NOT FEMA APPROVED

APPROXIMATE FLOODPLAIN DELINEATION STUDY
For
WHITE TANK FAN
(Site 38 – Hjalmarson and Kemna, 1992)

TECHNICAL DATA NOTEBOOK

November 2007

Prepared for:

Federal Emergency Management Agency
Risk Studies Division
Federal Insurance Administration
500 C Street, SW Room 422
Washington, DC 20472

Submitted by:

David Evans & Associates, Inc.
2140 E. Highland Avenue, Suite 200
Phoenix, Arizona 85016
(602) 678-5151

on behalf of:
Maricopa County Flood Control District
2801 West Durango Street
Phoenix, Arizona 85009
(602) 506-1501

DAVID EVANS AND ASSOCIATES INC.

NATIONAL FLOOD INSURANCE PROGRAM

FEMA NATIONAL SERVICE PROVIDER

February 3, 2009

Mr. Frank Brown, P.E., CFM
David Evans and Associates, Inc.
2141 East Highland Avenue, Suite 200
Phoenix, AZ 85016

IN REPLY REFER TO:
Case No.: 09-09-0271P
Communities: Town of Buckeye and
Maricopa County, AZ
Community Nos.: 040039 and 040037

316-AD

Dear Mr. Brown:

This is in regard to your request dated November 13, 2008, that the Department of Homeland Security's Federal Emergency Management Agency (FEMA) issue a revision to the Flood Insurance Rate Map (FIRM) for Maricopa County, Arizona and Incorporated Areas. Pertinent information about the request is listed below.

Identifier:	White Tank Fan, Site 38, Approximate Floodplain Delineation Study
Flooding Source:	White Tank Fan, Site 38
FIRM Panel(s) Affected:	04013C1545 H, 1540 H, 2005 H, and 2010 H

The data required to complete our review, which must be submitted within 90 days of the date of this letter, are listed on the enclosed summary.

If we do not receive the required data within 90 days, we will suspend our processing of your request. Any data submitted after 90 days will be treated as an original submittal and will be subject to all submittal/payment procedures, including the flat review and processing fee for requests of this type established by the current fee schedule. A copy of the notice summarizing the current fee schedule, which was published in the *Federal Register,* is enclosed for your information.

FEMA receives a very large volume of requests and cannot maintain inactive requests for an indefinite period of time. Therefore, we are unable to grant extensions for the submission of required data/fee for revision requests. If a requester is informed by letter that additional data are required to complete our review of a request, the data/fee **must** be submitted within 90 days of the date of the letter. Any fees already paid will be forfeited for any request for which the requested data are not received within 90 days.

If you have general questions about your request, FEMA policy, or the National Flood Insurance Program, please call the FEMA Map Assistance Center, toll free, at 1-877-FEMA MAP (1-877-336-2627). If you have specific questions concerning your request, please contact your case reviewer,

NATIONAL FLOOD INSURANCE PROGRAM

FEMA NATIONAL SERVICE PROVIDER

Summary of Additional Data Required to Support a
Letter of Map Revision

Case No.: 09-09-0271P

Requester: Mr. Frank Brown, P.E., CFM

Communities: Town of Buckeye and
Maricopa County, AZ

Community Nos.: 040039 and 040037

The issues listed below must be addressed before we can continue the review of your request.

1. Based on the submitted supporting documents, it is determined that some areas of shaded Zone X, located north of West Camelback Road and west of Sun Valley Parkway, and north of West Indian School Road, may have a higher flood hazard potential than is reflected by the shaded Zone X designation. Please revise the shaded Zone X designation at these locations to Zone A Inactive Alluvial Fan.

2. Please submit an annotated Flood Insurance Rate Map (FIRM), at the scale of the effective FIRM, that shows the base (1-percent-annual-chance) floodplain boundary delineations and how they tie into the boundary delineations shown on the effective FIRM.

Effective October 1, 2007, FEMA revised the fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps. In accordance with this schedule, the fee for your request is $5,600 and must be submitted before we can continue processing your request. Payment of this fee must be made in the form of a check or money order, payable in U.S. funds to the National Flood Insurance Program, or a credit card payment (Visa or MasterCard only). For identification purposes, the case number referenced above must be included on the check or money order. We will not perform a detailed technical review of your request until we receive this payment.

Please send the required data directly to us at the address shown at the bottom of this page. For identification purposes, please include the case number referenced above on all correspondence.

Flood Control District
of Maricopa County

INTEROFFICE MEMORANDUM

Date: July 18, 2007

To: Timothy S. Phillips, P.E., Chief Engineer and General Manager

From: Kathryn Gross, CFM, Planning and Project Management Division

Subject: White Tank Alluvial Fan 38 Floodplain Delineation, performed by David Evans and Associates

The floodplain study for the upper portion of White Tank Fan 38 is ready for use as the best available technical information. The study will be sent to FEMA shortly once the District and Town of Buckeye sign the FEMA forms.

The background on the study includes the following:

> The study was performed by David Evans and Associates (DEA) and was not under a District contract. DEA and the developer they are contracted with are stakeholders in the Buckeye/Sun Valley Area Drainage Master Study and Area Drainage Master Plan. The developers in the area were required to delineate the alluvial fan flood hazards impacting their properties when they chose not to wait for the District to perform the delineations as part of the Sun Valley Area Drainage Master Plan. This submittal represents the upstream portion of White Tank Fan 38. The study includes approximately 3 square miles of Zone A Alluvial Fan Floodplains and Alluvial Fan Administrative Floodways. The delineation was performed using geomorphic methods. The District contracted with JEFuller Hydrology and Geomorphology to perform the reviews through an on-call contract.

Please concur and authorize below the use of this new study.

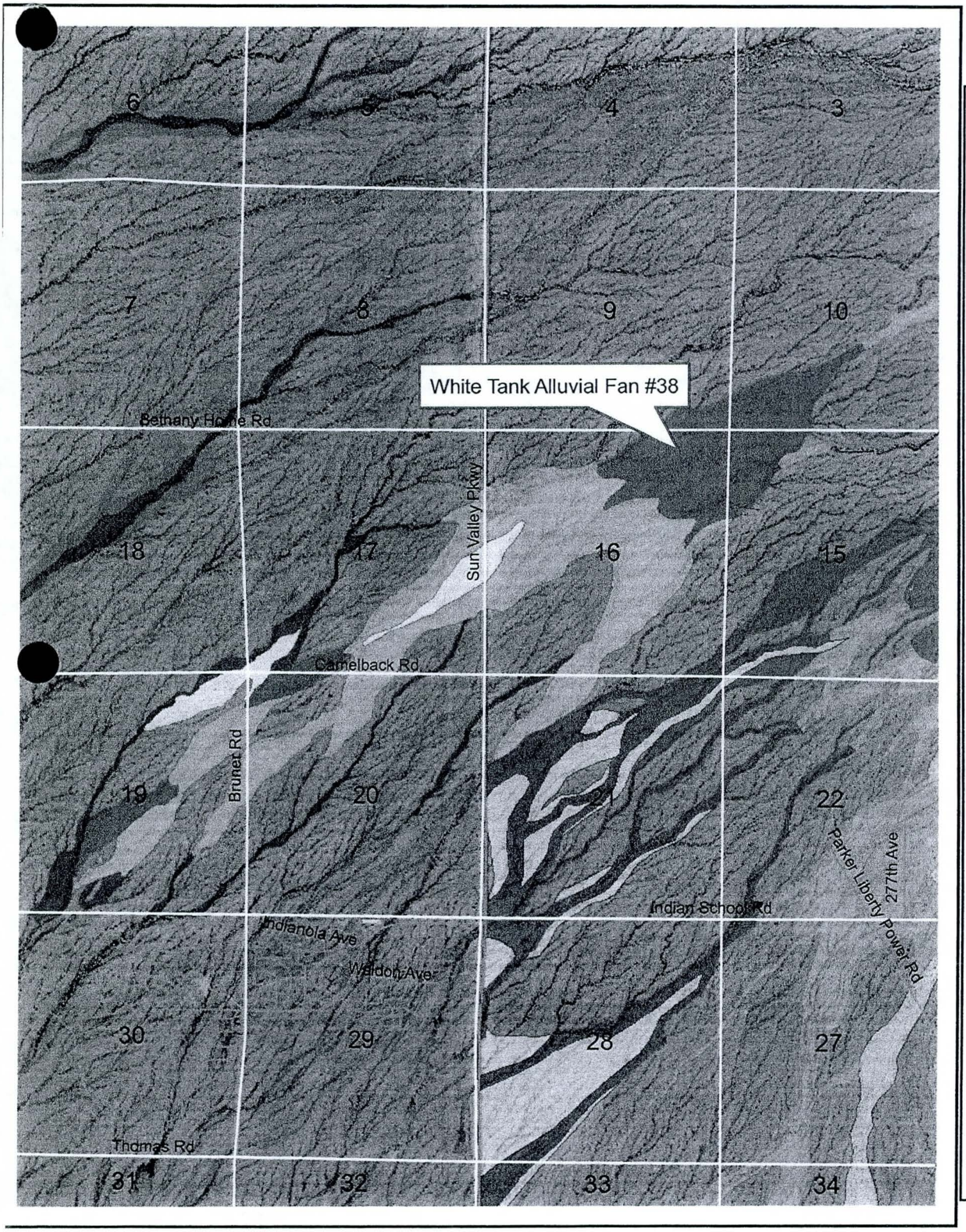
Lynn M. Thomas 7/19/07 Principal Engineer, Regulatory Division Date:	8/14/07 Timothy S. Phillips, P.E. Date: Chief Engineer and General Manager
7/18/07 Floodplain Delineation Review Coordinator Date:	Valerie A. Swick 7/19/07 SVADMP/On-call Review Project Manager Date:
7/18/07 Flood Delineation Branch Manager Date:	July 26, 2007 Planning Branch Manager Date:
8/9/07 Regulatory Division Manager	July 27, 2007 PPM Division Manager Date:

2801 West Durango Street Phoenix, Arizona 85009 Phone: 602-506-1501 Fax: 602-506-4601

	Assistant Project Manager N/A Date:
File Copies: 1. _____ 2. _____	YES ☒ GIS Posted (Pending Floodplain Only) in process Date: 7/13/07 N/A ☐ No County Permits in this area Date:

2801 West Durango Street Phoenix, Arizona 85009 Phone: 602-506-1501 Fax: 602-506-4601

White Tank Alluvial Fan #38
Approximate Zone A Alluvial Fan
Floodplains and Administrative Floodways



Legend

arterial

street

FPZNFCD-FAN_38apr07

ZONE

- AAFF
- AFHH
- AFUFD
- AFZA
- ZONE A

floodplainfema

ZONE

- A
- AAFF
- AE
- AEFW
- AFHH
- AFW
- AFZA
- AH
- ANI
- AO
- FW

floodplainfcd

ZONE

- A
- AAFF
- AE
- AFHH
- AFUFD
- AFW
- AFZA
- AH
- AO
- FW

0 0.4 0.8 1.6 2.4 3.2 Miles

N W E S

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TABLE OF CONTENTS

TITLE **PAGE #**

SECTION 1: INTRODUCTION **1**

1.1 PURPOSE OF STUDY 1
1.2 AUTHORITY FOR STUDY 1
1.3 LOCATION OF STUDY REACH 1
1.4 METHODOLOGY 4
1.4.1 Hydrology *4*
1.4.2 Hydraulics *4*
1.4.3 Geomorphic Analysis *5*
1.5 STUDY RESULTS 5

SECTION 2: ADWR/FEMA FORMS AND LOCAL GOVERNMENT/ADWR ABSTRACTS **1**

2.1 STUDY DOCUMENTATION ABSTRACT FOR FEMA SUBMITTALS 1
2.2 FEMA FORM 2

SECTION 3: SURVEY AND MAPPING INFORMATION **1**

3.1 FIELD SURVEY INFORMATION 1
3.2 MAPPING 1

SECTION 4: HYDROLOGIC ANALYSIS **1**

4.1 METHOD DESCRIPTION 1

SECTION 5: HYDRAULIC ANALYSIS **1**

5.1 METHOD DESCRIPTION 1
5.2 WORK STUDY MAPS 1
5.3 PARAMETER ESTIMATION 1
5.3.1 Roughness coefficients *1*
5.3.2 Expansions and contraction coefficients *1*
5.4 CROSS SECTION DESCRIPTION 3
5.5 MODELING CONSIDERATIONS 3
5.6 FLOODWAY MODELING 3
5.7 SPECIAL PROBLEMS ENCOUNTERED DURING THE STUDY 3
5.8 CALIBRATION 3
5.9 FINAL RESULTS 3
5.9.1 Hydraulic analysis results *3*
5.9.2 Verification of results *4*

SECTION 6: SPECIAL STUDIES **1**

6A: EROSION/SEDIMENT TRANSPORT 1
6B: GEOMORPHOLOGY 1
6B.1 Introduction *1*
6B.2 Previous Reports by Others *2*
6B.2.1 Technical Reports *2*
6B.2.2 Buckeye/Sun Valley ADMS *2*
6B.2.3 Developer Reports *3*
6B.3 Data Sources *3*
6B.3.1 NRCS Soils Map *3*
6B.3.2 AZGS Geologic Maps *3*
6B.3.3 AZGS Flood Hazard Maps *3*
6B.3.4 Aerial Photography *3*

6B.3.5 Topographic Mapping 4
6B.4 Method Description 4
6B.5 Stage 1: Recognizing and Characterizing Piedmont Landforms 5
6B.5.1 Composition 5
6B.5.1.1 Soils Data 5
6B.5.1.2 Surficial Geology 11
6B.5.1.3 Morphology 21
6B.5.1.4 Location 22
6B.5.1.5 Boundaries 23
6B.5.1.6 Conclusion 23
6B.6 Stage 2: Defining Active and Inactive Areas 27
6B.6.1 Introduction 27
6B.6.2.1 NRCS Soil Surveys 28
6B.6.2.2 AZGS Surficial Geology & Flood Hazard Mapping 28
6B.6.2.3 Interpretation of Topography 29
6B.6.2.4 Historical & Current Aerial Photograph Interpretation 29
6B.6.2.5 Drainage Pattern 29
6B.6.2.6 Surficial Characteristics 30
6B.6.2.7 Vegetation 30
6B.6.2.8 Sediment Delivery Potential 31
6B.6.3 Identification of Inactive Areas 31
6B.6.3.2 Summary of Active & Inactive Areas 35
6B.7 Stage 3: Defining the Approximate 100-year Floodplain 35
6B7.1 Types of Flooding 36
6B.7.1.1 Alluvial Fan 36
6B.7.1.2 Sheet Flow 36
6B.7.1.3 Stable Distributary 36
6B.7.2 Description of Mapping Issues 37
6B.7.3 Verification of Results 37
6B.4 Work Study Maps 38

SECTION 7: DRAFT FIS REPORT DATA **1**

7.1 SUMMARY OF DISCHARGES 1
7.2 FLOODWAY DATA 1
7.3 ANNOTATED FLOOD INSURANCE RATE MAPS 1
7.4 FLOOD PROFILES 1

LIST OF TABLES

TABLE #	TITLE	PAGE #
6-1	Soil Units and Characteristics	6-10 to 6-11
6-2	Surficial Geology Map Units	6-15
6-3	Flood Hazard Zone Map Units	6-20 to 6-21
6-4	Piedmont Flood Hazard Zones	6-44
7-1	Floodplain Discharge Rates	7-1

LIST OF APPENDICES

APPENDIX A: REFERENCES
APPENDIX B: GENERAL DOCUMENTATION AND CORRESPONDENCE
APPENDIX C: SURVEY FIELD NOTES
APPENDIX D: HYDROLOGIC ANALYSES SUPPORTING DOCUMENTATION
APPENDIX E: HYDRAULIC ANALYSES SUPPORTING DOCUMENTATION
APPENDIX F: EROSION/SEDIMENT TRANSPORT
APPENDIX G: PIEDMONT FLOOD HAZARD ASSESSMENT SUPPORTING DOCUMENTATION
APPENDIX H: FIELD PHOTOS

LIST OF FIGURES

FIGURE #	TITLE	PAGE #
FIGURE 1	Location Map	1-2
FIGURE 2	Vicinity Map	1-3
FIGURE 3	HEC-RAS Cross Section Locations	5-2
FIGURE 4	Soil Conservation Service Soils Map	6-7 to 6-9
FIGURE 5	Surficial Geology Map	6-12 to 6-14
FIGURE 6	Geologic Mapping Flood Hazards	6-17 to 6-19
FIGURE 7	Stage 3 Results - Aerial Photography	6-41 to 6-43
FIGURE 8	Stage 2 Results – Stable and Unstable Boundaries	6-32 to 6-34
FIGURE 9	Stage 1 Results – Landform Delineation	6-24 to 6-26
FIGURE 10	Hydrology Exhibit	4-2 to 4-4

EXHIBITS

EXHIBIT 1 HEC-RAS CROSS SECTION LOCATIONS
EXHIBIT 2 SOIL CONSERVATION SERVICE SOILS MAP
EXHIBIT 3 SURFICIAL GEOLOGY MAP
EXHIBIT 4 GEOLOGIC MAPPING FLOOD HAZARDS
EXHIBIT 5 STAGE 3 RESULTS - AERIAL PHOTOGRAPHY
EXHIBIT 6 STAGE 2 RESULTS – STABLE AND UNSTABLE BOUNDARIES
EXHIBIT 7 STAGE 1 RESULTS – LANDFORM DELINEATION
EXHIBIT 8 HYDROLOGY EXHIBIT

Section 1: INTRODUCTION

1.1 Purpose of study

The purpose of this floodplain delineation study is to identify and delineate the approximate 100-year floodplain for the White Tank alluvial fan whose apex is identified as Site 38 in Hjalmarson and Kemna (1992) in Section 10 of T2N, R4W in Maricopa County, Arizona using approximate methods. The name, Site 38 or Fan 38, will be used frequently in this report to refer to the alluvial fan which is the subject of this study to distinguish it from other alluvial fans present on the western piedmont of the White Tank Mountains located west of the Phoenix metropolitan area. This study incorporates the methods of assessing piedmont flood hazards as outlined in *Piedmont Hazard Assessment Manual for Maricopa County (PFHAM)* (Hjalmarson, 2003) and Guidelines *and Specifications for Flood Hazard Mapping Partners Appendix G* (FEMA 2002). A geomorphic approach will be the predominant method of analysis for the approximate flood hazards delineation for this study.

