use NH cards to show 4 channels and roadway in between
Add 2.5' to 5-ft piers for debris

```
NC     .038      .042      .025       0.3       0.5
ET               9.1       7.1                                 1550      3063       935      3063
X1     13.7       58      2133      3027       610       650      659
GR     1549     1000      1548      1155      1547      1333     1545      1417      1544      1521
GR   1543.3     1527      1544      1533      1545      1629     1546      1780    1546.6      1907
GR     1546     2021      1545      2024    1544.5      2027     1545      2030      1546      2070
GR     1545     2097      1546      2108      1544      2120     1545      2126      1544      2133
GR     1543     2137      1543      2150      1542      2162   1541.6      2165      1542      2167
GR     1543     2173      1546      2185      1546      2200     1545      2208      1546      2215
```



```
GR     1545     2228      1545      2271      1547      2280     1547      2424      1546      2434
GR   1545.7     2441      1546      2447      1548      2471     1548      2520      1549      2555
GR     1548     2585      1543      2603      1542      2606     1543      2614      1543      2665
GR     1544     2673      1548      2697      1548      2919     1544      2968      1543      2981
GR   1542.6     2983      1543      2985      1544      2992     1544      3014      1546      3027
GR     1547     3060      1550      3089      1551      3135

NH        7     0.02      2113     0.025      2191      0.02     2605     0.025      2680      0.02
NH     2976    0.025      3054      0.02      3063
ET               9.1       7.1                                 1550      3063       935      3063
X1    13.73       43      2107      3062         1         1        1
BT      -37      937    1550.5    1550.5      1212    1549.1   1549.1      1262    1548.4    1548.4
BT              1412    1545.1    1545.1      1512    1544.3   1544.3      1937    1546.4    1546.4
BT              2037    1547.7    1547.7      2106    1548.2   1548.2      2107    1548.2    1546.2
BT              2113    1548.2    1546.2      2148    1548.2   1546.2    2155.5    1548.2    1546.2
BT              2191      1548      1546      2197      1548     1546      2198      1548      1548
BT              2237    1547.5    1547.5      2337    1546.7   1546.7      2437    1547.5    1547.5
```

```
BT                 2487     1548.2     1548.2       2596     1549.2     1549.2       2597     1549.2     1547.2
BT                 2605     1549.2     1547.2       2638     1549.2     1547.2     2645.5     1549.2     1547.2
BT                 2680       1549       1547       2687       1549       1547       2688       1549       1549
BT                 2787     1548.2     1548.2       2887     1548.2     1548.2       2970     1549.3     1549.3
BT                 2971     1549.3     1547.3       2976     1549.4     1547.4       3013     1550.1     1548.1
BT               3020.5     1550.2     1548.2       3054       1551       1549       3062     1551.1     1549.1
BT                 3063     1551.1     1551.1
GR   1550.5         937     1549.1       1212     1548.4       1262     1545.1       1412     1544.3       1512
GR   1546.4        1937     1547.7       2037     1548.2       2106     1546.2       2107       1542       2113
GR   1541.6        2148     1546.2       2148     1546.2     2155.5     1541.6     2155.5       1542       2191
GR     1546        2197       1548       2198     1547.5       2237     1546.7       2337     1547.5       2437
GR   1548.2        2487     1549.2       2596     1547.2       2597       1542       2605     1542.0       2638
GR   1547.2        2638     1547.2     2645.5     1542.0     2645.5       1542       2680       1547       2687
GR     1549        2688     1548.2       2787     1548.2       2887     1549.3       2970     1547.3       2971
GR     1544        2976     1544.0       3013     1548.2       3013     1548.2     3020.5     1544.0     3020.5
GR     1544        3054     1549.1       3062     1551.1       3063
   Repeat GR cards for 13.74
   Repeat BT cards for 13.74

ET                   9.1        7.1                                       1550       3063        935       3063
X1    13.74            0                                 38         38       38
X2                                                                          1

ET                   9.1        7.1                                       1655       3063        935       3063
NC     .038         .042       .025
X1    13.75          58       2133       3027          1          1          1
GR     1549        1000       1548       1155       1547       1333       1545       1417       1544       1521
GR   1543.3        1527       1544       1533       1545       1629       1546       1780     1546.6       1907
GR     1546        2021       1545       2024     1544.5       2027       1545       2030       1546       2070
GR     1545        2097       1546       2108       1544       2120       1545       2126       1544       2133
GR     1543        2137       1543       2150       1542       2162     1541.6       2165       1542       2167
GR     1543        2173       1546       2185       1546       2200       1545       2208       1546       2215
GR     1545        2228       1545       2271       1547       2280       1547       2424       1546       2434
GR   1545.7        2441       1546       2447       1548       2471       1548       2520       1549       2555
GR     1548        2585       1543       2603       1542       2606       1543       2614       1543       2665
GR     1544        2673       1548       2697       1548       2919       1544       2968       1543       2981
GR   1542.6        2983       1543       2985       1544       2992       1544       3014       1546       3027
1
   24SEP03      17:29:52                                                                                PAGE     4


GR     1547        3060       1550       3089       1551       3135

   Adjust lengths to account for new sections
   Return n values to FIS values

NC     .038         .042       .052
         CROSS-SECTION PROVIDED BY AERIAL MAPPER SKEWED TO CONTAIN FLOW
ET                   9.1        7.1                                       8708      10232       8212      10433
X1    13.86          90       9330      10042        910        900        899
GR   1556.0        8212     1554.0       8550     1553.0       8600     1553.4       8617     1552.4       8685
GR   1551.6        8708     1551.5       8749     1550.6       8759     1551.7       8767     1552.1       8788
```

```
GR   1551.5      8817     1554.3      8863     1555.1      8895     1555.4      8908     1555.1      8935
GR   1555.0      8975     1555.5      9022     1556.1      9072     1556.9      9125     1557.1      9165
GR   1557.3      9223     1556.6      9242     1557.3      9263     1557.4      9298     1557.0      9319
GR   1556.1      9330     1553.5      9344     1552.5      9379     1551.4      9393     1552.9      9404
GR   1552.7      9416     1551.9      9420     1553.3      9429     1553.2      9446     1549.8      9464
GR   1549.3      9472     1549.8      9494     1553.0      9513     1553.6      9535     1553.4      9596
GR   1552.9      9605     1553.3      9613     1553.5      9634     1553.4      9666     1553.2      9716
GR   1552.5      9727     1553.4      9739     1552.6      9770     1553.6      9784     1553.4      9803
GR   1551.8      9819     1551.2      9831     1552.5      9842     1551.1      9855     1553.3      9864
GR   1553.3      9885     1551.8      9919     1549.0      9936     1549.0      9948     1551.6      9970
GR   1550.4      9983     1547.6      9991     1546.3     10000     1551.6     10009     1554.6     10023
GR   1555.7     10042     1555.6     10083     1554.3     10149     1550.9     10159     1552.6     10171
GR   1554.4     10197     1554.7     10232     1556.0     10271     1557.0     10327     1557.5     10379
GR   1557.7     10433     1557.5     10477     1557.5     10546     1557.7     10596     1557.6     10656
GR   1557.4     10695     1557.1     10752     1556.8     10820     1556.5     10873     1556.1     10945
GR   1555.9     10962     1555.7     11006     1558.1     11035     1561.0     11054     1561.7     11092
   Return expansion/contraction coefficients to normal

NC                                     0.1       0.3
        CROSS-SECTION PROVIDED BY AERIAL MAPPER SKEWED TO CONTAIN FLOW
ET                 9.1       7.1                                   8805     10529      8530     10608
X1    14.07         65      9879     10059      1050      1100    1134.1
GR   1565.4      8530      1564      8652      1562      8685    1560.7      8705    1560.7      8805
GR     1562      8920    1562.4      9043    1562.8      9116    1563.1      9185    1562.8      9201
GR   1562.8      9250    1563.3      9286    1563.7      9321    1563.4      9353    1562.5      9394
GR   1561.5      9417    1561.4      9462    1562.3      9530    1562.4      9554    1562.0      9566
GR   1562.0      9614    1562.3      9680    1563.1      9746    1563.6      9814    1564.0      9855
GR   1564.3      9879    1560.9      9898    1561.4      9904    1558.5      9924    1558.9      9938
GR   1558.9      9959    1557.5      9972    1557.5      9978    1558.5     10000    1562.0     10020
GR   1562.6     10040    1564.5     10059    1564.0     10077    1563.5     10125    1563.1     10151
GR   1562.6     10166    1562.7     10176    1562.2     10201    1563.1     10217    1563.0     10249
GR   1563.1     10300    1563.0     10338    1563.2     10381    1563.1     10396    1562.3     10404
GR   1563.1     10408    1563.1     10454    1563.1     10499    1564.1     10516    1565.5     10571
GR   1566.0     10608    1565.9     10656    1565.8     10710    1565.6     10758    1564.7     10813
GR   1564.3     10848    1564.8     10873    1565.1     10923    1570.0     10950    1570.8     10989
```

The following GR record has been modified as per discussion with the FEMA technical evaluator. From station 8450 to station 9500, the elevations are read from the topographic map. From station 9563 to station 11361, the elevations remain the same as provided by the Aerial Mapping Company, Inc (AMCI) (March 17, 1998).


```
ET                                 7.1                                   9210     10160
X1    14.30         73      9923     10027      1010      1210    1213.6
GR   1576.2      8450    1575.9      8550    1574.1      8650    1573.7      8750    1573.5      8850
GR   1573.4      8950    1573.3      9050    1572.5      9150    1572.5      9250    1571.9      9350
GR   1571.9      9450    1573.5      9500    1573.8      9563    1574.2      9626    1573.5      9652
```

```
GR   1573.1      9672     1573.8      9707     1573.7      9731     1573.8      9769     1573.2      9788
GR   1573.2      9836     1572.9      9878     1572.4      9906     1571.6      9923     1570.4      9941
GR   1565.1      9961     1565.2      9967     1560.0      9973     1560.3      9983     1559.6     10000
GR   1566.5     10011     1570.0     10027     1570.1     10045     1569.4     10052     1570.1     10062
GR   1571.0     10097     1571.2     10131     1571.1     10157     1572.5     10191     1572.9     10211
GR   1572.6     10251     1572.3     10297     1572.5     10351     1572.2     10386     1571.8     10410
GR   1572.1     10417     1571.7     10437     1571.7     10448     1571.5     10480     1571.6     10515
GR   1572.7     10552     1572.9     10571     1572.7     10608     1572.4     10642     1571.4     10681
GR   1571.6     10735     1571.9     10765     1572.0     10792     1571.2     10804     1571.8     10811
GR   1573.2     10852     1575.9     10899     1577.1     10931     1577.9     10967     1578.4     10992
GR   1578.7     11034     1578.6     11096     1578.4     11179     1578.2     11233     1577.7     11273
GR   1582.1     11295     1582.8     11336     1577.8     11361
1
   24SEP03      17:29:52                                                                          PAGE    6

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

 *PROF 1
0

 *SECNO 13.280

 3265 DIVIDED FLOW


 3470 ENCROACHMENT STATIONS=     9537.0   10802.0  TYPE=      1  TARGET=     1265.000
    13.280      9.90   1532.50       .00       .00   1533.21       .71       .00       .00   1530.90
   15700.0    2428.8    8758.7    4512.5     305.4    1278.4     787.5        .0        .0   1531.20
       .00      7.95      6.85      5.73      .038      .052      .042      .000   1522.60   9537.00
   .014002      390.      600.      610.         0         0         0       .00   1228.23  10800.57


 *SECNO 13.400

 3265 DIVIDED FLOW


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.61

    13.400     11.06   1537.86       .00       .00   1538.26       .40      5.05       .00   1537.60
   26700.0    4486.1   12725.6    9488.4    1060.9    2421.9    1822.1      56.7      24.2   1537.50
       .04      4.23      5.25      5.21      .038      .052      .042      .000   1526.80   8951.61
   .005936      650.      679.      590.         5         0         0       .00   2093.56  11083.57


 *SECNO 13.550
    13.550     11.15   1543.35       .00       .00   1543.98       .62      5.72       .00   1543.10
```

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   26700.0   12889.3   13808.1       2.6    1847.5    2426.2       2.5     143.0      59.0   1543.00
       .07      6.98      5.69      1.06      .038      .052      .042      .000   1532.20   8711.90
   .009204      740.      787.      850.         4         0         0       .00   1796.16  10508.06


CCHV=     .300 CEHV=     .500
*SECNO 13.700

3265 DIVIDED FLOW


3470 ENCROACHMENT STATIONS=      935.0    3063.0  TYPE=      1  TARGET=     2128.000
    13.700      6.59   1548.19       .00       .00   1548.91       .72      4.88       .05   1544.00
   26700.0   14080.3   12386.5     233.2    2285.6    1649.5      58.8     203.2      85.7   1546.00
       .10      6.16      7.51      3.97      .038      .025      .042      .000   1541.60   1125.99
   .006533      610.      659.      650.         2         0         0       .00   1884.17   3063.00


1
   24SEP03      17:29:52                                                                          PAGE     7

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


1490 NH CARD USED
*SECNO 13.730
1530 MANNINGS N VALUES FOR CHANNEL COMPOSITED

3265 DIVIDED FLOW


3301 HV CHANGED MORE THAN HVINS


3370 NORMAL BRIDGE, NRD=  37 MIN ELTRD=  1544.30 MAX ELLC=  1549.30

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=      935.0    3063.0  TYPE=      1  TARGET=     2128.000
    13.730      6.27   1547.87   1547.87       .00   1549.36      1.50       .01       .39   1546.20
   26700.0   17631.0    9069.0        .0    1644.8    1168.0        .0     203.3      85.7   1549.10
       .10     10.72      7.76       .00      .020      .021      .000      .000   1541.60   1286.18
   .006460        1.        1.        1.         3        12         0   -230.18   1293.40   3060.07


*SECNO 13.740
1530 MANNINGS N VALUES FOR CHANNEL COMPOSITED
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3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.82

3370 NORMAL BRIDGE, NRD=  37 MIN ELTRD=  1544.30 MAX ELLC=  1549.30

3470 ENCROACHMENT STATIONS=      935.0    3063.0  TYPE=      1  TARGET=     2128.000
    13.740      7.45   1549.05       .00       .00   1549.73       .68       .12       .24   1546.20
   26700.0   19496.4    7203.6        .0    2645.6    1819.2        .0     206.5      87.1   1549.10
       .10      7.37      3.96       .00      .020      .021      .000      .000   1541.60   1215.47
   .001956       38.       38.       38.         6         0         0   -433.79   1811.30   3061.92
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    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST

*SECNO 13.750

3470 ENCROACHMENT STATIONS=      935.0    3063.0  TYPE=      1  TARGET=     2128.000
    13.750      8.01   1549.61       .00       .00   1549.86       .25       .00       .13   1544.00
   26700.0   13063.2   13351.3     285.4    3843.6    2897.8     109.9     206.6      87.1   1546.00
       .10      3.40      4.61      2.60      .038      .025      .042      .000   1541.60   1000.00
   .001258        1.        1.        1.         3         0         0       .00   2063.00   3063.00