The information presented in this study will be used to update existing Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs). The information will also be used by local and regional planners and floodplain administrators to further promote sound land use practices and development on the floodplain.

1.2 Authority for study

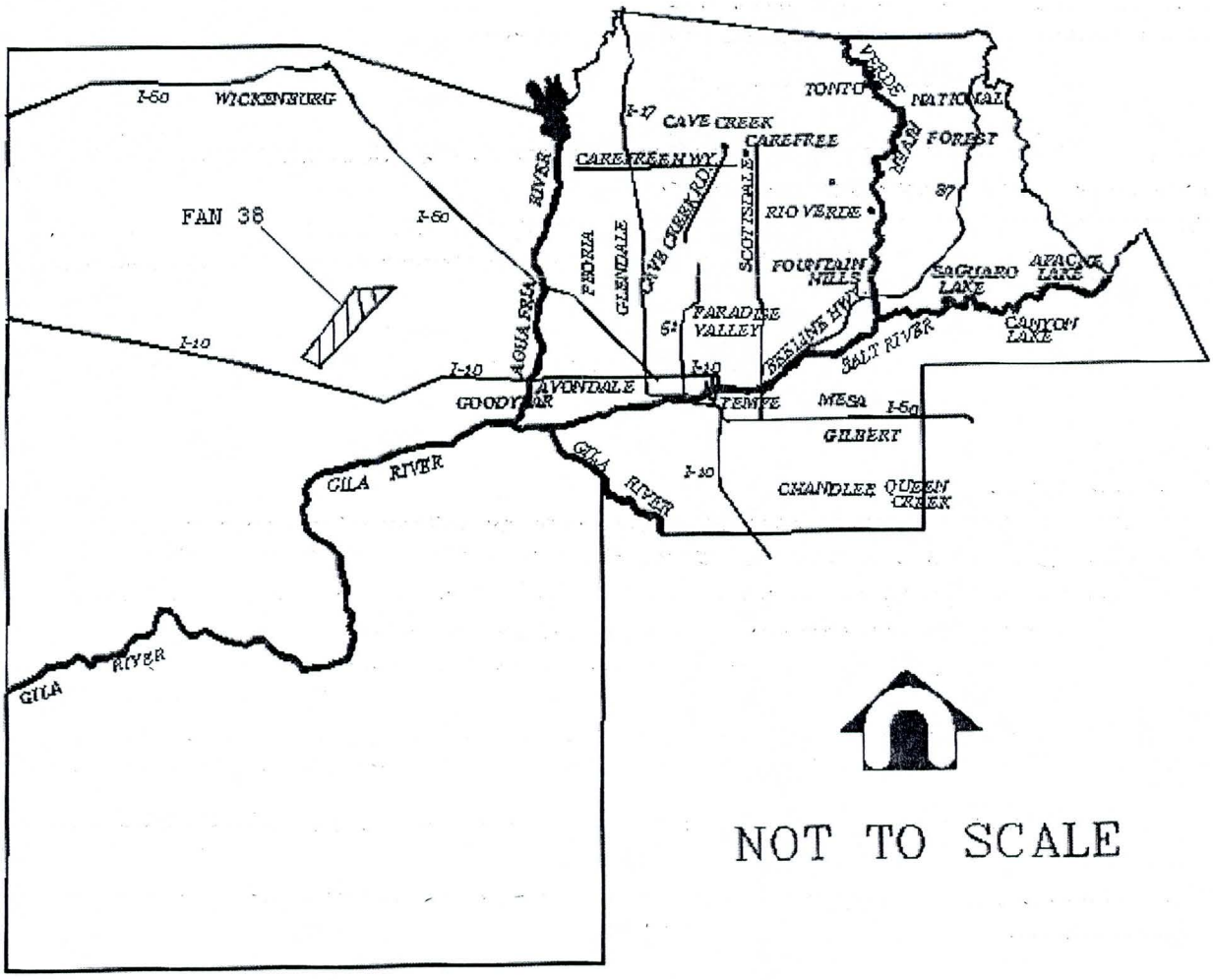
David Evans and Associates, Inc. (DEA) performed this study under contract with a consortium of developers to aid the Flood Control District of Maricopa County (FCDMC) in their determination of the flood hazards within the watershed. Fans 7, 8, 12, 37, and 39 were also studied as part of the overall project and will be submitted separately from this report. Each study followed similar methodology as was approved by FEMA in 2002 for Fan 36 (Site 36) under the *Approximate Floodplain Delineation Study for White Tank Fan (Site 36)* prepared by Wood Patel & Associates, Inc. in association with JE Fuller Hydrology & Geomorphology.

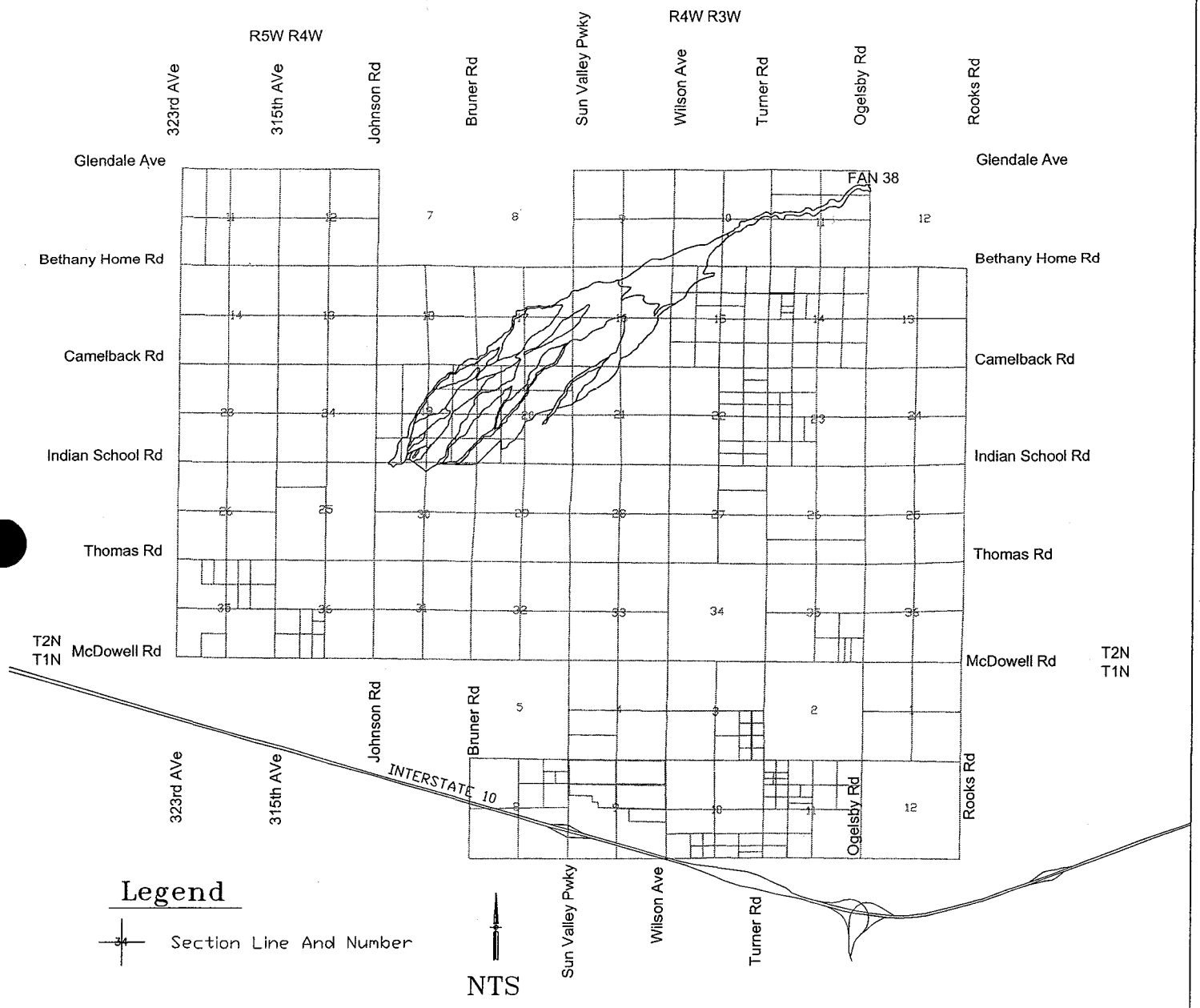
1.3 Location of study reach

The study area is located in west-central Maricopa County, Arizona; just north of Interstate 10 and east of the Hassayampa River. Refer to Figures 1 and Figure 2 located on the following pages. The total contributing area down to the hydrographic apex of Fan 38 is 3.5 square miles. Downstream from this point, the wash system diverges into numerous branches that form a distributary flow system. The approximate floodplain delineation extends upstream approximately 1-1/2 miles from the hydrographic apex and downstream over the piedmont from the hydrographic apex to the northern boundary of the residential construction area named Tartesso Unit 2, at the northern boundary of Sections 29 & 30, of Township 2 North, Range 4 West. The floodplain downstream of the Fan 38 Stage 3 delineation will be prepared as part of the LOMR submittal for Tartesso Unit 2.

The climate within the study area is semi-arid desert with an average annual precipitation of less than 10 inches. Annual rainfall amounts generally increase with increasing elevation within watersheds near the study area. Precipitation is typically divided into two seasons of comparative rainfall depths: summer and winter. The summer storms are associated with warm, moist tropical air masses that enter the state from the Gulf of Mexico producing moderate to intense afternoon and evening thunderstorms. Winter precipitation originates from the Pacific Ocean and produces light to moderate precipitation over relatively large areas.

Location Map
Figure 1





FAN 38 VICINITY MAP
FIGURE 2

1.4 Methodology

This study incorporates the methods for assessment of piedmont flood hazards as outlined in *PFHAM* and the *FEMA Guidelines*. The *FEMA Guidelines* are specific to the determination of flood hazards on alluvial fan landforms. The *PFHAM*, which is recommended for use in Maricopa County, Arizona, is applicable to the entire piedmont, not just in the vicinity of the fan apices. The *PFHAM* methodology incorporates geomorphic methods into the flood hazard assessment of piedmont surfaces. According to the *FEMA Guidelines*, the geomorphic approach is considered an "approximate method" because no base flood elevations are calculated with a geomorphic approach which relies heavily on qualitative information and interpretation of historical data and other studies.

In addition, a riverine portion of the system upstream of Fan 38's hydrographic apex was also delineated. In this stable reach, approximate normal-depth hydraulic calculations were performed to identify the flood hazard limits. The approximate normal-depth delineation of this reach was supplemented by interpretation of geomorphic information from maps, aerial photographs, and field observations. Again, no base flood elevations were determined in this reach.

1.4.1 Hydrology

The hydrologic information used in this study, as directed by FCDMC, were the results from the recently completed *Buckeye/Sun Valley Area Drainage Master Study* (ADMS) prepared for FCDMC by PBS & J Engineering (2005). The study resulted in 100-year, 6-hour and 24-hour HEC-1 models and the highest peak flow rates were used for this TDN. This is the best technical information available for the piedmont so it was used for this study.

Copies of the 100-year, 6-hour and 100-year, 24-hour HEC-1 models are included in Appendix D for reference. The ADMS computed a 100-year peak discharge at the hydrographic apex for Fan 38 of 1858 cfs for the 6-hour duration. A peak flow of 1839 cfs was determined for the 24-hour event. Traditional geomorphic methods were used to delineate the floodplains. The only area where hydraulics was used was above the hydrographic apex of Fan 38, at the beginning of the Zone A. Hydraulics were used in this area to show containment of the full fan flow (1858 cfs).

1.4.2 Hydraulics

Hydraulic calculations for the riverine reach of this study upstream of the hydrographic apex were limited primarily to individual cross sections using a Manning's calculation. The hydraulic analyses for the approximate floodplain delineations above the hydrographic apex are presented in Section 5 of the TDN. The cross sections and normal-depth calculations are presented in Appendix E. The flood hazards in the remainder of the study area were evaluated using a geomorphic approach as described in Section 6B.

1.4.3 Geomorphic Analysis

The flood hazard assessment for this study was accomplished through geomorphic methods used to identify the type and extent of the flood hazard within the study area. The procedures applied follow the three stage approach outlined in the *PFHAM* and the *FEMA Guidelines*. Section 6B discusses the geomorphic approach, a description of the methods, and results of the analyses. Section 6B has been added to the standard TDN format to accommodate the alternate methodology. The approach relies on previous surficial geologic mapping (Field and Pearthree, 1991), Geologic Mapping of Flood Hazards (Field and Pearthree, 1992), NRCS soil mapping, aerial photograph interpretation, field observations, and professional judgment.

1.5 Study Results

This study resulted in the new delineation of 2.9 square miles of approximate floodplain in the study area. The inundation areas for the newly delineated floodplains are shown on the maps in Section 6B and 7 and the Exhibits at the end of this notebook. The floodplain mapping also includes administrative floodways defined by FCDMC for the local management of flood hazards on the alluvial fan.

Section 2: ADWR/FEMA Forms and Local Government/ADWR Abstracts

2.1 Study Documentation Abstract for FEMA Submittals

Study Documentation Abstract For FEMA Submittals	Initial Study	**X** Restudy	CLOMR	LOMR	**X** Other

Section 2.1: Study Documentation Abstract for FEMA Submittals		
2.1.1	Date Study Accepted	
2.1.2	Study Prime Contractor	David Evans & Associates, Inc.
	Contact(s)	Michael Weinberg, P.E.
	Address	2140 E. Highland Avenue, Suite 200 Phoenix, AZ 85016
	Phone	(602) 678-5151
	Internal Reference Number	STAR0000-0131
2.1.3	FEMA Technical Review Contractor	Michael Baker, Jr.
	Contact(s)	Mounir Boudjemaa
	Address	3600 Eisenhower Ave. Suite 600 Alexandria, VA 22304
	Phone	703-317-6224
	Internal Reference Number	
2.1.4	FEMA Regional Reviewer	Michael Baker, Jr. Engineering
	Phone	(703) 960-8800
2.1.5	State Technical Reviewer	Arizona Department of Water Resources
	Phone	(602) 417-2400
2.1.6	Local Technical Reviewer	Flood Control District of Maricopa County (FCDMC)
	Phone	(602) 506-1501
2.1.7	Reach Description	
2.1.8	USGS Quad Sheet(s) with original photo date & latest photo revision date	Buckeye, NW 1958, photo revised 1982 White Tanks Mtn 1957, photo revised 1971
2.1.9	Unique Conditions and Problems	Alluvial fan
2.1.10	Coordination of Peak Discharges (Agency, Date, Comments)	Buckeye/Sun Valley Area Master Drainage Study obtained from Flood Control District of Maricopa County July 2006, CP#K2BR, 100-yr 6-hr HEC-1

2.2 FEMA Form

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
040039 – Buckeye 040037 - Maricopa	Maricopa County, Arizona and Incorporated Areas, Town of Buckeye, Maricopa County	AZ	04013C	2005 H	9/30/05
040039 – Buckeye 040037 - Maricopa	Maricopa County, Arizona and Incorporated Areas, Town of Buckeye, Maricopa County	AZ	04013C	1540 H	9/30/05
040039 – Buckeye 040037 - Maricopa	Maricopa County, Arizona and Incorporated Areas, Town of Buckeye, Maricopa County	AZ	04013C	1545 H	9/30/05

2. Flooding Source: White Tank Fan, Site 38

3. Project Name/Identifier: White Tank Fan, Site 38, Approximate Floodplain Delineation Study

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

5. Basis for Request and Type of Revision:

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

☐ Physical Change ☐ Improved Methodology/Data

☐ Regulatory Floodway Revision ☒ Other (Attach Description)

Flood Hazard added where no hazard had previously been mapped

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

Map changes based on flood hazard information meant to improve upon that shown on the flood map or within the flood study.