*SECNO 13.860

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     8212.0   10433.0  TYPE=      1  TARGET=     2221.000
    13.860      9.02   1555.32   1555.32       .00   1556.37      1.04      2.80       .40   1556.10
```

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   26700.0    9946.2   15548.6    1205.2    1072.3    2063.1     177.1     312.1     124.4   1555.70
       .13      9.28      7.54      6.81      .038      .052      .042      .000   1546.30   8326.27
   .016644      910.      899.      900.        20         8         0       .00   1524.04  10250.72


CCHV=     .100 CEHV=     .300
*SECNO 14.070

3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.83


3470 ENCROACHMENT STATIONS=     8530.0   10608.0  TYPE=      1  TARGET=     2078.000
    14.070      7.52   1565.02       .00       .00   1565.48       .45      9.05       .06   1564.30
   26700.0   18505.1    4848.6    3346.3    3323.9     854.2     872.0     416.3     167.9   1564.50
       .18      5.57      5.68      3.84      .038      .052      .042      .000   1557.50   8562.81
   .004985     1050.     1134.     1100.         6         0         0       .00   1989.48  10552.28


1
   24SEP03      17:29:52                                                                          PAGE    9

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


*SECNO 14.300

3265 DIVIDED FLOW


3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    14.300     14.55   1574.15   1574.15       .00   1575.12       .97      7.20       .15   1571.60
   26700.0    5872.7    9850.2   10977.1    1307.7     905.7    1857.4     532.4     220.3   1570.00
       .23      4.49     10.88      5.91      .038      .052      .042      .000   1559.60   8647.35
   .008612     1010.     1214.     1210.         5        12         0       .00   2210.98  10868.50


1
   24SEP03      17:29:52                                                                          PAGE   10


T1      Floodway Run - Method 1
T2      Updated:  9-2-03
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T3      Floodway Run - Method 1

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

     -10        3                                                                  1532.5

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

      2                  -1

1
   24SEP03      17:29:52                                                                                    PAGE   11

    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST

 *PROF 2
0

 *SECNO 13.280

 3265 DIVIDED FLOW

 3470 ENCROACHMENT STATIONS=     9537.0   10802.0  TYPE=      1  TARGET=     1265.000
    13.280      9.90   1532.50       .00   1532.50   1533.21       .71       .00       .00   1530.90
   15700.0    2428.8    8758.7    4512.5     305.4    1278.4     787.5        .0        .0   1531.20
       .00      7.95      6.85      5.73      .038      .052      .042      .000   1522.60   9537.00
   .014002      390.      600.      610.         0         0         0       .00   1228.23  10800.57

 *SECNO 13.400

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.26

 3470 ENCROACHMENT STATIONS=     9670.0   10602.0  TYPE=      1  TARGET=      932.000
    13.400     11.94   1538.74       .00   1537.86   1539.48       .75      6.28       .00   1537.60
   26700.0        .0   20872.9    5827.1        .0    2991.6     863.5      46.7      15.8   1537.50
       .03       .00      6.98      6.75      .000      .052      .042      .000   1526.80   9670.00
   .007915      650.      679.      590.         5         0         0       .00    932.00  10602.00

 *SECNO 13.550

 3470 ENCROACHMENT STATIONS=     9150.0   10494.0  TYPE=      1  TARGET=     1344.000
    13.550     12.07   1544.27       .00   1543.35   1544.79       .52      5.31       .00   1543.10
   26700.0    9550.9   17149.1        .0    1500.8    3169.5        .0     123.6      36.3 100000.00
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      .06       6.36       5.41        .00       .038       .052       .000       .000   1532.20   9150.00
   .005837      740.       787.       850.          4          0          0        .00   1344.00  10494.00

CCHV=     .300 CEHV=     .500
*SECNO 13.700

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS=     1550.0    3063.0  TYPE=      1  TARGET=     1513.000
1
   24SEP03      17:29:52                                                                                PAGE   12

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

    13.700       6.76   1548.36        .00   1548.19   1549.34        .98       4.32        .23   1544.00
   26700.0   10797.4   15599.1      303.4    1572.6    1799.6       65.2      183.2       57.0   1546.00
      .09       6.87       8.67       4.66       .038       .025       .042       .000   1541.60   1550.00
   .007892      610.       659.       650.          3          0          0        .00   1471.68   3063.00

1490 NH CARD USED
*SECNO 13.730
1530 MANNINGS N VALUES FOR CHANNEL COMPOSITED

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3370 NORMAL BRIDGE, NRD=  37 MIN ELTRD=  1544.30 MAX ELLC=  1549.30

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     1550.0    3063.0  TYPE=      1  TARGET=     1513.000
    13.730       7.01   1548.61   1548.61   1547.87   1550.16       1.55        .01        .28   1546.20
   26700.0   16493.5   10206.5        .0    1427.1    1514.5         .0      183.2       57.0   1549.10
      .09      11.56       6.74       .00       .020       .021       .000       .000   1541.60   1550.00
   .005993        1.         1.        1.        20          9          0   -360.00   1345.69   3061.23

*SECNO 13.740
1530 MANNINGS N VALUES FOR CHANNEL COMPOSITED
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3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.94

3370 NORMAL BRIDGE, NRD= 37 MIN ELTRD= 1544.30 MAX ELLC= 1549.30

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3470 ENCROACHMENT STATIONS= 1550.0 3063.0 TYPE= 1 TARGET= 1513.000

1

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
13.740	8.31	1549.91	1548.61	1549.05	1550.54	.63	.11	.28	1546.20
26700.0	16109.4	10590.6	.0	2150.7	2556.7	.0	186.6	58.3	1549.10
.09	7.49	4.14	.00	.020	.021	.000	.000	1541.60	1550.00
.001593	38.	38.	38.	21	9	0	-511.73	1512.40	3062.40

*SECNO 13.750

3470 ENCROACHMENT STATIONS= 1655.0 3063.0 TYPE= 1 TARGET= 1408.000

13.750	8.66	1550.26	.00	1549.61	1550.62	.37	.00	.08	1544.00
26700.0	7886.9	18414.6	398.4	2097.8	3486.0	133.6	186.7	58.3	1546.00
.09	3.76	5.28	2.98	.038	.025	.042	.000	1541.60	1655.00
.001293	1.	1.	1.	2	0	0	.00	1408.00	3063.00

*SECNO 13.860

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 8708.0 10232.0 TYPE= 1 TARGET= 1524.000

13.860	9.19	1555.49	1555.49	1555.32	1556.82	1.33	2.94	.48	1556.10
26700.0	6976.2	18241.7	1482.0	606.2	2180.4	194.5	276.8	84.9	1555.70
.12	11.51	8.37	7.62	.038	.052	.042	.000	1546.30	8708.00

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   .019190      910.      899.      900.        20         8         0       .00   1161.67  10232.00

CCHV=     .100 CEHV=     .300
*SECNO 14.070

3301 HV CHANGED MORE THAN HVINS

3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  2.06

3470 ENCROACHMENT STATIONS=     8805.0   10529.0  TYPE=      1  TARGET=     1724.000
1
   24SEP03      17:29:52                                                                                    PAGE   14

    SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
    Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
    TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
    SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST

    14.070       7.91   1565.41        .00   1565.02   1565.85        .44       8.94        .09   1564.30
   26700.0    17145.0     5246.5     4308.5     3115.0      922.8     1044.2      377.7      120.9   1564.50
       .17       5.50       5.69       4.13       .038       .052       .042       .000    1557.50   8805.00
   .004512      1050.      1134.      1100.          6          0          0        .00    1724.00  10529.00

*SECNO 14.300

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=     9210.0   10160.0  TYPE=      1  TARGET=      950.000
    14.300      15.41   1575.01   1575.01   1574.15   1576.49      1.47       6.93        .31   1571.60
   26700.0     9539.8   11911.5    5248.8    1472.8     995.8     580.3      480.2      153.9   1570.00
       .21       6.48      11.96       9.05       .038       .052       .042       .000    1559.60   9210.00
   .009178      1010.      1214.      1210.         20         12          0        .00     950.00  10160.00

1
   24SEP03      17:29:52                                                                                    PAGE   15

                                                                                THIS RUN EXECUTED 24SEP03    17:29:52
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HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

PROPOSED LOW FLOW BRIDGE

SUMMARY PRINTOUT

	SECNO	Q	CWSEL	DEPTH	ELMIN	EG	CRIWS	VCH	10*KS	XLCH	SSTA	TOPWID	ENDST
	13.280	15700.00	1532.50	9.90	1522.60	1533.21	.00	6.85	140.02	.00	9537.00	1228.23	10800.57
	13.280	15700.00	1532.50	9.90	1522.60	1533.21	.00	6.85	140.02	.00	9537.00	1228.23	10800.57
*	13.400	26700.00	1537.86	11.06	1526.80	1538.26	.00	5.25	59.36	678.60	8951.61	2093.56	11083.57
*	13.400	26700.00	1538.74	11.94	1526.80	1539.48	.00	6.98	79.15	678.60	9670.00	932.00	10602.00
	13.550	26700.00	1543.35	11.15	1532.20	1543.98	.00	5.69	92.04	787.30	8711.90	1796.16	10508.06
	13.550	26700.00	1544.27	12.07	1532.20	1544.79	.00	5.41	58.37	787.30	9150.00	1344.00	10494.00
	13.700	26700.00	1548.19	6.59	1541.60	1548.91	.00	7.51	65.33	659.00	1125.99	1884.17	3063.00
	13.700	26700.00	1548.36	6.76	1541.60	1549.34	.00	8.67	78.92	659.00	1550.00	1471.68	3063.00
*	13.730	26700.00	1547.87	6.27	1541.60	1549.36	1547.87	7.76	64.60	1.00	1286.18	1293.40	3060.07
*	13.730	26700.00	1548.61	7.01	1541.60	1550.16	1548.61	6.74	59.93	1.00	1550.00	1345.69	3061.23
*	13.740	26700.00	1549.05	7.45	1541.60	1549.73	.00	3.96	19.56	38.00	1215.47	1811.30	3061.92
*	13.740	26700.00	1549.91	8.31	1541.60	1550.54	1548.61	4.14	15.93	38.00	1550.00	1512.40	3062.40
	13.750	26700.00	1549.61	8.01	1541.60	1549.86	.00	4.61	12.58	1.00	1000.00	2063.00	3063.00
	13.750	26700.00	1550.26	8.66	1541.60	1550.62	.00	5.28	12.93	1.00	1655.00	1408.00	3063.00
*	13.860	26700.00	1555.32	9.02	1546.30	1556.37	1555.32	7.54	166.44	899.00	8326.27	1524.04	10250.72
*	13.860	26700.00	1555.49	9.19	1546.30	1556.82	1555.49	8.37	191.90	899.00	8708.00	1161.67	10232.00
*	14.070	26700.00	1565.02	7.52	1557.50	1565.48	.00	5.68	49.85	1134.10	8562.81	1989.48	10552.28
*	14.070	26700.00	1565.41	7.91	1557.50	1565.85	.00	5.69	45.12	1134.10	8805.00	1724.00	10529.00
*	14.300	26700.00	1574.15	14.55	1559.60	1575.12	1574.15	10.88	86.12	1213.60	8647.35	2210.98	10868.50
*	14.300	26700.00	1575.01	15.41	1559.60	1576.49	1575.01	11.96	91.78	1213.60	9210.00	950.00	10160.00

SUMMARY PRINTOUT TABLE 110

	SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
	13.280	1532.50	.00	1533.21	1228.23	2428.84	8758.70	4512.46	1265.00	9537.00	9671.00	10110.00	10802.00
	13.280	1532.50	.00	1533.21	1228.23	2428.84	8758.70	4512.46	1265.00	9537.00	9671.00	10110.00	10802.00
*	13.400	1537.86	.00	1538.26	2093.56	4486.06	12725.58	9488.36	.00	.00	9670.00	10319.00	.00
*	13.400	1538.74	.88	1539.48	932.00	.00	20872.87	5827.13	932.00	9670.00	9670.00	10319.00	10602.00
	13.550	1543.35	.00	1543.98	1796.16	12889.30	13808.06	2.63	.00	.00	9688.00	10494.00	.00
	13.550	1544.27	.92	1544.79	1344.00	9550.90	17149.10	.00	1344.00	9150.00	9688.00	10494.00	10494.00
	13.700	1548.19	.00	1548.91	1884.17	14080.35	12386.48	233.18	2128.00	935.00	2133.00	3027.00	3063.00
	13.700	1548.36	.18	1549.34	1471.68	10797.45	15599.15	303.40	1513.00	1550.00	2133.00	3027.00	3063.00
*	13.730	1547.87	.00	1549.36	1293.40	17630.98	9069.02	.00	2128.00	935.00	2107.00	3062.00	3063.00
*	13.730	1548.61	.74	1550.16	1345.69	16493.49	10206.51	.00	1513.00	1550.00	2107.00	3062.00	3063.00
*	13.740	1549.05	.00	1549.73	1811.30	19496.43	7203.57	.00	2128.00	935.00	2107.00	3062.00	3063.00
*	13.740	1549.91	.86	1550.54	1512.40	16109.36	10590.64	.00	1513.00	1550.00	2107.00	3062.00	3063.00
	13.750	1549.61	.00	1549.86	2063.00	13063.25	13351.32	285.43	2128.00	935.00	2133.00	3027.00	3063.00
	13.750	1550.26	.65	1550.62	1408.00	7886.94	18414.63	398.43	1408.00	1655.00	2133.00	3027.00	3063.00
*	13.860	1555.32	.00	1556.37	1524.04	9946.20	15548.63	1205.16	2221.00	8212.00	9330.00	10042.00	10433.00
*	13.860	1555.49	.17	1556.82	1161.67	6976.25	18241.72	1482.03	1524.00	8708.00	9330.00	10042.00	10232.00
*	14.070	1565.02	.00	1565.48	1989.48	18505.06	4848.59	3346.34	2078.00	8530.00	9879.00	10059.00	10608.00
*	14.070	1565.41	.39	1565.85	1724.00	17144.99	5246.54	4308.48	1724.00	8805.00	9879.00	10059.00	10529.00
*	14.300	1574.15	.00	1575.12	2210.98	5872.70	9850.17	10977.13	.00	.00	9923.00	10027.00	.00
*	14.300	1575.01	.87	1576.49	950.00	9539.77	11911.46	5248.78	950.00	9210.00	9923.00	10027.00	10160.00

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24SEP03 17:29:52 PAGE 17

PROPOSED LOW FLOW BRIDGE

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	13.280	.00	.00	.00	1522.60	15700.00	1532.50	.00	1533.21	140.02	6.85	2371.26	1326.80
	13.280	.00	.00	.00	1522.60	15700.00	1532.50	.00	1533.21	140.02	6.85	2371.26	1326.80
*	13.400	678.60	.00	.00	1526.80	26700.00	1537.86	.00	1538.26	59.36	5.25	5304.82	3465.37
*	13.400	678.60	.00	.00	1526.80	26700.00	1538.74	.00	1539.48	79.15	6.98	3855.08	3001.10

	13.550	787.30	.00	.00	1532.20	26700.00	1543.35	.00	1543.98	92.04	5.69	4276.14	2783.11
	13.550	787.30	.00	.00	1532.20	26700.00	1544.27	.00	1544.79	58.37	5.41	4670.26	3494.79
	13.700	659.00	.00	.00	1541.60	26700.00	1548.19	.00	1548.91	65.33	7.51	3993.93	3303.34
	13.700	659.00	.00	.00	1541.60	26700.00	1548.36	.00	1549.34	78.92	8.67	3437.43	3005.52
*	13.730	1.00	1544.30	1549.30	1541.60	26700.00	1547.87	1547.87	1549.36	64.60	7.76	2812.82	3321.84
*	13.730	1.00	1544.30	1549.30	1541.60	26700.00	1548.61	1548.61	1550.16	59.93	6.74	2941.58	3449.01
*	13.740	38.00	1544.30	1549.30	1541.60	26700.00	1549.05	.00	1549.73	19.56	3.96	4464.79	6036.47
*	13.740	38.00	1544.30	1549.30	1541.60	26700.00	1549.91	1548.61	1550.54	15.93	4.14	4707.39	6689.40
	13.750	1.00	.00	.00	1541.60	26700.00	1549.61	.00	1549.86	12.58	4.61	6851.30	7527.43
	13.750	1.00	.00	.00	1541.60	26700.00	1550.26	.00	1550.62	12.93	5.28	5717.38	7426.42
*	13.860	899.00	.00	.00	1546.30	26700.00	1555.32	1555.32	1556.37	166.44	7.54	3312.50	2069.61
*	13.860	899.00	.00	.00	1546.30	26700.00	1555.49	1555.49	1556.82	191.90	8.37	2980.99	1927.41
*	14.070	1134.10	.00	.00	1557.50	26700.00	1565.02	.00	1565.48	49.85	5.68	5050.17	3781.54
*	14.070	1134.10	.00	.00	1557.50	26700.00	1565.41	.00	1565.85	45.12	5.69	5082.03	3974.90
*	14.300	1213.60	.00	.00	1559.60	26700.00	1574.15	1574.15	1575.12	86.12	10.88	4070.74	2877.16
*	14.300	1213.60	.00	.00	1559.60	26700.00	1575.01	1575.01	1576.49	91.78	11.96	3048.94	2787.07

PROPOSED LOW FLOW BRIDGE

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
	13.280	15700.00	1532.50	.00	.00	.00	1228.23	.00
	13.280	15700.00	1532.50	.00	.00	.00	1228.23	.00
*	13.400	26700.00	1537.86	.00	5.36	.00	2093.56	678.60
*	13.400	26700.00	1538.74	.88	6.24	.88	932.00	678.60
	13.550	26700.00	1543.35	.00	5.49	.00	1796.16	787.30
	13.550	26700.00	1544.27	.92	5.54	.92	1344.00	787.30
	13.700	26700.00	1548.19	.00	4.83	.00	1884.17	659.00
	13.700	26700.00	1548.36	.18	4.09	.18	1471.68	659.00
*	13.730	26700.00	1547.87	.00	-.32	.00	1293.40	1.00
*	13.730	26700.00	1548.61	.74	.25	.74	1345.69	1.00
*	13.740	26700.00	1549.05	.00	1.18	.00	1811.30	38.00
*	13.740	26700.00	1549.91	.86	1.30	.86	1512.40	38.00

	13.750	26700.00	1549.61	.00	.56	.00	2063.00	1.00
	13.750	26700.00	1550.26	.65	.35	.65	1408.00	1.00
*	13.860	26700.00	1555.32	.00	5.72	.00	1524.04	899.00
*	13.860	26700.00	1555.49	.17	5.23	.17	1161.67	899.00
*	14.070	26700.00	1565.02	.00	9.70	.00	1989.48	1134.10
*	14.070	26700.00	1565.41	.39	9.92	.39	1724.00	1134.10
*	14.300	26700.00	1574.15	.00	9.13	.00	2210.98	1213.60
*	14.300	26700.00	1575.01	.87	9.61	.87	950.00	1213.60

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SUMMARY OF ERRORS AND SPECIAL NOTES

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WARNING SECNO=     13.400  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     13.400  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     13.730  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     13.730  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     13.730  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     13.730  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     13.730  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=     13.740  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=     13.740  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=     13.740  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     13.860  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     13.860  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     13.860  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=     13.860  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     13.860  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     13.860  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=     14.070  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=     14.070  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     14.300  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     14.300  PROFILE=  1  MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     14.300  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     14.300  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     14.300  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL
```