Please see the FEMA Web site at http://www.fema.gov/mit/tsd/frm_fees.htm **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: Michael Weinberg, P.E.	Company: David Evans & Associates	
Mailing Address: 2141 E. Highland Ave, Ste 200 Phoenix AZ 85016	Daytime Telephone No.: 602-678-5151	Fax No.: 602-678-5155
	E-Mail Address: miw@deainc.com	
Signature of Requester (required):		Date: 11/9/07

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

Community Official's Name and Title: Timothy Philips, P.E., Chief Engineer & General Manager		Telephone No.: 602.506.1501
Community Name: Maricopa County, Arizona	Community Official's Signature (required):	Date:

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: Michael Weinberg, P.E.	License No.: 36390	Expiration Date: March 31, 2008
Company Name: David Evans & Associates, Inc.	Telephone No.: 602-678-5151	Fax No.: 602-678-5155
Signature:		Date: 11/9/07

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

Map changes based on flood hazard information meant to improve upon that shown on the flood map or within the flood study.

Please see the FEMA Web site at http://www.fema.gov/mit/tsd/frm_fees.htm **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: Michael Weinberg, P.E.	Company: David Evans & Associates	
Mailing Address: 2141 E. Highland Ave, Ste 200 Phoenix AZ 85016	Daytime Telephone No.: 602-678-5151	Fax No.: 602-678-5155
	E-Mail Address: miw@deainc.com	
Signature of Requester (required): Michael W		Date: 11/9/07

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

Community Official's Name and Title: Timothy Philips, P.E., Chief Engineer & General Manager		Telephone No.: 602.506.1501
Community Name: Maricopa County, Arizona	Community Official's Signature (required):	Date: 3/3/08

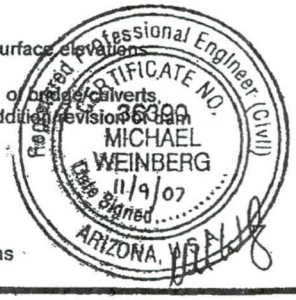
CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

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: Michael Weinberg, P.E.	License No.: 36390	Expiration Date: March 31, 2008
Company Name: David Evans & Associates, Inc.	Telephone No.: 602-678-5151	Fax No.: 602-678-5155
Signature: Michael W		Date: 11/9/07

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



D. SIGNATURE (continued)

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: Michael Weinberg, P.E.	Company: David Evans & Associates	
Mailing Address: 2141 E. Highland Ave, Ste 200 Phoenix, AZ 85016	Daytime Telephone No.: 602-678-5151	Fax No 602-678-5155
	E-Mail Address: miw@deainc.com	
Signature of Requester (required): MW		Date 11/9/07

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 Jeanine Guy, Town Manager		Telephone No.: (623)349-6000
Community Name: Town of Buckeye	Community Official's Signature (required): SIGN HERE	Date: 11/12/08

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: Michael Weinberg, P.E.	License No.: 36390 30013	Expiration Date: March 31, 2008
Company Name: David Evans & Associates, Inc	Telephone No.: 602-678-5151	Fax No.: 602-678-5155
Signature: MW		Date: 11/9/07

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: White Tank Alluvial Fan, Site 38 (Hjalmarson and Kemna, 1992)
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/mit/tsd/en_modl.htm.

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	Water-Surface Elevations (ft.) Proposed/Revised
Downstream Limit	See attached annotated FIRMs			
Upstream Limit	See attached annotated FIRMs			

2. Hydraulic Method Used: HEC-RAS

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

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/mit/tsd/frm_soft.htm. 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:	Floodway File Name:
Corrected Effective Model*	Natural File Name:	Floodway File Name:
Existing or Pre-Project Conditions Model	Natural File Name:	Floodway File Name:
Revised or Post-Project Conditions Model	Natural File Name:	Floodway File Name:
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/mit/tsd/en_modl.htm.

Explanation

Items 2, 3 & 4 – No water surface elevations or profiles were computed for this study. Only inundation limits i.e. Zone A, are shown.

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 ALLUVIAL FAN FLOODING FORM	*O.M.B. No. 3067-0148* *Expires September 30, 2005*

PAPERWORK REDUCTION ACT

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.**

Flooding Source: White Tank Fan 38
Note: Fill out one form for each flooding source studied

A. THREE-STAGE ANALYSIS (Based on FEMA Guidelines dated February 23, 2000)

1. Stage 1 Analysis

   a. The landform is composed of (check one) ☒ alluvial ☐ debris flow deposits.

   b. Source of data used to determine composition, morphology, and location of the landform: AZGS surficial geology mapping, Soil Survey of Aguila-Carefree

   c. Is there an NRCS soils survey and soil survey map available? ☒ Yes ☐ No
   If Yes, please include a copy of the map and any pertinent sections of the soil survey Pertinent excerpts located in Section G.6

2. Stage 2 Analysis

   a. The alluvial fan exhibits ☐ active ☐ inactive ☒ a combination of active and inactive alluvial fan flooding.

   b. Approximate age of inactive fan surfaces (thousands of years): > 10,000 yrs

   c. Is there an opportunity for avulsions that could lead channels or sheet floods across the older fan surfaces?
   ☐ Yes ☒ No

   d. Is there evidence of head cutting that could lead to stream piracy? ☐ Yes ☒ No

   e. Is there geomorphic evidence of past avulsions during the Holocene epoch? ☒ Yes ☐ No

   f. The fan exhibits the following types of flooding (check one):

   ☒ Flooding along stable channels
   ☒ Sheet flow
   ☐ Debris flow
   ☒ Unstable flow path flooding

3. Stage 3 Analysis

   The boundaries of the 1%-annual-chance floodplain have been determined using (check one):

   ☐ Risk-Based Analysis
   ☐ FEMA FAN program (if discharge at the apex is different than that given in the effective FIS, then attach MT-2, Form 2 along with a plot of the flood frequency curve on log-normal probability paper and include the drainage area above the hydrographic apex, and the mean, standard deviation, and skew coefficient of the curve)
   ☐ Sheet flow Methods
   ☐ Hydraulic Analytical Methods
   ☒ Geomorphic Data, Post-Flood Hazard Verification, and Historical Information
   ☐ Composite Methods

B. STRUCTURAL FLOOD CONTROL MEASURES

1. The following structural flood control measures are proposed or built (check one):

   ☐ Channelization ☐ Levee/Floodwall ☐ Dam ☐ Sedimentation Basin

2. Do the constructed or proposed structural measures affect flood hazards (including velocity, scour, and sediment deposition) on other areas of the fan? ☐ Yes ☐ No

3. Attach completed Form 3 (Riverine Structures Form).

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

5. Please attach a copy of the formal Operations and Maintenance Plan.

C. MAPPING REQUIREMENTS

Attach a certified topographic work map showing the following:

- The boundaries of the alluvial fan including: toe, topographic and hydrologic apexes, and lateral boundaries
- The delineation of the active and inactive portions of the fan as determined by the Stage 2 analysis
- The revised 1%-annual-chance floodplain boundaries, as determined by the Stage 3 Analysis, that tie into the effective floodplain boundaries
- The correct alignment of all structural features
- The map scale

Section 3: SURVEY AND MAPPING INFORMATION

3.1 Field Survey Information

Ground control survey work associated with the topographic mapping was performed by RBF Consulting of Phoenix, Arizona under a contract with the FCDMC. The survey data for this project is presented in the North American Datum of 1983 (NAD 83), 1992 Central Zone of Arizona State Plane Coordinate System. Elevations are referenced to the North American Vertical Datum of 1988 (NAVD88). No additional survey was required for this study.

3.2 Mapping

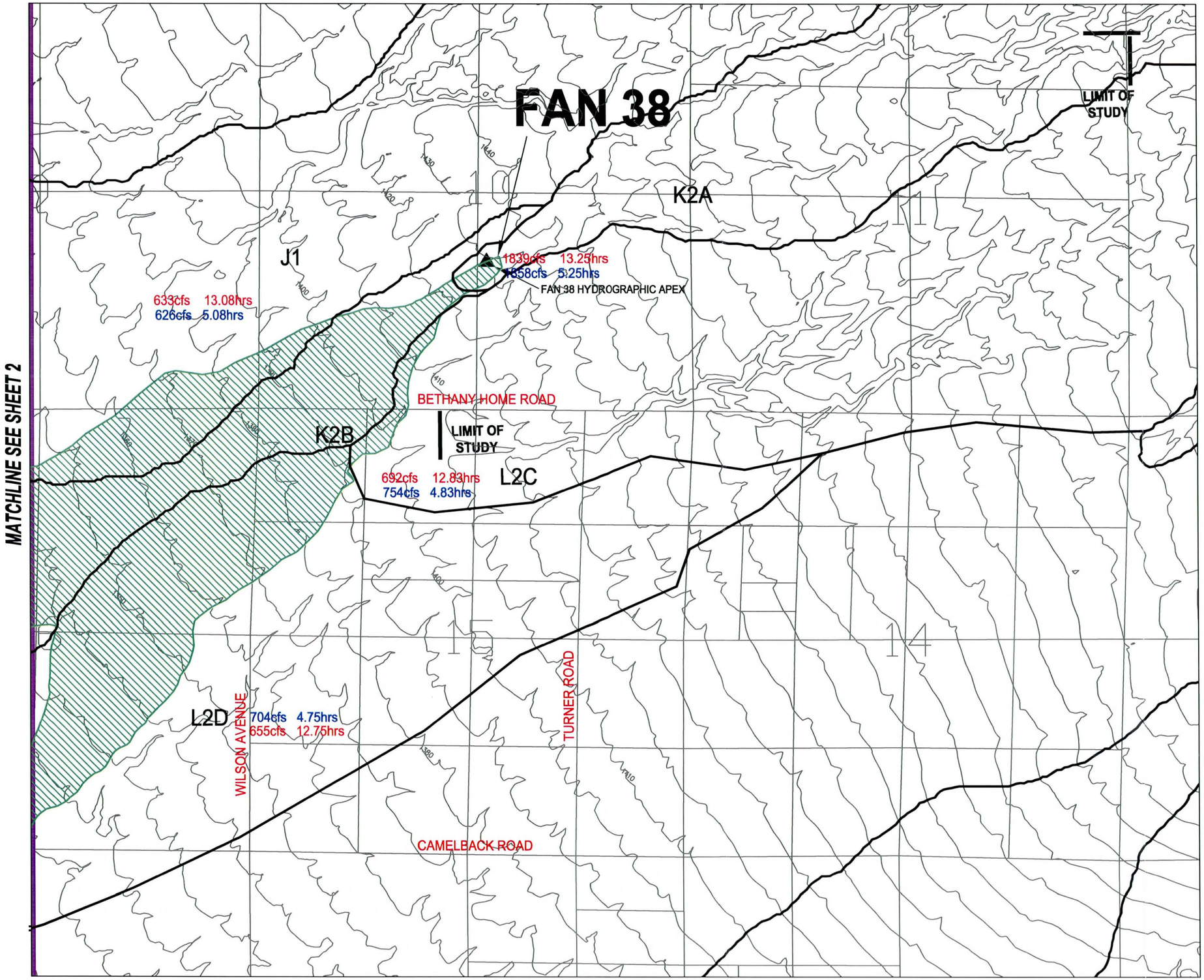
The topographic mapping and aerial photography was provided by Landata Airborne Systems of Irvine California, under a contract with the FCDMC in 2000/2001. The flight dates for the mapping were 12/16/00, 12/17/00, and 12/27/00. The topographic mapping was prepared by photogrammetric methods to national map accuracy standards for 1-inch equals 500 feet with a 10-foot contour interval.

Section 4: HYDROLOGIC ANALYSIS

4.1 Method Description

There is no stream flow gage information in the vicinity of Fan 38; therefore, synthetic rainfall-runoff estimates were used to estimate the 100-year discharge. The hydrologic information used in this study was derived from the FCDMC's Buckeye/Sun Valley ADMS, as directed by the FCDMC, and Fan 38 was found to have a concentrated peak flow of 1858 cfs. Copies of the 100-year, 6 and 24 hour models for both the Sub-basins E-K and L-R models along with their associated sub-basin boundary maps can be found in Appendix D for reference. Previous hydrologic studies for the overall watershed resulted in similar peak flow rates. The hydrologic data applied in this study was used only in the riverine delineations upstream of the hydrographic apex to substantiate that the entire total apex flow could reasonably be conveyed within the flood hazard boundary (Zone A) as determined using geomorphic means.

Figure 10 on the following pages contains the Buckeye/Sun Valley ADMS resulting Q's and sub-basin boundaries as compared to the discharges used in the Stage 3 analysis. Exhibit 8, located in the back pocket, represents a larger scale version of the same drawing.



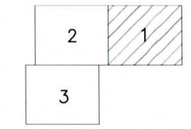
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- 1858cfs — 100 Yr, 24-Hr Peak Flows w/Time Of Peak from Buckeye/Sun Valley ADMS
- 1858cfs — 100 Yr, 6-Hr Peak Flows W/Time Of Peak From Buckeye/Sun Valley ADMS
- Concentration Point
- HEC-1 Sub-Basin Boundary
- L2C — HEC-1 Sub-Basin ID
- 15 — Section Lines and Numbers

SHEET INDEX



DAVID EVANS AND ASSOCIATES INC.
2141 East Highland Avenue, Suite 200
Phoenix, Arizona 85016
Phone: 602.678.5151

FIGURE 10
HYDROLOGY EXHIBIT

	BY	DATE
DESIGN	SXW	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXW	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3

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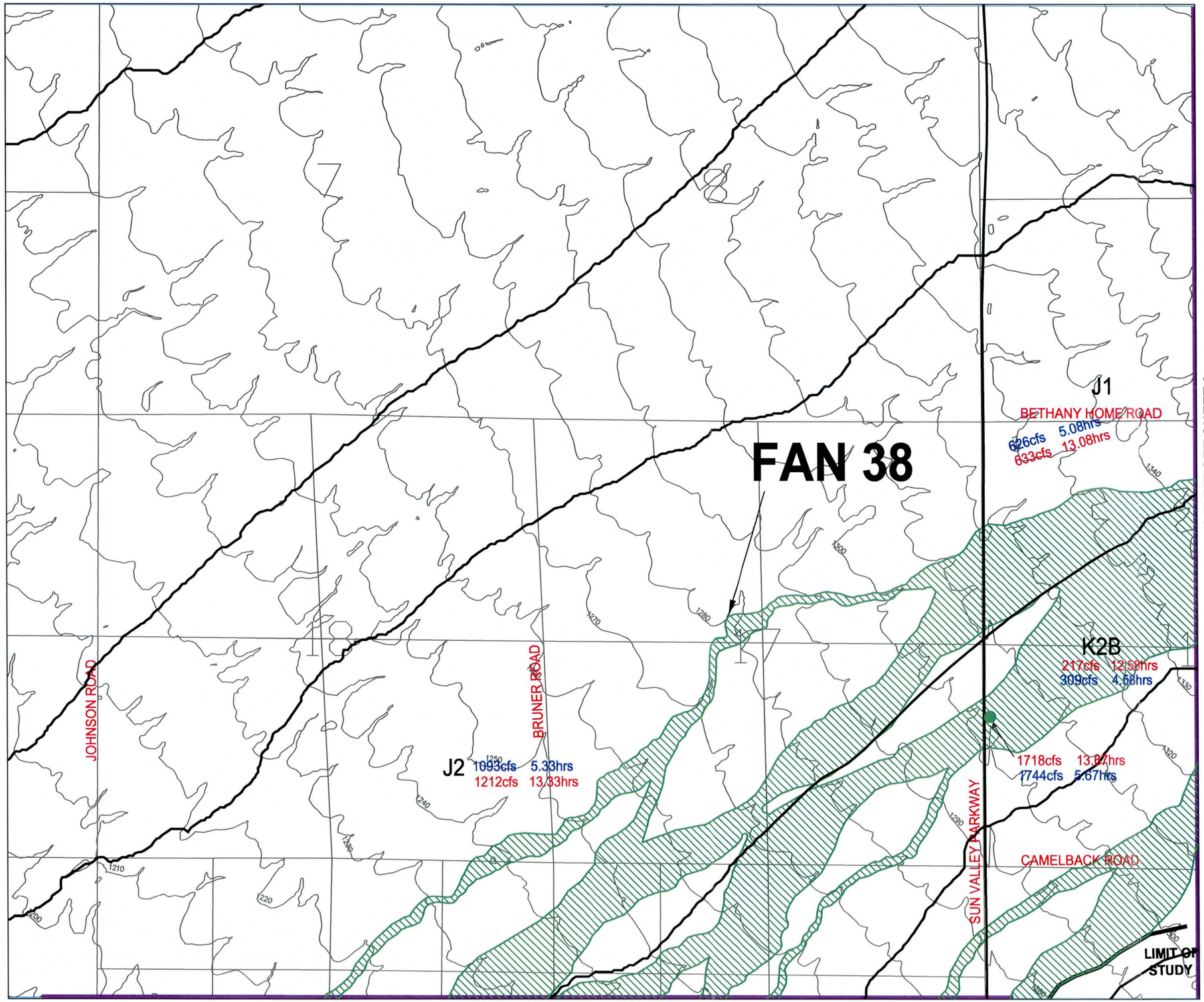