1

Floodway width summary: PROPOSED LOW FLOW BRIDGE
Profile No. 2

Section Number	Elevation Increase	Top Width	Left Encroach Station	Left Sta Distance From Center	Center Station	Right Sta Distance From Center	Right Encroach Station
13.280	.00	1265.00	9537.00	353.50	9890.50	911.50	10802.00
13.400	.88	932.00	9670.00	324.50	9994.50	607.50	10602.00
13.550	.92	1344.00	9150.00	941.00	10091.00	403.00	10494.00
13.700	.18	1513.00	1550.00	1030.00	2580.00	483.00	3063.00
13.730	.74	1513.00	1550.00	1034.50	2584.50	478.50	3063.00
13.740	.86	1513.00	1550.00	1034.50	2584.50	478.50	3063.00
13.750	.65	1408.00	1655.00	925.00	2580.00	483.00	3063.00
13.860	.17	1524.00	8708.00	978.00	9686.00	546.00	10232.00
14.070	.39	1724.00	8805.00	1164.00	9969.00	560.00	10529.00
14.300	.87	950.00	9210.00	765.00	9975.00	185.00	10160.00

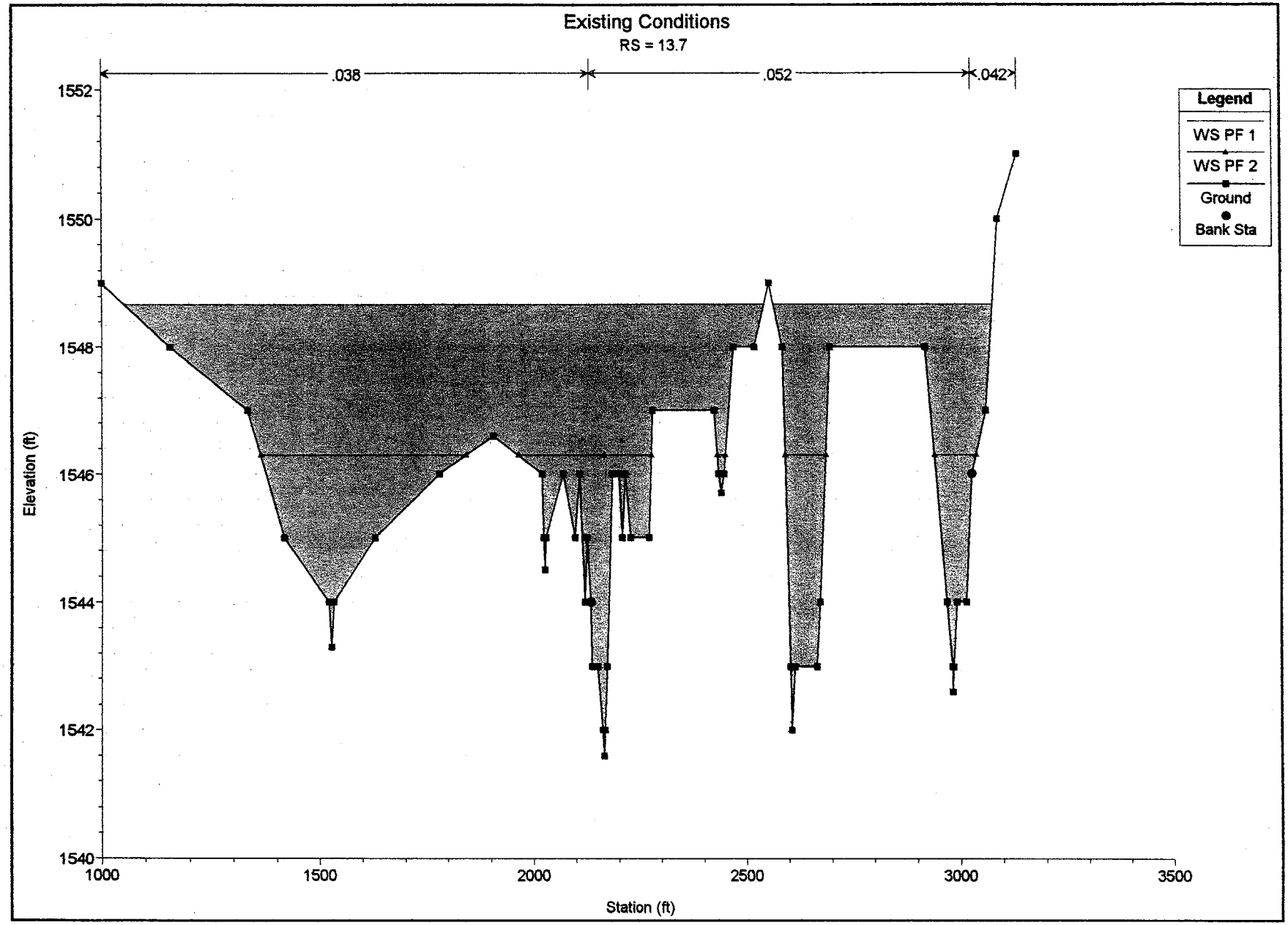
1

FLOODWAY DATA, PROPOSED LOW FLOW BRIDGE
PROFILE NO. 2

STATION	FLOODWAY WIDTH	FLOODWAY SECTION AREA	FLOODWAY MEAN VELOCITY	WATER SURFACE ELEVATION WITH FLOODWAY	WATER SURFACE ELEVATION WITHOUT FLOODWAY	DIFFERENCE
13.280	1264.	2371.	6.6	1532.5	1532.5	.0
13.400	932.	3855.	6.9	1538.8	1537.9	.9
13.550	1344.	4670.	5.7	1544.3	1543.4	.9
13.700	1513.	3437.	7.8	1548.4	1548.2	.2
13.730	1511.	2942.	9.1	1548.6	1547.9	.7
13.740	1512.	4707.	5.7	1550.0	1549.1	.9
13.750	1408.	5717.	4.7	1550.2	1549.6	.6
13.860	1524.	2981.	9.0	1555.5	1555.3	.2
14.070	1724.	5082.	5.3	1565.4	1565.0	.4
14.300	950.	3049.	8.8	1575.0	1574.1	.9

Appendix E.3:

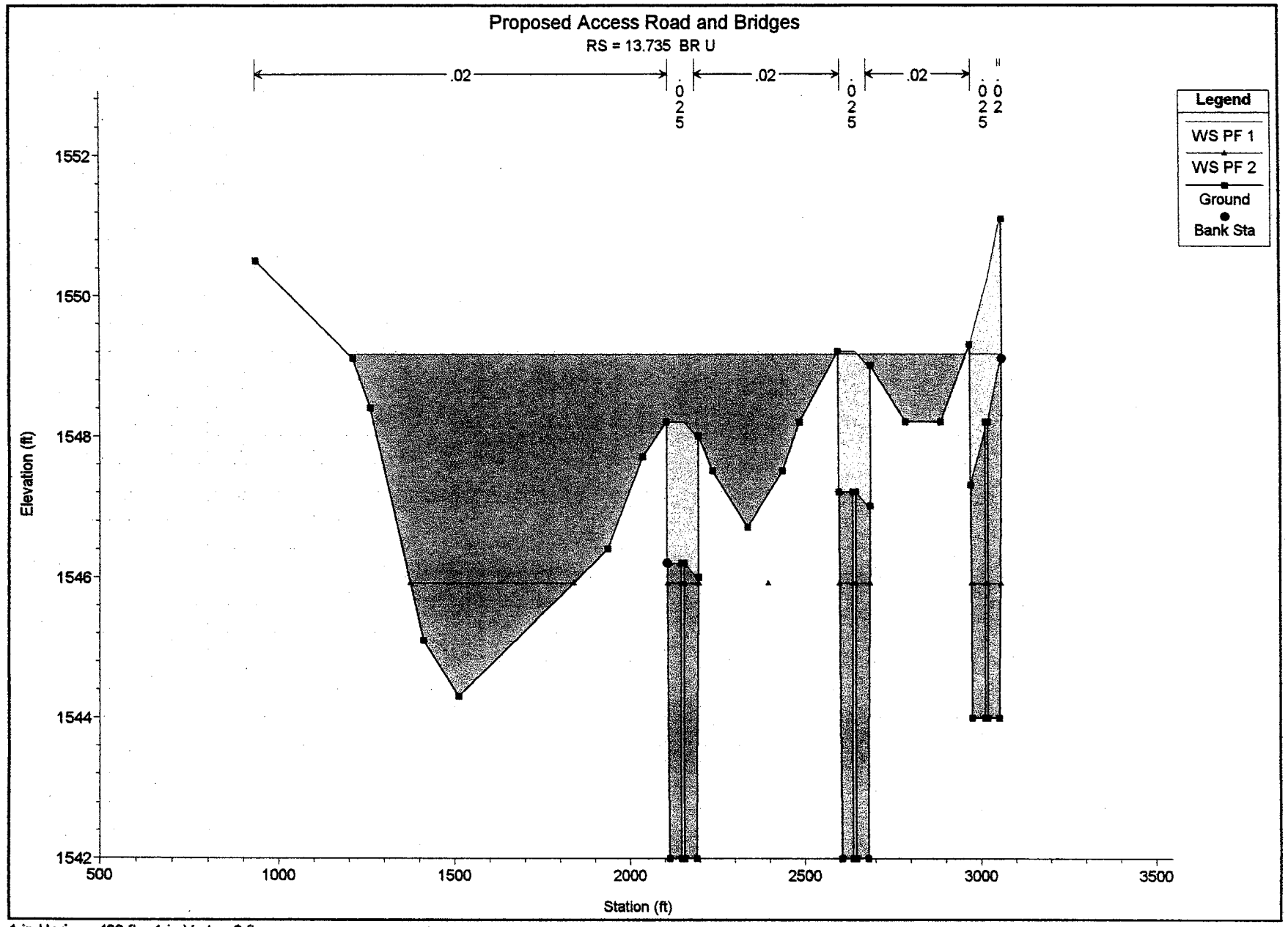
HEC-RAS Cross Sections and Hydraulic Tables