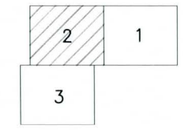
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38
ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN
DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- 1858cfs — 100 Yr, 24-Hr Peak Flows w/Time Of Peak from Buckeye/Sun Valley ADMS
- 1858cfs — 100 Yr, 6-Hr Peak Flows W/Time Of Peak From Buckeye/Sun Valley ADMS
- Concentration Point
- HEC-1 Sub-Basin Boundary
- L2C — HEC-1 Sub-Basin ID
- 15 — Section Lines and Numbers

SHEET INDEX



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DAVID EVANS
AND ASSOCIATES INC.
2141 East Highland Avenue, Suite 200
Phoenix, Arizona 85016
Phone: 602.678.5151

FIGURE 10
HYDROLOGY EXHIBIT

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 2 OF 3

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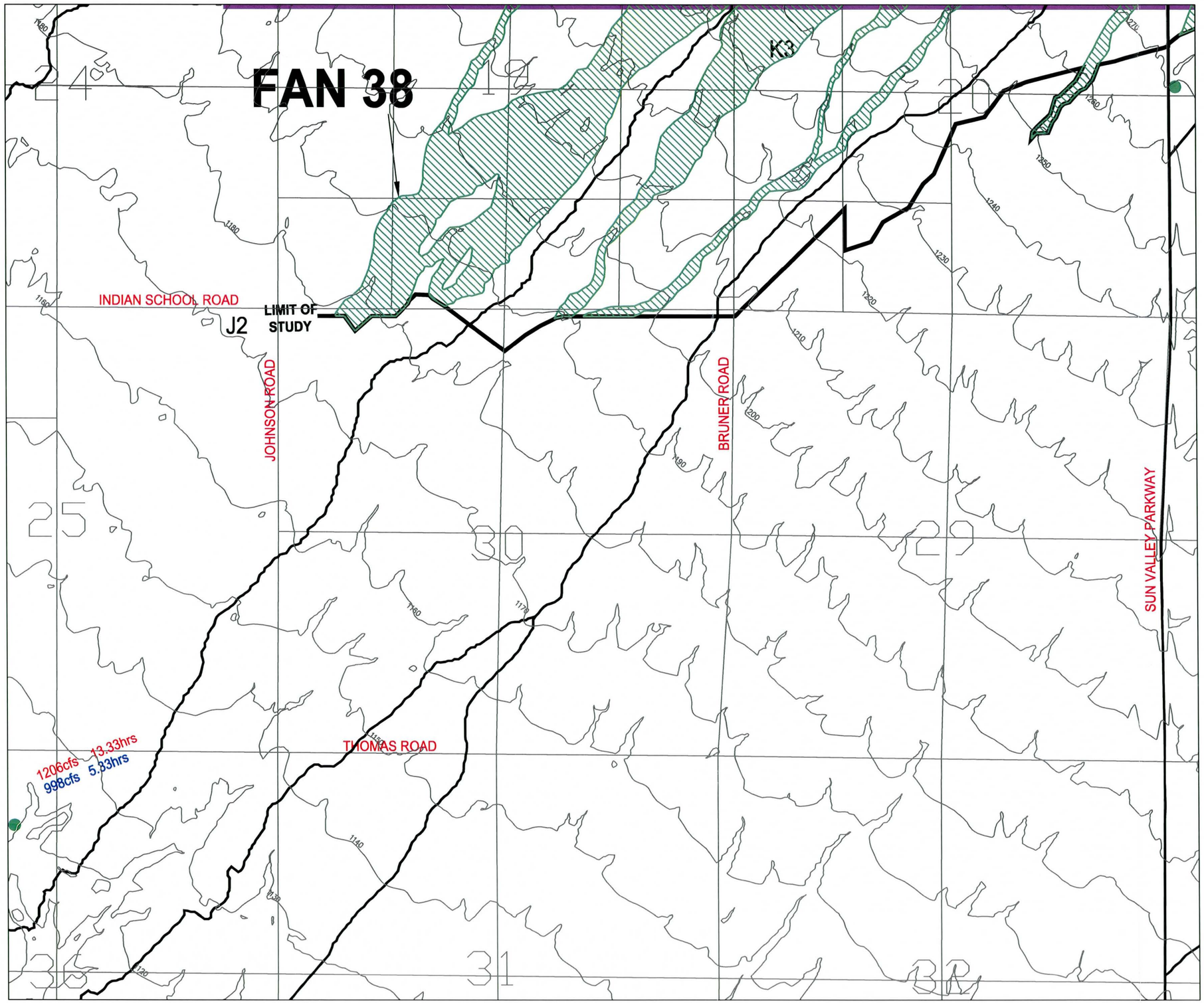
MATCHLINE SEE SHEET 2



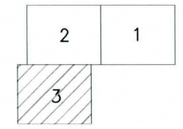
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- 1858cfs — 100 Yr, 24-Hr Peak Flows w/Time Of Peak from Buckeye/Sun Valley ADMS
- 1858cfs — 100 Yr, 6-Hr Peak Flows W/Time Of Peak From Buckeye/Sun Valley ADMS
- Concentration Point
- HEC-1 Sub-Basin Boundary
- L2C — HEC-1 Sub-Basin ID
- 15 — Section Lines and Numbers

SHEET INDEX



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NTS

DAVID EVANS AND ASSOCIATES INC.
2141 East Highland Avenue, Suite 200
Phoenix, Arizona 85016
Phone: 602.678.5151

FIGURE 10
HYDROLOGY EXHIBIT

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

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Section 5: HYDRAULIC ANALYSIS

5.1 Method Description

This study used approximate hydraulic methods to determine the flood hazard zone delineation only in the area directly above the hydrographic apex. Geomorphology was the method that was used to determine the flood hazard zones for all areas downstream of the hydrographic apex.

Flow rates were based on the full fan flow of 1858 cfs. Adjustments were made to the Zone A floodplain based on interpretation of aerial photographs, geomorphology, and field interpretation. The final floodplain was at least as wide as the computed width using normal depth computations.

5.2 Work Study Maps

Figure 3, located on the next pages, shows the location of the HEC-RAS cross sections, topography obtained from the Buckeye/Sun Valley ADMS, thalwegs associated with the Fan 38 apex, as well as the resulting approximate floodplain delineation (from geomorphology). The HEC-RAS analysis is located in Appendix E. Exhibit 1, located in the back pocket, is a 1"=600' scale version of Figure 3.

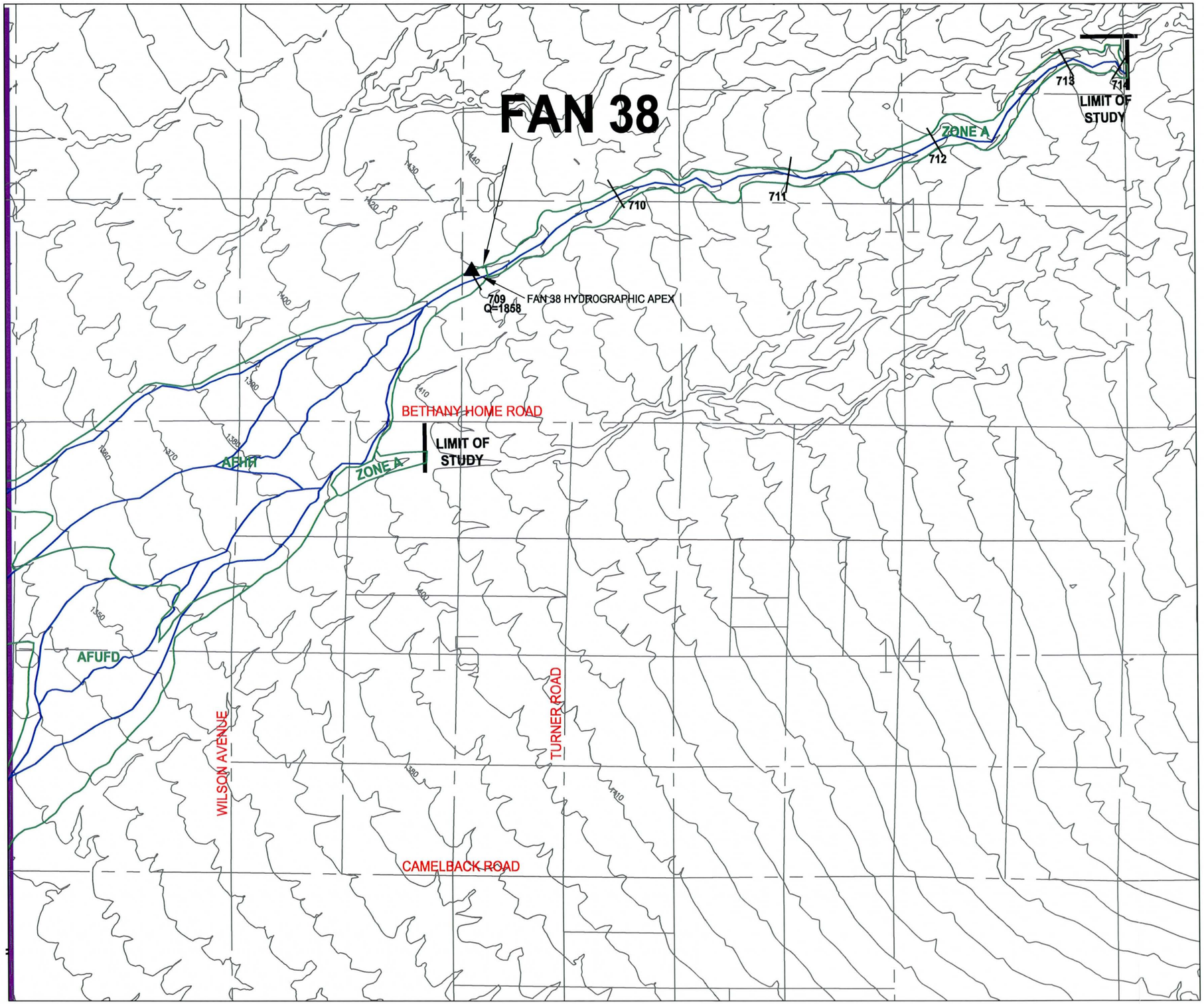
5.3 Parameter Estimation

5.3.1 Roughness coefficients

Manning's n-values for representative reaches were determined using methods outlined in FCDMC and Ven T. Chow's *Open Channel Hydraulics*, 1959. The basis for evaluation of the roughness conditions in each reach included examination of reaches in the field and interpretation of aerial photographs. An overall n value of 0.05 was used for this approximate study which is generally described as winding, cobbly with low shrubs and with over banks generally consisting of high density of medium height shrubs or low density of medium high shrubs with some trees. The n values chosen is consistent with those used in the Fan 36 Approximate Study which used 0.04 to 0.055 in similar terrain.

5.3.2 Expansions and contraction coefficients

No step backwater modeling was performed for this study; therefore, expansions and contraction coefficients were not considered.



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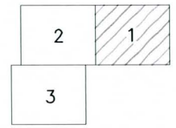
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Fan 38 Thalwegs
- Q=500 Flow Values
- 714 HEC-RAS Cross Section Location and ID
- 15 Section Lines and Numbers
- AFHH Alluvial Fan High Hazard
- AFUFD Alluvial Fan Uncertain Flow Distribution
- AAFF Approximate Alluvial Fan Floodway
- AFZA Alluvial Fan Zone A Flooding
- SHX Shaded Zone X

SHEET INDEX



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Phoenix, Arizona 85016
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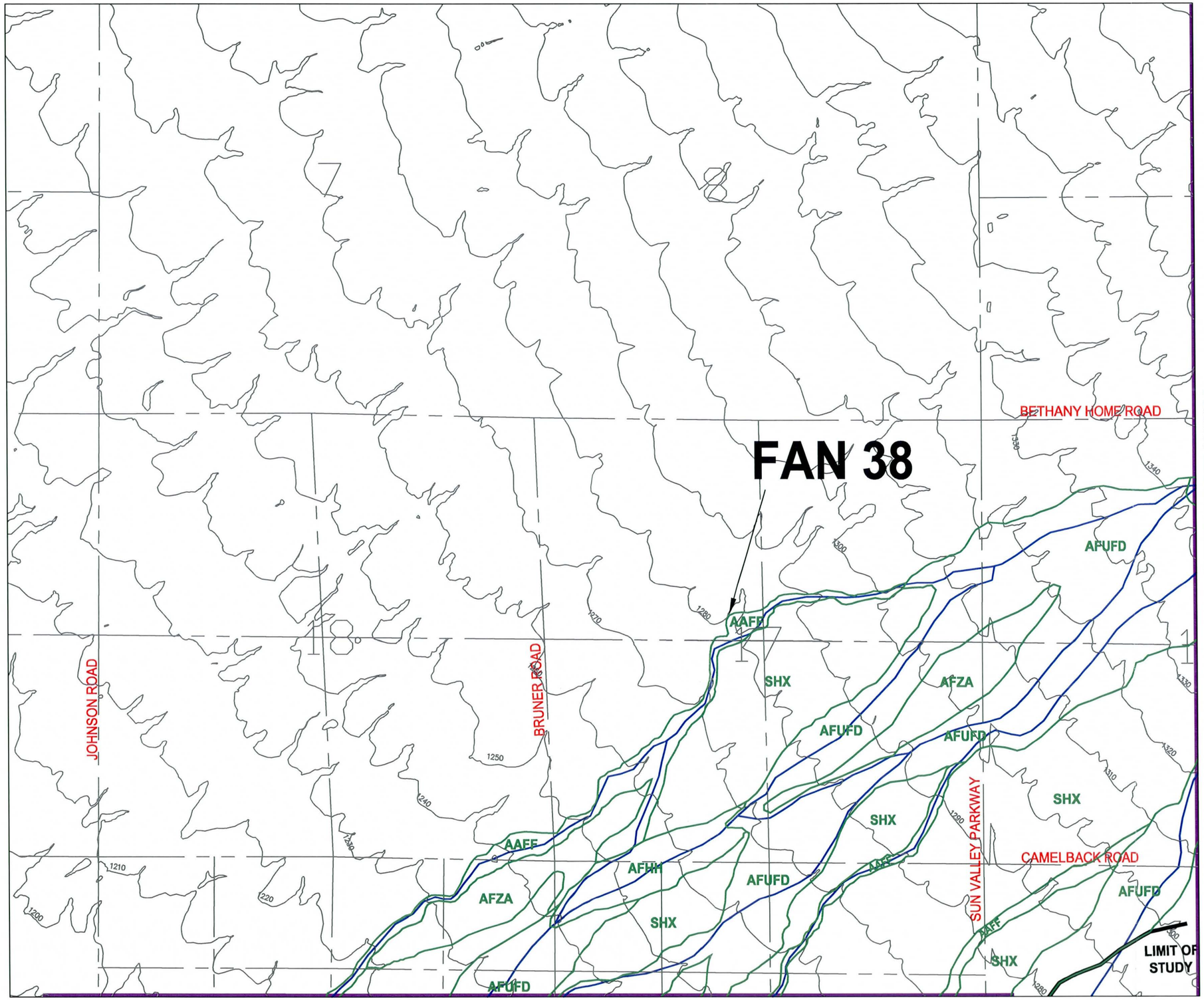
FIGURE 3
HEC-RAS CROSS SECTION LOCATIONS

	BY	DATE
DESIGN	SXW	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXW	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 1 OF 3



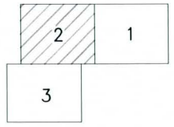
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Fan 38 Thalwegs
- Q=500 — Flow Values
- 714 — HEC–RAS Cross Section Location and ID
- 15 — Section Lines and Numbers
- AFHH — Alluvial Fan High Hazard
- AFUFD — Alluvial Fan Uncertain Flow Distribution
- AAFF — Approximate Alluvial Fan Floodway
- AFZA — Alluvial Fan Zone A Flooding
- SHX — Shaded Zone X

SHEET INDEX



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SHEET 2 OF 3

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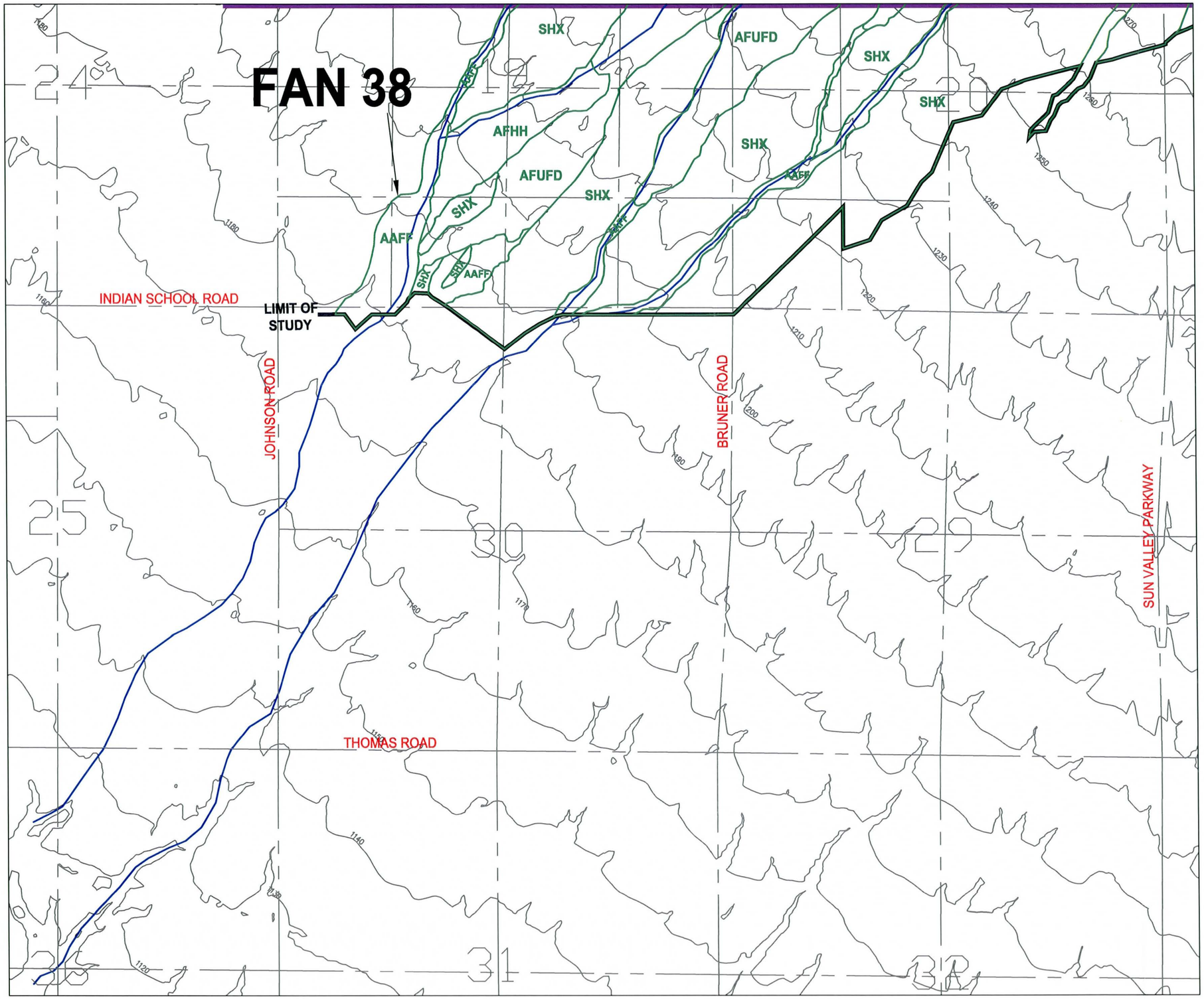

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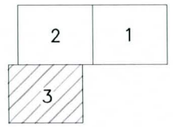

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FIGURE 3
HEC-RAS CROSS SECTION LOCATIONS

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PLANS	SXM	11/07
PLANS CHK.	MIW	11/07

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SHEET 3 OF 3

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5.4 Cross Section Description

Representative cross sections were taken from 10' contour mapping provided by the FCDMC. The locations are depicted on Figure 3 and Exhibit 1.

5.5 Modeling Considerations

Modeling was limited to normal depth computations of flow at individual cross sections. A capacity check was performed at each cross to establish a reasonable capacity to compare to the geomorphic results. The capacity check was used to validate our determination that there was geologic evidence as well as current physical/topographic evidence that the entire fan flow could reasonably be contained in the Zone A area.

The computer program HEC-RAS Version 3.1.3 was used to facilitate the capacity calculations using normal depth computations. The resulting output is included in Appendix E. The flow rates from the Buckeye/Sun Valley ADMS, as previously discussed in Section 4.1, were used for the hydraulic modeling. Similarly, the topography generated as part of the ADMS was used to derive the geometry data for each cross section.

5.6 Floodway Modeling

No floodway was modeled as part of this approximate study using conventional hydraulic floodway analyses. Administrative floodways were delineated as part of the Stage 3 analysis of the 100-year floodplain downstream of the hydrographic apex. The identification and designation of the various alluvial fan administrative floodways are described in Section 6B.

5.7 Special Problems Encountered During the Study

No special problems were encountered in the approximate hydraulic analyses.

5.8 Calibration

No hydraulic calibration was performed due to the lack of data from which to calibrate.

5.9 Final Results

5.9.1 Hydraulic analysis results

The approximate method for delineation of the 100-year floodplain upstream of the hydrographic apex resulted in approximately 1.65 (thalweg) miles of new riverine floodplain using traditional hydraulic methods. Geomorphic methods were relied on through the active portions downstream of the apex. Section 6B discusses in more detail the approximately six (thalweg) miles of additional floodplain determined downstream of the apex. The entire approximate floodplain, both upstream and downstream of the apex, is depicted in Figure 3 and Exhibit 1.

The geomorphic modeling approach selected conservatively assumes minimal impact on alluvial fan flooding.

Floodplain delineations are currently underway for fans 37 and 39 which are adjacent to Fan 38. Their associated approximate floodplain boundaries will tie into the Fan 38 floodplain boundaries where appropriate.

5.9.2 Verification of results

The results of the hydraulic analyses upstream of the fan apex are considered reasonable based on engineering judgment, field observations, and results of previous modeling on similar watercourses. The limits of the floodplain downstream of the apex were evaluated from a geomorphic perspective and the surfaces shown within the floodplain lie within areas whose geomorphology suggests that they have been and will continue to be prone to flooding. This is true of both the approximate hydraulic method used above the hydrographic apex, presented in Section 5, as well as the geomorphic assessment used below the hydrographic apex described in Section 6B.

Section 6: SPECIAL STUDIES

6A: EROSION/SEDIMENT TRANSPORT

Neither erosion nor sediment transport analyses were part of this study. However Ayres Associates prepare a sediment transport study as part of the Buckeye/Sun Valley Area Drainage Master Study. A copy is included in Appendix F. The objective of the study was to evaluate the 100-year storm event sediment yield for each of the three Buckeye Flood Retarding Structures located immediately upstream of Interstate 10 and compare the results with the original sediment yield analysis performed for the design of the structures. One of the deliverables for the study was sediment load using concentration by volume and depths of deposition by sub-basin (Tables 2.24, 2.25, 3.1, and 3.2). Sub-basins K1 and K2 contribute the flow to Fan 38; however, these sub-basins were not specifically studied as part of the sediment report. Therefore, no sediment information is available through that report pertaining to Fan 38.

6B: GEOMORPHOLOGY

6B.1 Introduction

This section of the Technical Data Notebook describes the geomorphic methods used to delineate the flood hazards on the Site 38 piedmont. Section 6B is organized to generally follow the outline of the *Piedmont Flood Hazard Assessment Manual* format and the *FEMA Guidelines for Determining Flood Hazards on Alluvial Fan.* Since parts of the geomorphic assessment required consideration of the hydrologic and hydraulic characteristics of the piedmont, some of the information presented in Sections 4 and 5 may be reiterated in this section. Both the PFHAM and the FEMA 2002 Guidelines describe a three stage delineation process. The FEMA Guidelines are intended only for alluvial fans, whereas the PFHAM is applicable to a wider range of piedmont surfaces.

The three stage delineation approach includes the following steps:

- Stage 1: Recognize and characterize alluvial fan landforms
- Stage 2: Define active and inactive areas of erosion and deposition
- Stage 3: Define the 100-year floodplain

The Stage 1 (Geomorphic Evaluation) and Stage 2 (Landform Stability Assessment) delineations were prepared by Ayres Associates under contract with the FCDMC. The Final Report is located in Appendix G, specifically G.3, for reference. The detailed discussion of the Stage 3 approach is located in Section 6B.7.

Downstream of the hydrographic apex, geomorphic methods were used to delineate the flood hazard zones, whereas upstream of the hydrographic apex, geomorphic methods were used to compliment and refine conventional approximate normal-depth hydraulic methods, as described in Section 5 of this TDN.

6B.2 Previous Reports by Others

6B.2.1 Technical Reports

- *Flood Hazards of Distributary-flow Areas in Southwestern Arizona:* U.S. Geological Survey Water Resources Investigations Report 91-4171 (1991) prepared by Hjalmarson and Kemma
- *Surficial Geology around the White Tank Mountains, Central Arizona,* AZGS Open File Report 91-8 (1991), prepared by Field & Pearthree. The entire text of the study along with relevant exhibits in the Fan 38 area can be found in Appendix G, specifically under G.1.
- *Geologic Mapping of Flood Hazards in Arizona: An Example from the White Tank Mountain, Maricopa County.* AZGS Open File Report 91-10 (1992), prepared by Field & Pearthree. A copy of the report and the applicable exhibits can be found in Appendix G, specifically under G.2.
- *White Tank Fan (Site 36) Approximate Floodplain Delineation Study* (2001) prepared by Wood Patel in association with JEFuller Hydrology and Geomorphology. A copy of the revised floodplain and associated flood zones for Site 36 is included in Appendix A for reference. Due to the shear size of the report, a copy is not provided as reference. However, the Site 36 approximate delineation was submitted to and approved by FEMA; therefore, a copy resides with both FEMA and with FCDMC who manages the Town of Buckeye's floodplains.
- *White Tanks Wash Flood Insurance Study, FCD No. 90-64* prepared by Alpha Engineering Group, Inc.
- *Buckeye/Sun Valley Area Drainage Master Study Technical Data Notebook, Volume VI: Sediment Transport Studies, Final* July 2005 prepared by PBSJ

6B.2.2 Buckeye/Sun Valley ADMS

The FCDMC recently completed an area drainage master study (ADMS) for the Buckeye/Sun Valley area. One of the deliverables for the study was the *Final Report, Geomorphic Evaluation and Landform Stability Assessment Buckeye/Sun Valley Areas Drainage Master Study* prepared by Ayres Associates (May 2005). Included in the report are the results of the Stage 1 analysis and mapping that covers the watershed in which Fan 38 is included. Pertinent excerpts of this report are included for reference in Appendix G, specifically G.3. Also included in the report are the results of the Stage 2 analysis and mapping.

6B.2.3 Developer Reports

Several master planned community developments are underway west of the White Tank Mountains. To facilitate the delineation of existing flood hazards, Stardust Tartesso W12, Pulte Homes, Lennar Homes, Communities Southwest, and Scottsdale Development Incorporated hired three engineering firms to perform the Stage 3 analysis for fans 37, 38, 39, 7, 8, and 12. Fan 37 is being prepared by Coe & Van Loo Consultants, Inc.; Fan 39 by CMX Group, Inc.; Fan 38, under this cover, by David Evans and Associates; and fans 7, 8, and 12 by David Evans and Associates under a separate report.

6B.3 Data Sources

6B.3.1 NRCS Soils Map

Soils maps developed by the US Department of Agriculture's Soil Conservation Service provided additional information in the determination of approximate floodplain hazards. The soils report utilized for this study was *Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona* (Camp 1986).

6B.3.2 AZGS Geologic Maps

Surficial geology maps have been prepared in and around the study area. Establishing an approximate time period for the cessation of major depositions is an indicator of future flooding potential. Pertinent excerpts of the Field and Pearthree Open File Report 91-8 are included for reference in Appendix G.

6B.3.3 AZGS Flood Hazard Maps

As a result of the Field and Pearthree Open File Report 91-8, the Open File Report 91-10 was prepared which included flood hazard maps. Pertinent excerpts of the Open File Report 91-10 are located in Appendix G, specifically G.2.

6B.3.4 Aerial Photography

Color, digital, orthophotography was provided by the FCDMC and used extensively in the delineation of the flood hazards. Although topographic maps were utilized to fine-tune the floodplain, aerial photography was used in a similar fashion as surficial geology and soils maps to determine the flood hazard zones. Vegetation, as seen on aerial photography as well as ground photos, is a good indicator or degree of flooding experienced over the last fifty or so years.

6B.3.5 Topographic Mapping

Topographic mapping was also provided by the FCDMC. The mapping was used in the Manning's analyses to establish approximate conveyance capacities downstream of the fan. Exhibit 1 located in the back pocket, shows topography along with cross section locations as well as the flood hazard boundaries. It should be noted that flood hazard boundaries were determined primarily from geomorphologic mapping and refined using topographic mapping.

6B.4 Method Description

The White Tank Fan, Site 38, Approximate Floodplain Delineation Study area is located on the western slope of the White Tank Mountains in western Maricopa County, Arizona. The watershed contributing to the hydrographic apex encompasses approximately 3.5 square miles. The piedmont surface downstream of the hydrographic apex encompasses an area of approximately 5.3 square miles. A geomorphic approach was chosen as the primary method for evaluating the flood hazards downstream of the apex, while traditional methods were employed in the stable areas upstream of the apex.

This portion of the TDN describes the methods used to identify the type and extent of the flood hazard within the study area. This follows the procedures as outlined in the *PFHAM* and the *FEMA Guidelines*. The *PFHAM* describes a procedure that follows a 3 stage process: Stage 1 identifies and characterizes the piedmonts landforms, Stage 2 identifies stable (inactive) and unstable (active) areas on the piedmonts and Stage 3 defines and characterizes the flood hazards. Stages 1 and 2 assessments were prepared by Ayres Associates as part of the Buckeye/Sun Valley Area Drainage Master Study. The results or pertinent excerpts of their studies are included in this report to follow the *FEMA Guidelines* format. Pertinent excerpts of the Final Report are located in Appendix G, specifically under G.3 relating to Stage 1 and Stage 2.

The Ayres Report relied heavily on the *PFHAM* methodology for the Stage 1 and 2 assessments. Stage 1 of the *PFHAM* alluvial fan methodology is the recognition and characterization of piedmont landforms. The intent of the Stage 1 assessment is to distinguish alluvial fan landforms from riverine, sheet flow, ponding, or coastal landforms. If the landform being evaluated is determined to be an alluvial fan, then the delineation should proceed using the *PFHAM/FEMA* procedures. If the landform is not an alluvial fan, then traditional floodplain delineation procedures should be applied.

The Stage 1 delineation relied on the following types of information:

- Composition: Alluvial fans are landforms constructed from deposits of alluvial sediments or debris flow materials. These deposits are an accumulation of loose, unconsolidated to weakly consolidated sediments transported by stream flow or debris flow processes as exhibited on geologic maps or field reconnaissance.
- Morphology: Alluvial fans are landforms that have the shape of a partially or fully extended fan, exhibiting dendritic, anastomosing, and/or distributary flow paths as observed on topographic maps or aerial photographs.
- Location: Alluvial fans are landforms usually located at topographic breaks where stream channels become markedly less confined than upstream of the topographic break.
- Boundaries: The distal terminus of an alluvial fan is defined by a stream that intersects the fan and transports deposits away from the fan, a playa lake, an alluvial plain, or smoother, gentler slopes on the piedmont plain. The toe can be identified on topographic maps, aerial photographs, or field reconnaissance. The lateral boundaries of the fan are the edges of deposited and reworked alluvial materials. This may be a channel, swale or confining mountainside or another alluvial fan lateral boundary as is the case in much of the White Tank piedmont.

6B.5 Stage 1: Recognizing and Characterizing Piedmont Landforms

Stage 1 of the PFHAM/FEMA alluvial fan methodology consists of recognizing and characterizing piedmont landforms. The primary objective of the Stage 1 analysis is to distinguish alluvial fan landforms from riverine, sheet flow, ponding, or coastal landforms. If an alluvial fan landform is identified, the location of the topographic and hydrographic apices must be determined. Refer to The Final Report Geomorphic Evaluation and Landform Stability Assessment prepared by Ayres Associates for an elaboration of the four principle landforms.