Existing Conditions
RS = 13.7
.038
.052
.042
Legend
WS PF 1
WS PF 2
Ground
Bank Sta
Elevation (ft)
1552
1550
1548
1546
1544
1542
1540
1000
1500
2000
2500
3000
3500
Station (ft)

Existing Conditions

HEC-RAS Plan: Imported Pla River: RIVER-1 Reach: Reach-1 Profile: PF 1

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	14.89	26700	1583.20	1597.41	1596.57	1599.17	0.0054	13.0	3302	664	0.7
Reach-1	14.74	26700	1581.70	1591.75	1591.46	1594.01	0.0093	15.6	3026	896	0.9
Reach-1	14.54	26700	1571.60	1583.52	1581.63	1584.56	0.0074	8.2	3309	813	0.6
Reach-1	14.3	26700	1559.60	1574.37	1574.37	1575.18	0.0073	10.2	4565	2237	0.6
Reach-1	14.07	26700	1557.50	1564.78	1564.26	1565.34	0.0077	6.8	4582	2022	0.6
Reach-1	13.86	26700	1546.30	1556.09	1555.24	1556.63	0.0083	6.2	4621	1870	0.6
Reach-1	13.7	26700	1541.60	1548.67	1547.70	1549.17	0.0073	4.3	4933	2003	0.5
Reach-1	13.55	26700	1532.20	1543.30		1543.93	0.0116	6.3	4177	1784	0.6
Reach-1	13.4	26700	1526.80	1538.13	1537.04	1538.46	0.0046	4.8	5871	2137	0.4
Reach-1	13.28	26700	1522.60	1532.73	1532.53	1533.53	0.0149	7.4	3832	1891	0.7
Reach-1	13.16	26700	1521.50	1528.59		1529.02	0.0058	6.1	5342	2319	0.5
Reach-1	13.08	26700	1518.20	1527.87		1527.97	0.0012	3.3	11452	2733	0.2
Reach-1	13.04	26700	1518.80	1527.13		1527.59	0.0020	5.8	5015	1067	0.4
Reach-1	13.02	26700	1519.00	1525.14	1524.14	1526.94	0.0032	10.8	2477	405	0.8
Reach-1	13	26700	1518.50	1523.64	1523.64	1526.21	0.0056	12.9	2076	404	1.0



1 in Horiz. = 400 ft 1 in Vert. = 2 ft

HEC-RAS Plan: Imported Pla River: RIVER-1 Reach: Reach-1 Profile: PF 1

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	14.89	26700	1583.20	1597.41	1596.57	1599.17	0.0054	13.0	3302	664	0.7
Reach-1	14.74	26700	1581.70	1591.75	1591.46	1594.01	0.0093	15.6	3026	896	0.9
Reach-1	14.54	26700	1571.60	1583.52	1581.63	1584.56	0.0074	8.2	3309	813	0.6
Reach-1	14.3	26700	1559.60	1574.37	1574.37	1575.18	0.0073	10.2	4565	2237	0.6
Reach-1	14.07	26700	1557.50	1565.22	1564.26	1565.61	0.0045	5.5	5513	2157	0.4
Reach-1	13.86	26700	1546.30	1555.26	1555.26	1556.35	0.0216	8.5	3215	1492	0.9
Reach-1	13.75	26700	1542.00	1549.62	1547.90	1549.93	0.0009	4.1	5952	1952	0.4
Reach-1	13.735	Bridge									
Reach-1	13.72	26700	1542.00	1547.90	1547.90	1549.07	0.0050	8.7	3066	1303	0.9
Reach-1	13.55	26700	1532.20	1543.30		1543.93	0.0116	6.3	4177	1784	0.6
Reach-1	13.4	26700	1526.80	1538.13	1537.04	1538.46	0.0046	4.8	5871	2137	0.4
Reach-1	13.28	26700	1522.60	1532.73	1532.53	1533.53	0.0149	7.4	3832	1891	0.7
Reach-1	13.16	26700	1521.50	1528.59		1529.02	0.0058	6.1	5342	2319	0.5
Reach-1	13.08	26700	1518.20	1527.87		1527.97	0.0012	3.3	11452	2733	0.2
Reach-1	13.04	26700	1518.80	1527.13		1527.59	0.0020	5.8	5015	1067	0.4
Reach-1	13.02	26700	1519.00	1525.14	1524.14	1526.94	0.0032	10.8	2477	405	0.8
Reach-1	13	26700	1518.50	1523.64	1523.64	1526.21	0.0056	12.9	2076	404	1.0

Plan: Imported Pla RIVER-1 Reach-1 RS: 13.735 Profile: PF 1 Opening: Single BR

E.G. US. (ft)	1549.93	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	1549.62	E.G. Elev (ft)	1549.83	1549.44
Q Total (cfs)	26700.00	W.S. Elev (ft)	1549.16	1547.93
Q Bridge (cfs)	4287.60	Crit W.S. (ft)	1547.93	1547.93
Q Weir (cfs)		Max Chl Dpth (ft)	7.16	5.93
Weir Sta Lft (ft)		Vel Total (ft/s)	5.76	9.32
Weir Sta Rgt (ft)		Flow Area (sq ft)	4634.27	2864.54
Weir Submerg		Froude # Chl	0.03	0.04
Weir Max Depth (ft)		Specif Force (cu ft)	15165.10	13389.69
Min El Weir Flow (ft)	1544.31	Hydr Depth (ft)	2.73	2.61
Min El Prs (ft)	1549.10	W.P. Total (ft)	2231.54	1528.27
Delta EG (ft)	0.86	Conv. Total (cfs)	568862.9	304185.0
Delta WS (ft)	1.72	Top Width (ft)	1699.17	1097.86
BR Open Area (sq ft)	1024.34	Frctn Loss (ft)	0.14	0.01
BR Open Vel (ft/s)	4.32	C & E Loss (ft)	0.25	0.17
Coef of Q		Shear Total (lb/sq ft)	0.29	0.90
Br Sel Method	Energy only	Power Total (lb/ft s)	1.65	8.40

Plan: Imported Pla RIVER-1 Reach-1 RS: 13.735 BR U Profile: PF 1

Left Sta	Right Sta	Flow	Area	W.P.	% Conv.	Hydr D.	Velocity
(ft)	(ft)	(cfs)	(sq ft)	(ft)		(ft)	(ft/s)
937.00	2107.00	18363.23	1691.95	785.15	68.78	2.16	10.85
LB 2107.00	2186.58	1992.76	287.43	153.89	7.46	3.99	6.93
2186.58	2266.17	207.28	29.72	22.04	0.78	2.85	6.97
2266.17	2584.50						
2584.50	2664.08	3017.64	467.45	395.15	11.30	7.85	6.46
2664.08	2743.67	724.46	97.82	47.44	2.71	4.27	7.41
2743.67	2902.83						
2902.83	2982.42	166.24	30.71	23.83	0.62	2.69	5.41
2982.42	RB 3062.00	2228.39	259.47	100.77	8.35	3.69	8.59

Plan: Imported Pla RIVER-1 Reach-1 RS: 13.735 BR U Profile: PF 1

E.G. Elev (ft)	1549.83	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.67	Wt. n-Val.	0.020	0.025	
W.S. Elev (ft)	1549.16	Reach Len. (ft)	38.00	38.00	38.00
Crit W.S. (ft)	1547.93	Flow Area (sq ft)	2744.18	1890.09	
E.G. Slope (ft/ft)	0.002203	Area (sq ft)	2744.18	1890.09	
Q Total (cfs)	26700.00	Flow (cfs)	20016.46	6683.54	
Top Width (ft)	1699.17	Top Width (ft)	907.04	792.13	
Vel Total (ft/s)	5.76	Avg. Vel. (ft/s)	7.29	3.54	
Max Chl Dpth (ft)	7.16	Hydr. Depth (ft)	3.03	2.39	
Conv. Total (cfs)	568862.9	Conv. (cfs)	426465.3	142397.7	
Length Wtd. (ft)	38.00	Wetted Per. (ft)	907.10	1324.44	
Min Ch El (ft)	1542.00	Shear (lb/sq ft)	0.42	0.20	
Alpha	1.30	Stream Power (lb/ft s)	3.03	0.69	
Frctn Loss (ft)	0.14	Cum Volume (acre-ft)	168.76	171.58	65.61
C & E Loss (ft)	0.25	Cum SA (acres)	69.87	45.09	32.19

Appendix F:

Erosion and Sediment Transport Supporting Documentation

TETRA TECH, INC.