6B.5.1 Composition

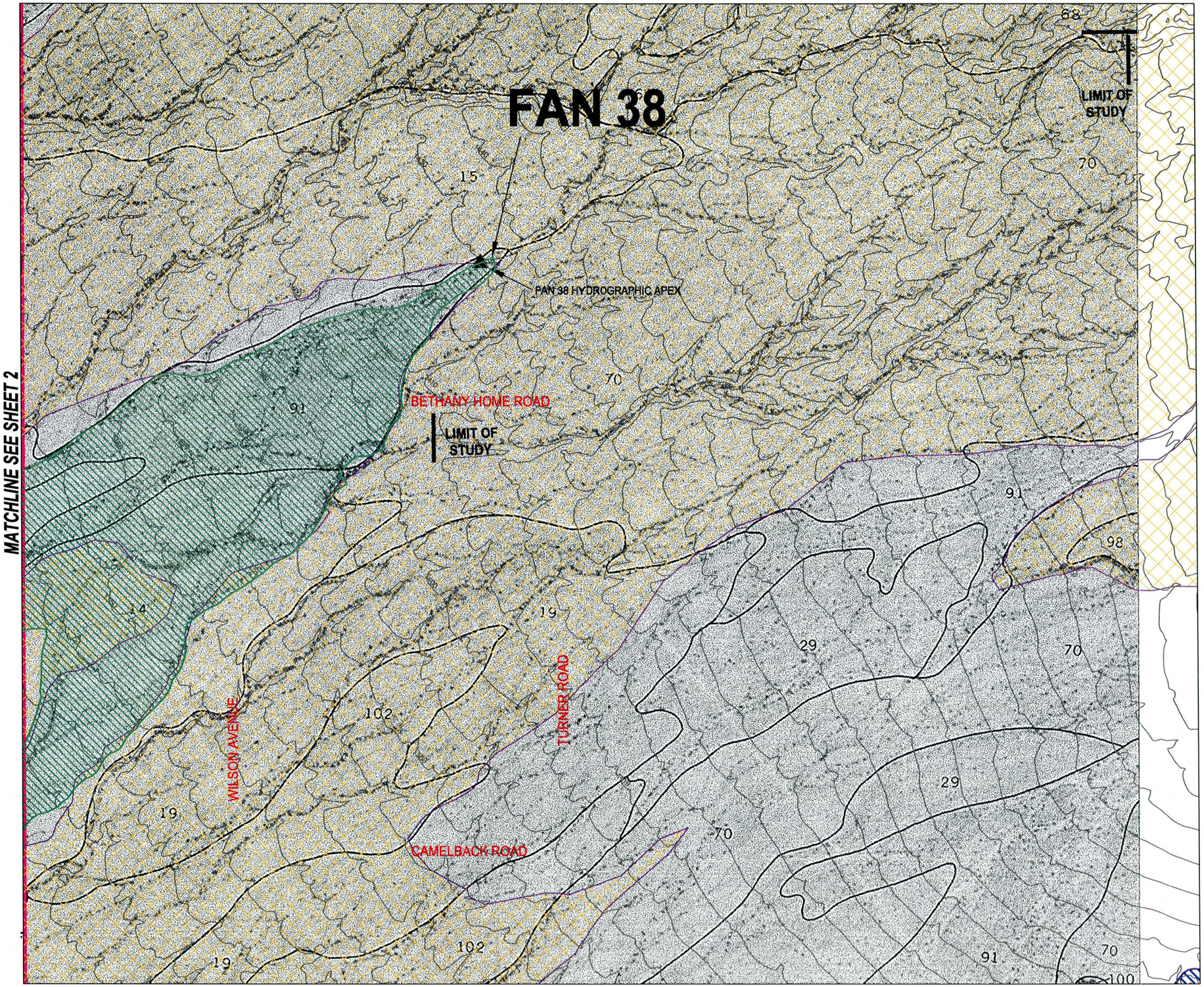
NRCS soils maps and AZGS Surficial Geology and flood hazard mapping were utilized by Ayres Associates to identify the four landforms. The resulting Stage 1 mapping has been included in Appendix G, G.3 as shown on Sheets 2 and 4 of 5 for Task 2.6.2. The conclusion reached by Ayres Associates was that the entire Fan 38 area was determined to be either alluvial fan or relict fan.

6B.5.1.1 Soils Data

Figure 4 on the following pages, depicts the NRCS soils classifications overlain on the USGS topographic quadrangles within the Fan 38 watershed. Also included on the figure are the landform polygons as determined by the Ayres Associates report. A full size plot of the soils map, Exhibit 2 at 1"=600', can be found in the back pocket. The three main categories of landforms distinguished by the NRCS map unit descriptions are: 1) drainage ways, floodplains, and alluvial fans, 2)

alluvial fan terraces, and 3) mountains and hill slopes. Within the vicinity of Fan 38, Ayres Associates determined that alluvial fan and relict fans were the predominate landform feature. Generally, soils 4 was found within the drainage ways, soil 91 in the vicinity of the fan apex, and soils 14, 15, 96, 99, and 102 were found in the fan terraces i.e. relic fan based on the Ayres Associates' determination.

A more detailed description of each soil type present in the shadow of the fan is discussed in Table 6-1 located on the following page. Pertinent excerpts of the Soil Survey of Aguila-Carefree Area report can be found in Appendix G.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN

APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Soils Boundary
- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- 40 SCS Soils Map Unit
- 15 Section Lines and Numbers

SHEET INDEX

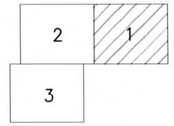


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FIGURE 4
SOILS CONSERVATION SERVICE MAP

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PLANS	SXWI	11/07
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SHEET 1 OF 3

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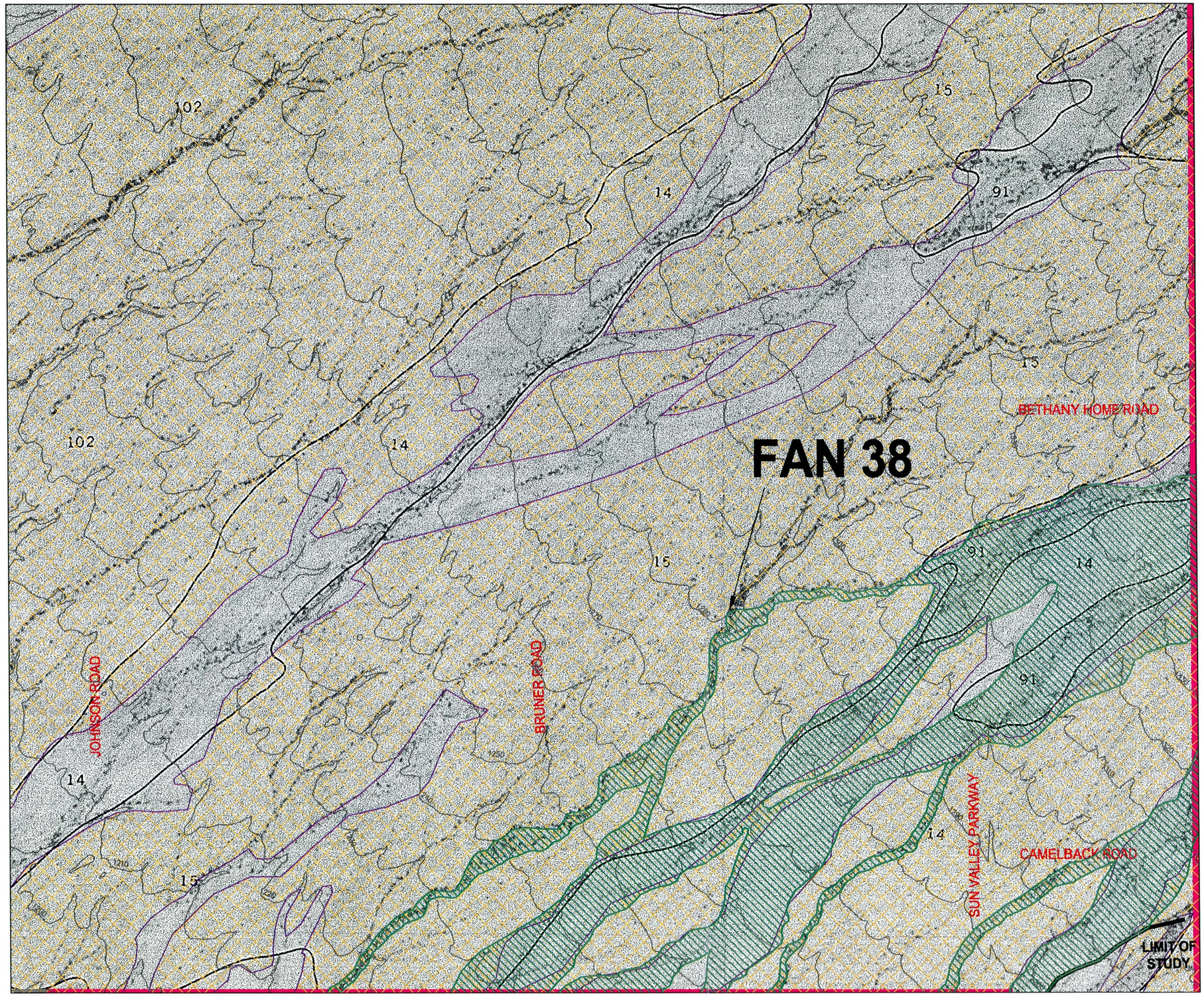

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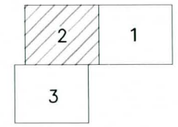

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SHEET 2 OF 3

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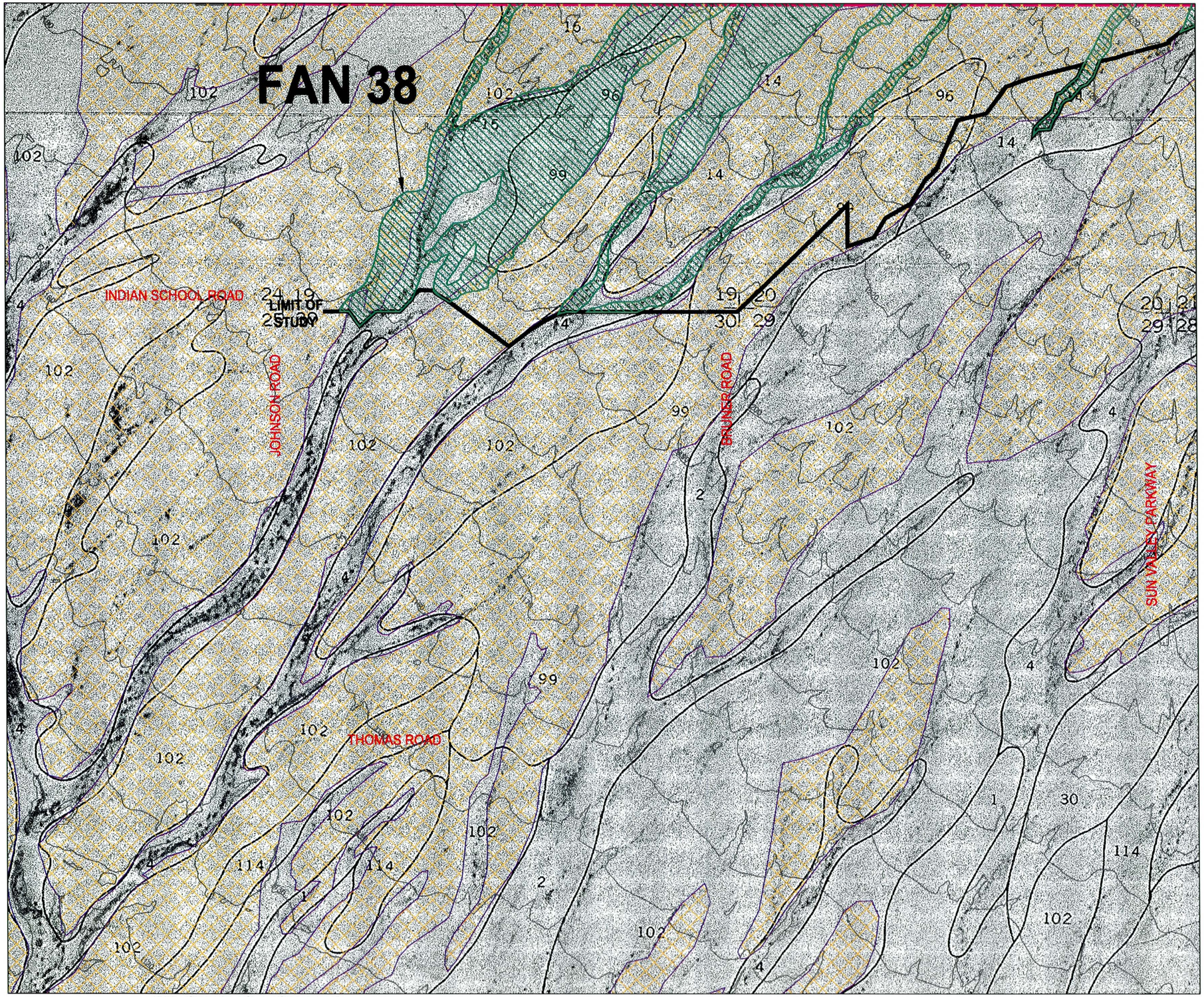

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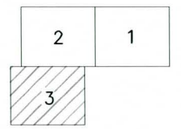

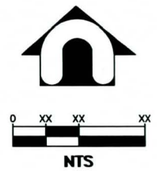

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SHEET 3 OF 3

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Soil Units and Characteristics

Table 6.1

SCS Soil Map Unit[1]	**Soil composition**	**Landform location**	Relevant characteristics to Piedmont Assessment
Antho-Carrizo-Maripo complex (4)	35% Antho 30% Carrizo 20% Maripo	-Floodplains and drainage ways -Slope is 0% to 3% -Elevation is 1,100 to 2,100	-Antho soil formed in alluvium derived dominantly from acid and basic igneous rock, surface layer brown sandy loam 3" thick, light brown, slightly calcareous sandy load to 60" or more, runoff is slow and hazard of water erosion is moderate. -Carrizo soil formed in alluvium derived from acid and basic igneous rock, surface layer is pinkish gray, calcareous vary gravelly sand and very gravelly coarse sand to depth of 60" or more, runoff is slow, hazard of erosion is severe. -Maripo soil is formed in alluvium derived dominantly from acid and basic igneous rock, surface layer is light brown sandy loam about 18" thick, light brown calcareous very gravelly loamy sand to 60" or more, runoff is slow and hazard of water erosion is moderate.
Carrizo (14)		-Floodplains and alluvial fans -Slope is 0% to 3% -Elevation is 1,200 to 1,400	-it formed on alluvium derived dominantly from acid and basic igneous rock, surface is pinkish gray, calcareous very gravelly sand about 1" thick, underlying material to depth of 60" or more is pinkish gray, calcareous very gravelly sand and very gravelly course sand, runoff is slow and hazard of water erosion is slight.
Carrizo-Gunsight complex (15)	50% Carrizo 30% Gunsight	-Fan terraces -Slope is 1% to 5% -Elevation 1,200 to 2,200	-Carrizo soil formed in alluvium derived dominantly from acid and basic igneous rock, surface layer is light yellowish brown gravelly sandy loam, subsurface layer is brown gravelly sandy loam about 4" thick, underlying material to depth of 60" or more is light brown, brown, and strong brown very gravelly sand and very gravelly coarse sand, runoff is slow and hazard of water erosion is slight. -Gunsight soil formed in alluvium derived from acid and basic igneous rock, upper 1" of surface layer is light brown, calcareous vary gravelly sandy loam and lower 9" is light brown, calcareous very gravelly sandy loam, underlying material to depth of 45" is pinkish white, weakly cemented or strongly cemented calcareous very gravelly sandy loam, runoff is slow and hazard of water erosion is slight.
Momoli-Carrizo complex (91)	45% Momoli 35% Carrizo	-Fan terraces -Slope 0% to 3% -Elevation 1,400 to 2,200	-Momoli soil formed in alluvium derived from acid and basic igneous rock, surface layer pinkish gray 1" thick, calcareous very gravelly sandy load, brown calcareous very gravelly sandy loam to 60" or more, runoff slow and hazard of erosion is slight. -Carrizo soil formed in alluvium derived from acid and basic igneous rock, surface layer is pinkish gray 2" thick, upper 9" of underlying material is light brown, next 60" or more brown, runoff is slow, hazard of erosion is slight.

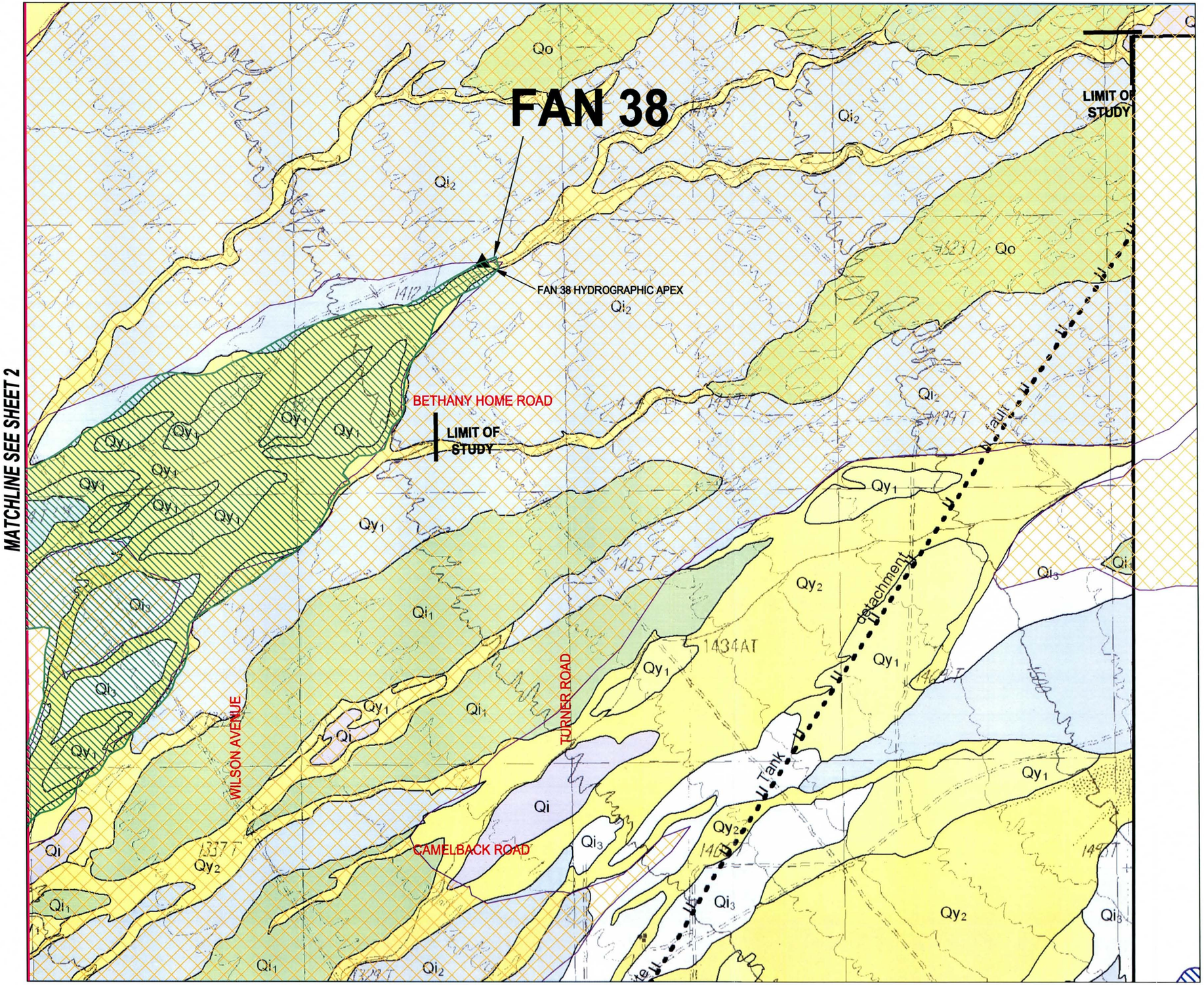
Pinaleno-Tres Hermanos complex (96)	45% Pinaleno 40% Tres Hermanos	-Fan terraces - Slope 1% to 10% -Elevation is 2,000 to 2,500	-Pinaleno soil formed in alluvium derived dominantly from acid and basic igneous rock, surface layer is yellowish red very gravelly clay loam about 1" thick, upper 11" is yellowish red, calcareous gravelly clay load and very gravelly clay loam, lower 12" is light brown, calcareous gravelly loam, runoff is slow and hazard of water erosion is slight. -Tres Hermanos soil formed in alluvium derived dominantly from acid and basic igneous rock, surface layer is reddish yellow gravelly loam about 2" thick, upper 4" is reddish yellow, calcareous clay loam and lower 16" is yellowish red, calcareous gravelly and very gravelly clay load, runoff is slow and hazard of water erosion is slight.
Pinamt – Tremant complex (99)	45% Pinamt 35% Tremant	- Fan terraces - Slope 1% to 10% - Elevation is 1,200 to 2,200	-Pinamt soil formed in alluvium derived from acid and basic igneous rock, upper 1" surface layer is brown, calcareous extremely gravelly sandy load and lower 2" is light brown, calcareous very gravelly loam, cuts and fills highly susceptible to erosion.
Rillito (102)		- Fan terraces - Slope 1% to 8% - Elevation is 1,100 to 1,800	- Upper layer of soil is pinkish gray, calcareous gravelly loam about 14" thick, runoff is slow and hazard of water erosion is slight.

[1] From Soil Survey, Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona (Camp, 1986)

6B.5.1.2 Surficial Geology

Surficial geology maps have been prepared in and around the study area. Establishing an approximate time period for the cessation of major depositions is an indicator of future flooding potential. Figure 5, on the following pages, depict the geologic classifications overlain on the USGS topographic quadrangles within the area of Fan 38. Also included on the figure are the landform polygons as determined by the Ayres Associates report. It should be noted that when the images containing the surficial geology were scanned, the image didn't match up exactly with the topography and aerial photo. A full size plot of the surficial geology map, Exhibit 3 at 1"=600', can be found in the back pocket.

Figure 5 shows the entire piedmont study area is composed of alluvium of either Pleistocene or Holocene in age on alluvial fans or terraces. Generally Y1, Y2, M1b, and M2 are present downstream of Fan 38. And again Ayres Associates determined that alluvial fan and relict fans were the predominate landform feature within the vicinity of Fan 38. The various map units shown on the map are explained in greater detail on Table 6-2 located on the following page. Pertinent excerpts of the Field and Pearthree Open File Report 91-8 are included for reference in Appendix G.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- Surficial Geology Boundary
- Y2 — Late Holocene Alluvial Fans
- Y1 — Late To Early Holocene Alluvial Fans & Terraces
- Y — Undifferentiated Holocene Alluvial Surfaces
- M2 — Latest To Late Pleistocene Alluvial Fans
- M1b — Middle To Late Pleistocene Alluvial Fans
- M12 — Middle Or Late Pleistocene Distal Alluvial Fans
- M1a — Middle To Early Pleistocence Alluvial Fans
- 15 — Section Lines and Numbers

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SHEET INDEX

2	1
3	

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FIGURE 5
SURFICIAL GEOLOGY MAP FROM AZGS

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 1 OF 3

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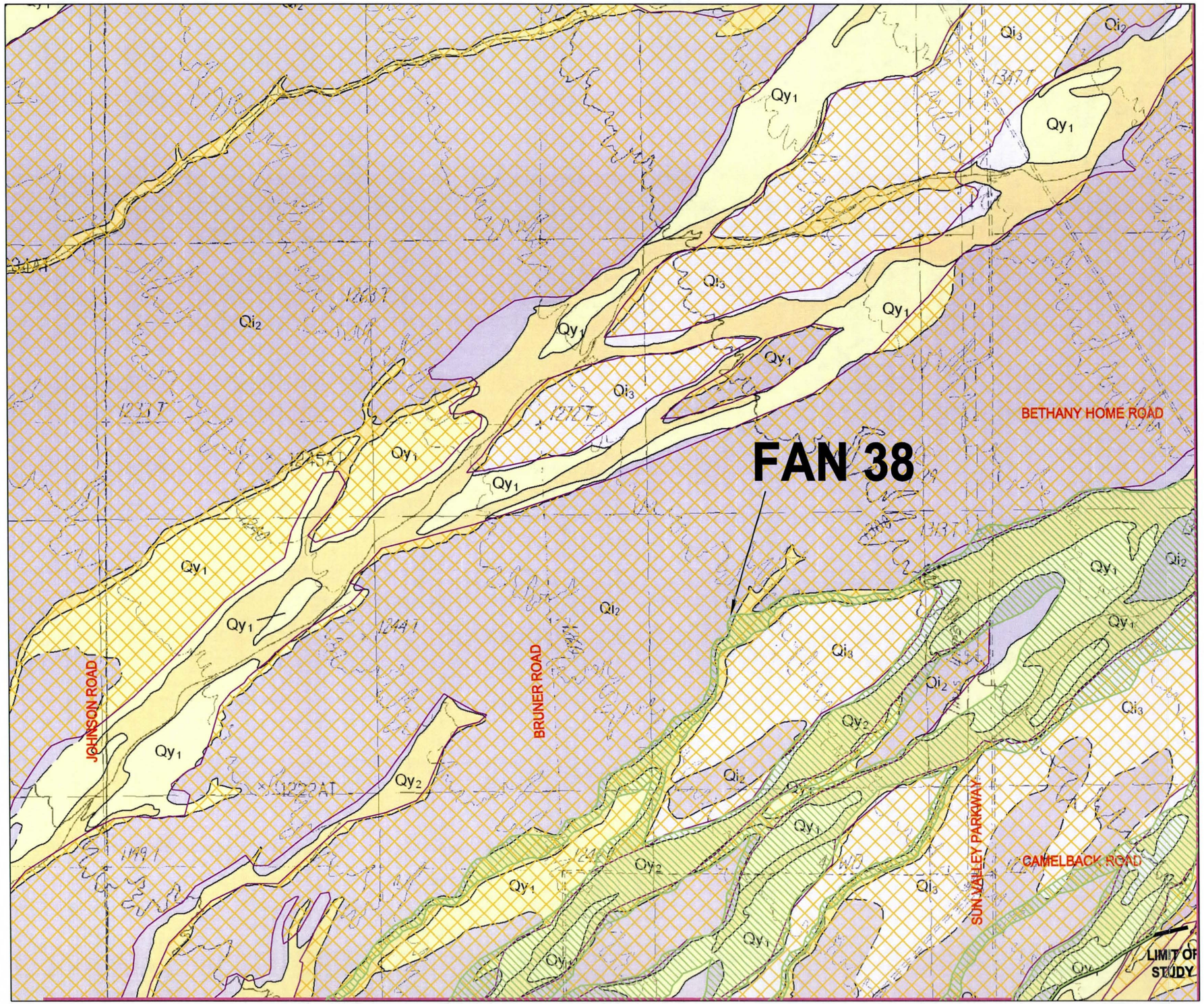

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN

APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- Surficial Geology Boundary
- Y2 — Late Holocene Alluvial Fans
- Y1 — Late To Early Holocene Alluvial Fans & Terraces
- Y — Undifferentiated Holocene Alluvial Surfaces
- M2 — Latest To Late Pleistocene Alluvial Fans
- M1b — Middle To Late Pleistocene Alluvial Fans
- M12 — Middle Or Late Pleistocene Distal Alluvial Fans
- M1a — Middle To Early Pleistocence Alluvial Fans
- 15 — Section Lines and Numbers

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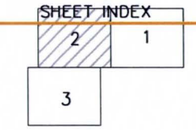

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FIGURE 5
SURFICIAL GEOLOGY MAP FROM AZGS

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DESIGN	SXW	11/07
DESIGN CHK.	MW	11/07
PLANS	SXW	11/07
PLANS CHK.	MW	11/07

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CHIEF ENGINEER AND GENERAL MANAGER

SHEET 2 OF 3

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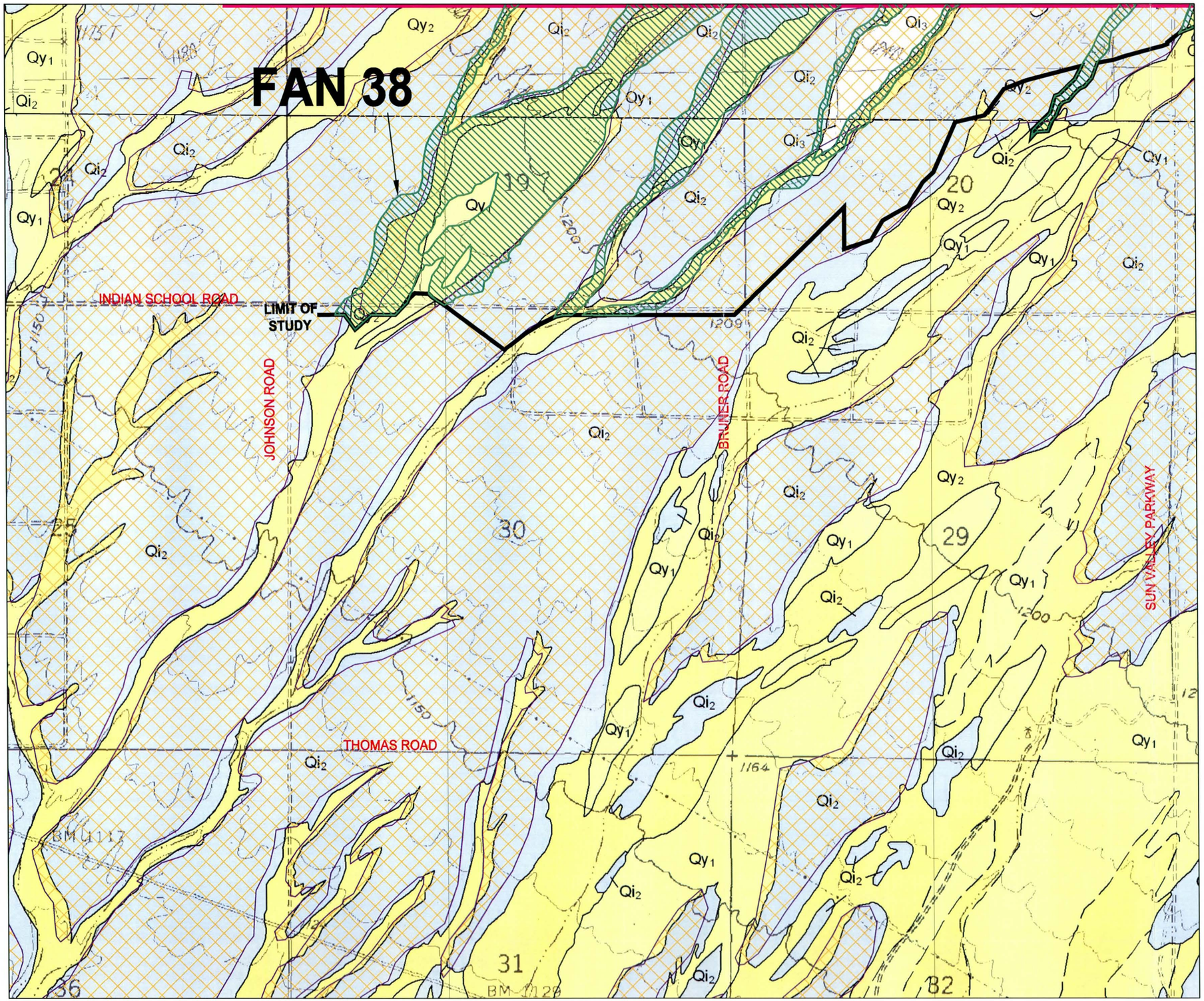

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- Surficial Geology Boundary
- Y2 — Late Holocene Alluvial Fans
- Y1 — Late To Early Holocene Alluvial Fans & Terraces
- Y — Undifferentiated Holocene Alluvial Surfaces
- M2 — Latest To Late Pleistocene Alluvial Fans
- M1b — Middle To Late Pleistocene Alluvial Fans
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- M1a — Middle To Early Pleistocence Alluvial Fans
- 15 — Section Lines and Numbers

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SHEET INDEX

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FIGURE 5
SURFICIAL GEOLOGY MAP FROM AZGS

	BY	DATE
DESIGN	SXW	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXW	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

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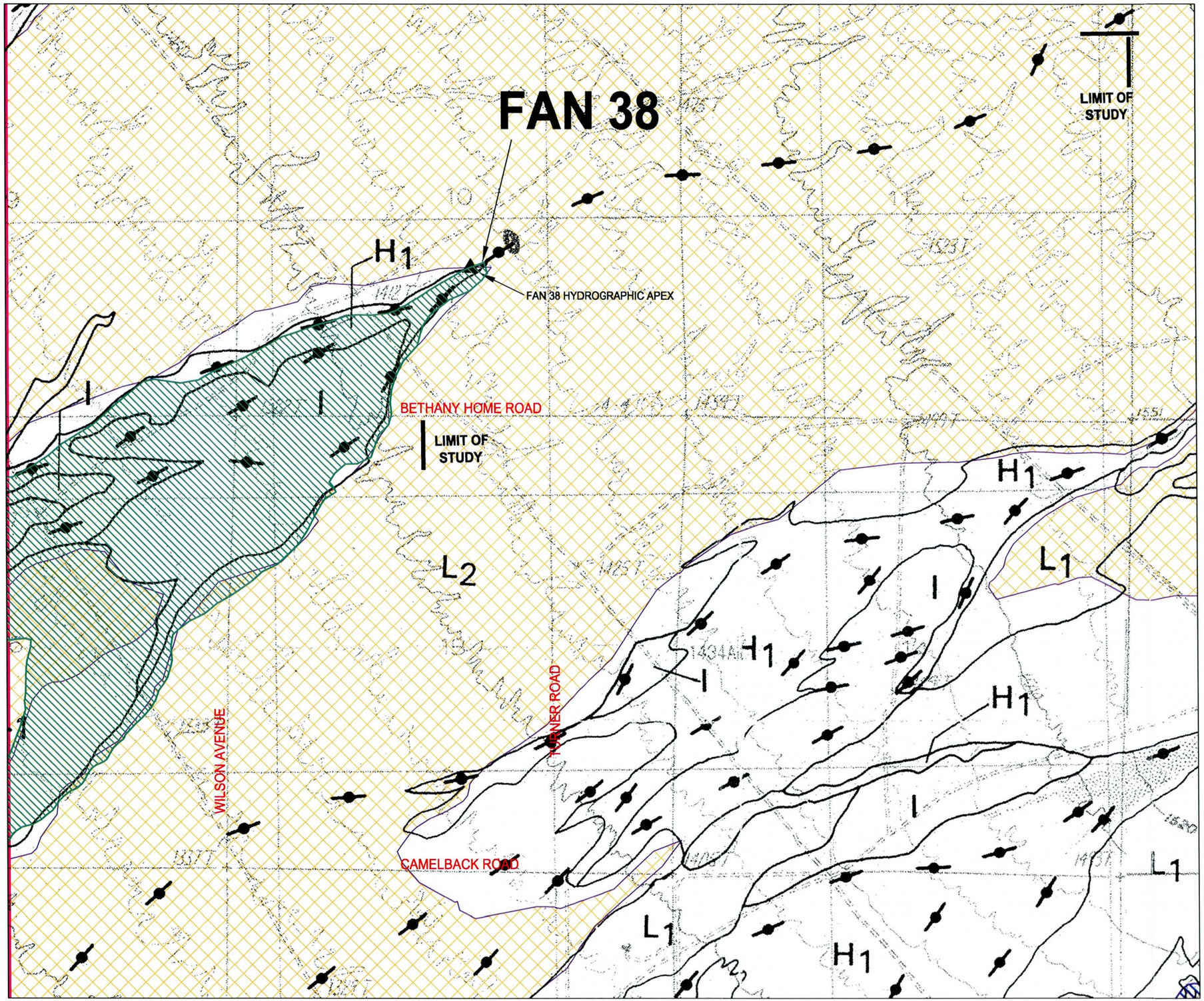
Surficial Geology Map Units