CLIENT _____ JOB NO. _____ PAGE _____
PROJECT _____ DATE CHECKED _____ DATE 2-5-03
DETAIL _____ CHECKED BY _____ COMPUTED BY LKR

Total Scour

1) At Piers

	East	Central	West
Pier Scour	7.7'	8.0'	8.6'
Contraction	8.3	2.1	2.8
Pressure-Flow	8.0	8.5	7.5
Total	24	18.6 19	18.9 19

2) At Abutments

	East	Central	West
Abutment	22.0	23.0	19.0
Contraction	8.3	2.1	2.8
Pressure-Flow	8.0	8.5	7.5
	38.3	33.6	29.3
	38	34	30

3) Scour Hole Width = 2 x Scour Depth (one side)

Scour Holes overlap - Combine depths USE 40' for Piers and Abutments
50' for east bridge

TETRA TECH, INC.

CLIENT Damon Williams JOB NO. PAGE
PROJECT North Gateway Access Rd DATE CHECKED DATE 1-29-03
DETAIL Scour Calcs CHECKED BY COMPUTED BY LKR

SUMMARY OF
SCOUR CALCULATIONS

1) General Scour = 0

per Skunk Creek Master Plan (Stantec, 2001)
Project site is within a reach that will aggrade during the 100-yr flood

2) Long-term Degradation/Aggradation = 0 (no degradation)

per Skunk Creek Master Plan (J.E. Fuller, 2001)
reach is aggradational for the long-term, effected by backwater behind CAP

3) Contraction Scour = East= 8.3' Central= 2.1' West= 2.8'

See attached calcs

4) Abutment Scour = 22' (East), 23' (Central), 19' (West)

See attached calcs per HEC-18

5) Pressure-Flow Scour = East= 8' Central= 8.5' West= 7.5'

See attached calcs

6) Pier Scour = East= 7.1' Central= 8.0' West= 8.6'

See attached calcs

7) Roadway Scour = 8'- downstream side 4'- upstream side

See attached calcs

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CLIENT Damon Williams JOB NO. PAGE
PROJECT DATE CHECKED DATE 2-4-03
DETAIL Pier Scour CHECKED BY COMPUTED BY LKR

Pier Scour per HEC-18

Eqn 21 $\frac{Y_s}{Y_1} = 2.0\, K_1 K_2 K_3 K_4 \left\{ \frac{a}{Y_1} \right\}^{0.65} Fr_1^{0.43}$

From tables on pg. 37 $K_1 = 1.0$ $K_2 = 1.0$ $K_3 = 1.1$ $K_4 = 1.0$

$\frac{Y_s}{Y_1} = 2.2 \left(\frac{a}{Y_1} \right)^{0.65} Fr_1^{0.43}$ $a = 4' = 1.2m$

$Y_s = 2.5\, Y_1^{.35}\, Fr_1^{0.43}$ $Fr_1 = v/\sqrt{gY_1}$ $g = 9.8 m^2/s$

	Y_1	v_1	Fr_1	Y_s
East Bridge	2.2m	2.1m/s	0.45	2.3m or 7.7ft
Central Bridge	2.2m	2.3m/s	0.50	2.4m or 8.0ft
West Bridge	1.6m	3.0m/s	0.76	2.6m or 8.6ft

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CLIENT Damon Williams | JOB NO. | PAGE
PROJECT | DATE CHECKED | DATE 2-3-03
DETAIL Pressure-Flow Scour | CHECKED BY | COMPUTED BY LKR

Pressure-Flow Scour **METRIC** per HEC-18, also Umbrell 1998 (see below)

1) Calculate critical velocity (V_c)

$$V_c = 1.58\left[(SG-1)\,g\,D_{50}\right]^{0.5}\left(\frac{Y}{D_{50}}\right)^{0.167}$$

$$= 1.58\left[(2.65-1)\,9.8\,D_{50}\right]^{0.5}$$

$$= 6.35\,D_{50}^{0.33}\,Y^{0.167}$$

$Y = 7.1\,ft = 2.2\,m$

$$= 7.22\,D_{50}^{.33} \quad D_{50} \text{ in } m$$

From Skunk Creek Master Plan $d_{50} = 2mm$

$$= 7.22\,(.002)^{.33}$$

$$= 0.93\,m/s \quad (3.0\,ft/s)$$

Approach velocity (V_a) = 6 → 10 ft/s $V_a > V_c$ **LIVE BED SCOUR**

From Eqn 7 (Umbrell, et al, Journal of Hydraulic Eng., 1998)

$$Y_s = Y_a\left\{1.102\left[\left(1-\frac{W}{Y_a}\right)\frac{V_a}{V_c}\right]^{0.603}\right\} - H_b$$

V_c → 0.93 m/s

(ENGLISH)

	Y_a m	W m	V_a m/s	H_b m	Y_s
East Bridge	(7.1) 2.2	(1.0) 0.3	(6.8) 2.1	(4.1) 1.2	(8') 2.4
Central Bridge	(7.1) 2.2	(0) 0	(7.6) 2.3	(5.1) 1.6	(8.5') 2.6
West Bridge	(5.1) 1.6	(0) 0	(9.7) 3.0	(4.2) 1.3	(7.5') 2.3

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CLIENT Damon Williams
PROJECT
DETAIL CONTRACTION SCOUR

JOB NO.
DATE CHECKED
CHECKED BY

PAGE
DATE 1-30-03
COMPUTED BY LKR
Revised 2/5/03

Equation 17, pg. 30 of HEC-18 (FWHA, 1995)

$$Y_2/Y_1 = (Q_2/Q_1)^{6/7}(W_1/W_2)^{K_1=0.69} \qquad Y_S = Y_2 - Y_0$$

Y_S = scour
Y_0 = existing depth

Y_1 = upstream depth* $\quad Q_1$ = flow in u/s channel $\quad W_1$ = bottom width (upstream)

Y_2 = contracted depth $\quad Q_2$ = flow in contracted section $\quad W_2$ = bottom width (contracted)

Bridge	Q_2	Q_1	W_2	W_1	Y_1	SOLVE $\langle Y_2 \rangle$	Y_0	$Y_S = Y_2 - Y_0$
East	6707	4780	99	181	7.6	$\langle 15.4 \rangle$	7.1	8.3
Central	5508	5288	98	123	7.6	$\langle 9.2 \rangle$	7.1	2.1
West	5275	4848	98	129	7.6	$\langle 9.9 \rangle$	7.1	2.8

@ XS-515
$Y_1 = 49.6 - 42 = 7.6$

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CLIENT Damon Williams | JOB NO. | PAGE
PROJECT | DATE CHECKED | DATE 1-29-03
DETAIL ABUTMENT SCOUR | CHECKED BY | COMPUTED BY LKR

Hydraulics for each bridge opening
Use bank stationing and flow distribution to obtain hydraulics (HEC-RAS)

HEC-2 STATION ±	East Bridge	Central Bridge	West Bridge
L	2106	2597	2976
R	2196	2687	3063
invert	1542	1542	1544
depth*	7.1	7.1	5.1
v	6.7	7.6	9.7
Froude #	0.44	0.50	0.76
Y_s	21.7	22.6	18.6

where Y_s = Abutment scour

$$Y_s = Y_1 \, 4 \, Fr^{0.33} \frac{K_1}{0.55}$$ (Eqn 29) pg 49 of HEC-18 (FWHA, 1995)

Y_1 = flow depth

Fr = Froude number

K_1 = 0.55 for spill-through abutments

TETRA TECH, INC.

CLIENT Damon Williams JOB NO. PAGE
PROJECT DATE CHECKED DATE
DETAIL Roadway Scour CHECKED BY COMPUTED BY

Roadway Scour

1) Roadway Overflow (Scour below Channel Drops, pg. 6.18, City of Tucson Standards Manual)

look at left overbank for worst-case scour, assume submerged weir

HEC-RAS Sta 937 to 2106

$Q = 17,887$ cfs
$W = 1169'$

$q = Q/W = 15.3$ cfs/ft

h = drop height

~ Sta 3800 h = 1.4 (Inv. = 43)
~ Sta 3300 h = 3.8 (Inv = 44)

Y = d/s depth of flow WSEL = 47.9

@ h_{max} Y = 3.9

@ h_{min} Y = 4.9

$$Z = 0.581\, q^{2/3} (h/Y)^{0.411} [1 - h/Y]^{-0.118}$$

h	Y	h/Y	h/Y ≤ 0.99?	Z	Z' (double q)
1.4	4.9	0.29	O.K.	2.2'	3.5
3.8	3.9	0.97	O.K.	5.4'	8.6

} worst case range

Preliminary design based on 8' scour - O.K.

Use 8' for toe-down on d/s side of road

Use 4' on u/s side of road

Appendix 5:

Design Data

MEMORANDUM

To: File
From: Larry K. Roberts, P.E.
Date: July 23, 2002, revised April 17, 2003

RE: Summary of Hydraulic and Scour Design Parameters
North Gateway Water Reclamation Plant Access Road at Skunk Creek

(1) Water Surface Elevation at Proposed Bridges: 1549.16
(2) Mean Velocity through bridges: varies, 7 to 10 ft/s

(3) Scour Elevations

	West Bridge	Central Bridge	East Bridge
Invert Elev. (Aztec Plans)	1544.0	1542.0	1542.0
Total Scour at Piers and Abutments	40 ft	40 ft	50 ft
Total Scour Elevations at Piers and Abutments	1504.0	1502.0	1492.0

(4) Angle of Attack

Flow lines approaching bridge are approximately perpendicular to the bridges.

(5) Required Bank Protection

Bank protection at the abutments of each bridge will extend laterally in each direction for a distance of 30 feet on the upstream side, 15 feet on the downstream side. The bank protection at the abutments will tie into the slope protection along both the upstream and downstream side of the proposed access road. The slope protection along the access road will have an 8-foot toe-down along the downstream side of the road, and a 4-foot toe-down along the upstream side of the road. The depths of 8 feet and 4 feet will be measured below the existing ground elevation at the base of the proposed fill slope.

(6) Special Drainage Considerations

(a) Design discharge is the 100-year flow event (26,700 cfs)
(b) The water surface elevation will rise an additional 0.49 ft. immediately upstream of the bridges
(c) Abutment side slopes must be spill-through, and not vertical
(d) The 8-foot toe-down for the abutment bank protection should gradually transition (4H:1V) to the 4-foot toe-down for the upstream side of the roadway slope protection

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North Gateway Access Rd
Riprap sizing

LKR
3/03

Using incipient motion criteria, d_{50} for riprap can be determined by

$$D_{50} = \frac{0.005\, V_a^{3.5}}{q^{1/2}}$$

where V_a = maximum average flow velocity
$= 1.15 \times V_{channel}$

q = unit discharge
$= v_a \times d$

Bridge	$V_{channel}$ (ft/s)	V_a (ft/s)	d (ft)	D_{50} (ft)	
East	6.8	7.8	7.1	0.89	→ use 1
Central	7.6	8.7	7.1	1.2	→ use 1.5
West	9.7	11.2	5.1	3.1	→ use 3

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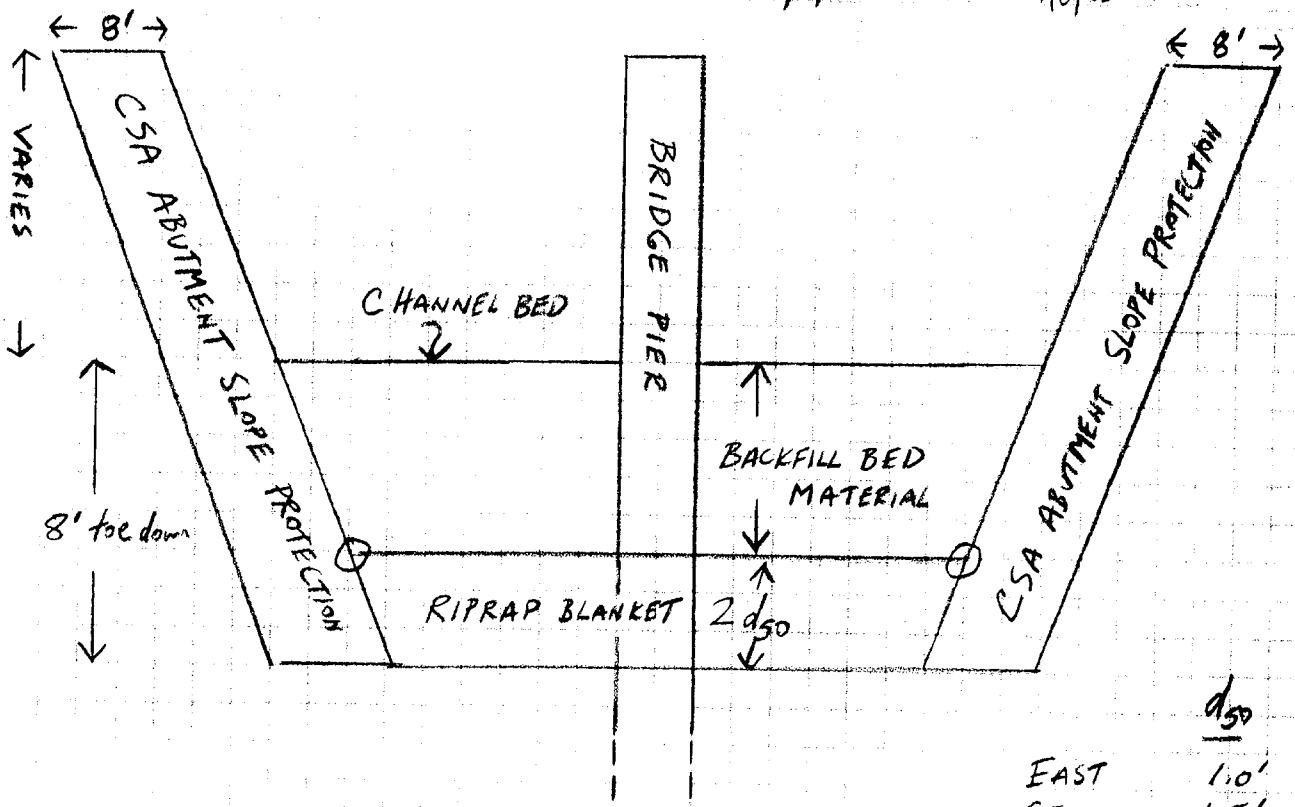
North Gateway Access Road
RIPRAP BLANKET SCHEMATIC

LKR 4/1/03

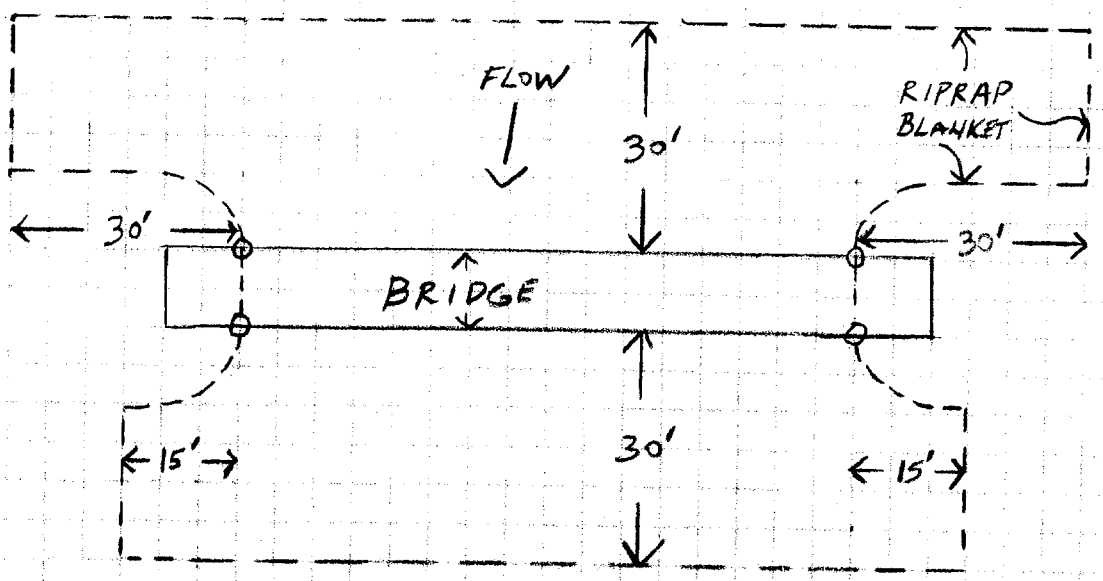
MEZ 4/2/03



	d_{50}
EAST	1.0'
CENTRAL	1.5'
WEST	3.0'

CROSS SECTION

NTS



PLAN VIEW

NTS

Appendix G:

HEC-2 Files on Diskette