Table 6-2

Map Unit	Name	Relevant Distinguishing Characteristics	SCS Soils present
Y2	Late Holocene alluvial fans, low terraces, and active stream channels	Age- <3,000 years Soil composition – fine silts and sands on lower piedmont, very gravelly sands and silts on middle piedmont Surface features – undissected, display distributary drainage patterns, typically smooth but bar and swale topography present on middle piedmont, desert pavement and desert varnish absent, no soil development. Soil great groups – Torrifluvents and Torriorthents Flooding potential- occasional to frequent.	Antho-Carrizo-Maripo complex (4), Carrizo (14) , Carrizo-Gunsight complex (15), Momoli-Carrizo complex (91), Pinamt – Tremant complex (99)
Y1	Late to early Holocene alluvial fans and terraces	Age- 1,000 to 10,000 years Soil composition – coarse poorly sorted, angular to sub angular admixture of silt, sand, and gravel on middle piedmont, fine silts and sands on lower piedmont, Surface features – smooth and flat with an incipient dendritic drainage pattern on lower piedmont surfaces, well preserved bar and swale topography with very little tributary drainage development on middle piedmont, poorly developed desert pavement over 50% to 85% of surface, surface cobbles are lightly and incompletely varnished to brownish black Soil great groups – Torrifluvents, Torriorthents, and Camborthids Flooding potential- not subject to flooding at present, however, because typically there is little topographic relief between active channels and Y1 surfaces, they could potentially become subject to flooding through minor shifts in depositional patterns.	Carrizo (14, Momoli-Carrizo complex (91),
M1b	Middle to late Pleistocene alluvial fans	Age – 150,000 to 300,000 years Soil composition – poorly sorted, angular to sub angular admixture of silt, sand, and gravel Surface features – moderately dissected on upper piedmont with 1-6 m of relief above active channels, may be less than 1 m on lower and middle piedmont, interfluve areas are broad and flat with original gravel bar and swale topography poorly preserved, moderately to well developed cobble to pebble desert pavement found over 50% to 75% of surface, surface cobbles are incompletely varnished to black on top and reddish brown to dull orange on undersides. Soil great groups –Haplargids and Calciorthids Flooding potential- most areas are isolated from flooding except in entrenched channel, but areas of low relief on the middle and lower piedmont could become susceptible to flooding with relatively minor shifts in depositional patterns	Carrizo (14) Carrizo-Gunsight complex (15), Pinaleno-Tres Hermanos complex (96), Rillito (102)
M2	Middle or late Pleistocene distal alluvial fans	Age – 10,000 to 300,000 years Soil composition – moderately old relict alluvial fan and terrace deposits Surface features – moderately dissected by active channels which are incised <1-3 m, broad flat interfluves with moderately to well preserved original gravel bar and swale topography, poorly to moderately developed desert pavement, incompletely varnished to very dark brown with reddish brown to more commonly dull orange undersides Soil great groups –Haplargids and Calciorthids Flooding potential – restricted to entrenched channels except for low relief areas on lower piedmont.	Carrizo (14)

As a result of the Field and Pearthree Open File Report 91-8, the Open File Report 91-10 was prepared which included flood hazard maps. Figure 6, on the following pages, reveals the flood hazard classifications overlaid on the USGS topographic quadrangles within the area of Fan 38. Also included on the figure are the landform polygons as determined by the Ayres Associates report. A full size plot of the geologic mapping flood hazards, Exhibit 4 at 1"=600', can be found in the back pocket. Pertinent excerpts of the Open File Report 91-10 are located in Appendix G. The various map units shown on the map are explained in greater detail on Table 6-3 located on the following page. Generally H1, H2, L1, L2 and I are present downstream of Fan 38. H1 and H2 represent the highest flood hazards; L1 and L2 are relatively low while I is described as "Intermediate" flood hazard potential.



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN

APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- Flood Hazard Map Boundary
- H1 Very High Flood Potential
- H2
- I Intermediate Flood Potential
- L1 Relatively Low Flood Potential
- L2 Very Low Flood Potential
- 15 Section Lines and Numbers

SHEET INDEX

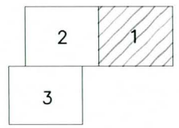

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FIGURE 6

GEOLOGIC MAPPING FLOOD HAZARDS FROM AZGS

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

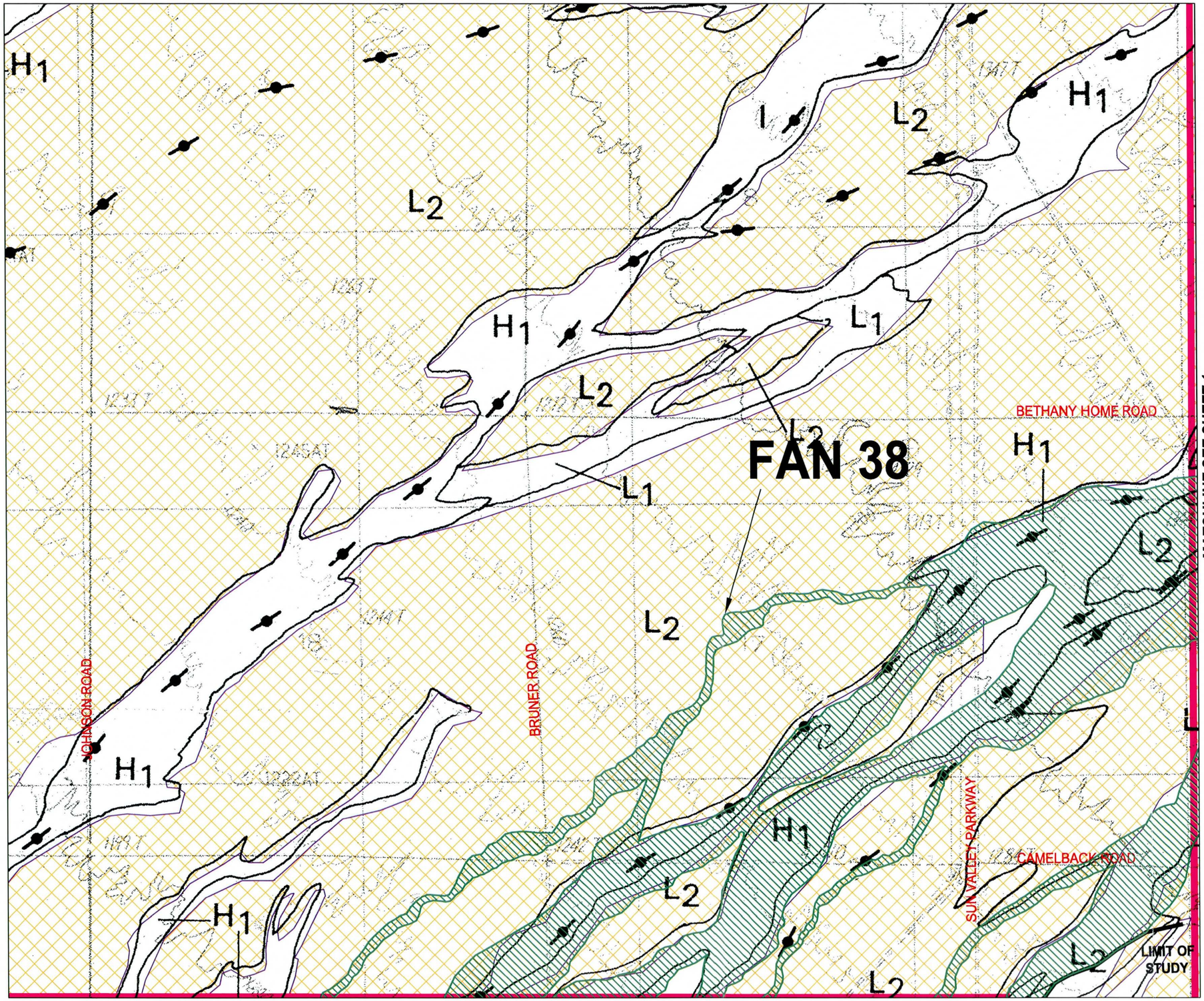
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3



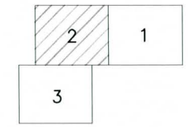
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- Flood Hazard Map Boundary
- H1 Very High Flood Potential
- H2 High Flood Potential
- I Intermediate Flood Potential
- L1 Relatively Low Flood Potential
- L2 Very Low Flood Potential
- 15 Section Lines and Numbers

SHEET INDEX



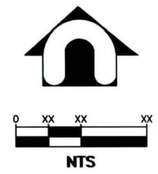


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FIGURE 6
GEOLOGIC MAPPING FLOOD HAZARDS FROM AZGS

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 2 OF 3

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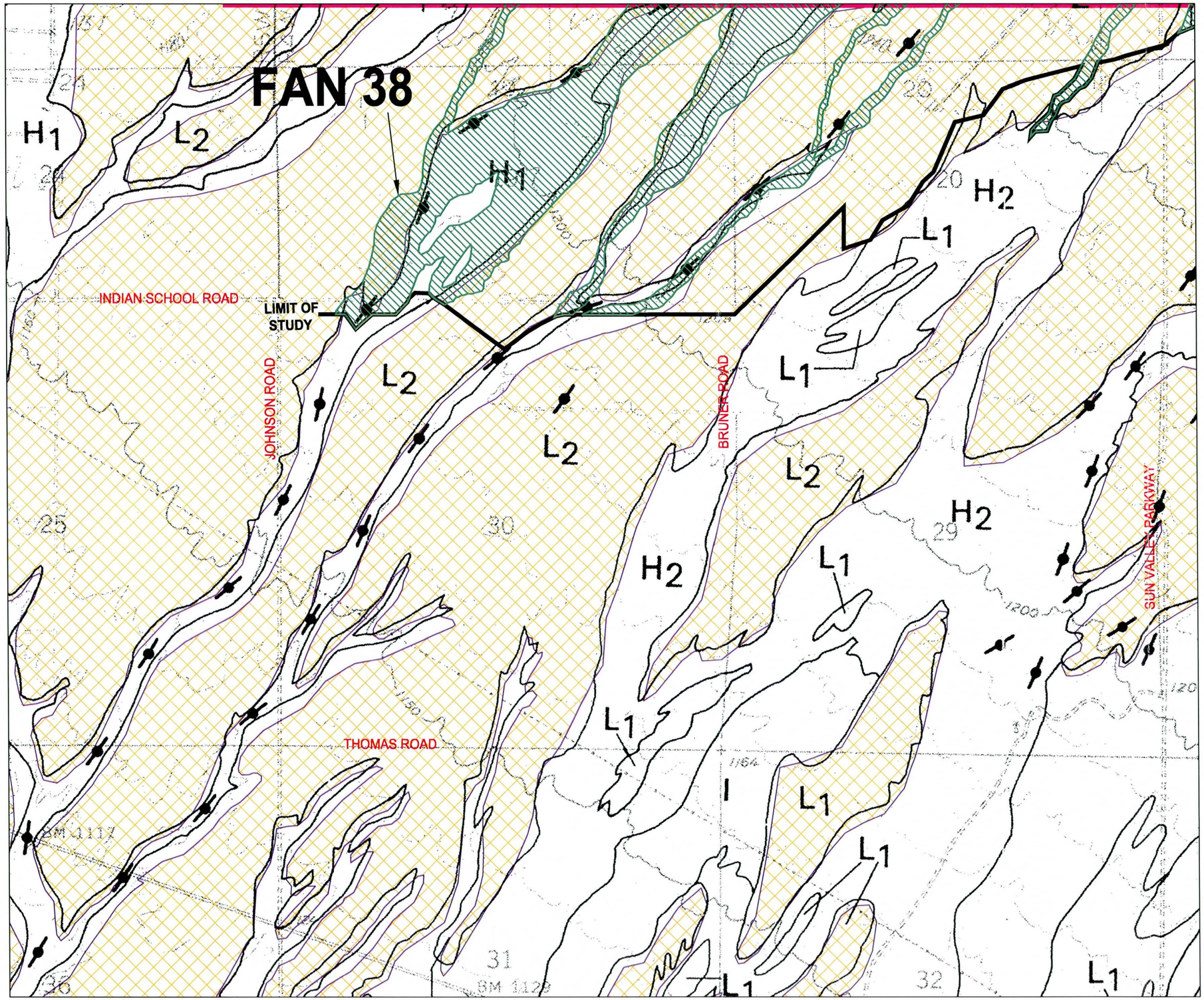

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
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- H2 High Flood Potential
- I Intermediate Flood Potential
- L1 Relatively Low Flood Potential
- L2 Very Low Flood Potential
- 15 Section Lines and Numbers

SHEET INDEX

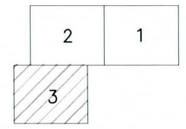

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FIGURE 6
GEOLOGIC MAPPING FLOOD HAZARDS FROM AZGS

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 3 OF 3

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Flood Hazard Zone Map Units
Table 6-3

Map Unit	Relevant Distinguishing Characteristics
H1	-Flood hazard –Highest, extensive young deposits. -Distribution – entrenched reaches of major drainages and distributary flow areas on middle and upper piedmont -Channel pattern – braided (anastomosing) or distributary. Potential for localized, high-velocity, relative deep, channelized flows and sheet flooding; some potential for drastic shifts in channel position. -Soil Group- Torrifluvents -Surface relief - less than 2', bar and swale topography. -Surface Texture: Silt to very gravelly sand. -Surface Color: Dull yellow-orange. -Desert varnish - unvarnished gravel. -Vegetation - brittle bush, rabbit bush, bunch grass, creosote. -Estimated surface age - historical to late Holocene (0 to 2,000 yrs old)
H2	-Flood hazard - Moderate to High flood potential. Extensive young deposits. -Distribution - channels small to nonexistent. Predominantly shallow sheet flooding; channelized flow very limited in extent; broad areas probably inundated in large floods. -Channel pattern - distributary; incipient dendritic drainage in less active areas. -Soil Group - Torrifluvents. -Surface relief: less than 2' with uncommon 4' arroyo cuts; smooth surface. -Surface texture - sandy silt with 10% scattered gravel; less active areas have granule to pebble lag. -Surface Color: dull yellow-orange. -Desert varnish - unvarnished gravel -Vegetation - creosote, brittle bush. -Estimated surface age - historical to late Holocene (0 to 2,000 yrs old)
Map Unit	Relevant Distinguishing Characteristics
I	-Flood hazard - Intermediate flood potential. Areas not flooded (1,000 yrs) recently. -Distribution – adjacent to H1 and H2 is distributary flow areas and lower piedmont. -Channel pattern: Widely spaced, dendritic tributary drainages, near or within distributary drainage systems, and little topographic relief separates these areas from active alluvial fans or channel. Could become flood prone with relatively modest changes in channel configurations, widely spaced, dendritic tributary drainages. -Soil Groups - Torrifluvents and Camborthids. -Surface relief - less than 4' in distributary flow areas and less than 3' on lower piedmont; bar and swale topography will preserved in distributary flow area. -Surface texture - open desert pavement consisting of granules and small cobbles. -Surface color - dull yellow-orange. Desert varnish - unvarnished to weakly developed over 10% of the surface, brownish black

	on top and orange on undersides. Vegetation - brittle bush, creosote, palo verde. Estimated surface age - late Holocene to latest Pleistocene (1,000 to 15,000 yr old)
L1	-Flood hazard - Relatively low flood potential. Areas not flooded for at least 10,000 years -Distribution – down slope from and adjacent to distributary flow areas on middle and lower piedmont. -Channel pattern – moderately spaces, dendritic tributary drainages, near or within distributary drainage networks and typically with little topographic relief separating L1 from I, H1, or H2 surfaces. Localized sheet flooding possible. -Soil Groups - Camborthids and Haplargids. -Surface relief - 1 to 10', fairly smooth subdued bar and swale topography. -Surface Texture - open to closed desert pavement consisting of granules and cobbles. -Surface color - bright brown to orange. -Desert Varnish - weakly to moderately developed over 50% of surface – brownish black to grayish brown on top and dull orange to reddish brown on undersides. -Vegetation - brittle bush, creosote, cane cholla. -Estimate surface age - late Pleistocene to middle Pleistocene (15,000 to 250,000 yrs old)
L2	-Flood hazard - Very low flood potential, restricted to small channels and localized sheet flooding. Areas not flooded for at least 10,000 years or much longer -Distribution – upper and middle piedmont and adjacent to Hassayampa River -Channel pattern – closely to widely spaced, dendritic tributary drainages; rounded interfluves in areas of highest relief, spatially or topographically separated from distributary networks. -Soil Groups - Haplargids and Durorthids. -Surface relief - 5 to 40' fairly smooth surface; uncommon bar and swale topography. -Surface Texture - closed desert pavement consisting of cobbles and pebbles; uncommon salt-shattered cobbles; in place, surface is denuded and covered by petrocalcic fragments. -Surface color - dull orange. -Desert Varnish - well developed over 50 to 100% on undenuded surfaces – black on top and dark red to dull orange on undersides. -Vegetation – jumping cholla, brittle bush, creosote -Estimated surface age – Late Pleistocene to Pliocene (50,000 to 1,000,000+ yrs old

6B.5.1.3 Morphology

According to the National Research Council definition, "alluvial fans are landforms that have the shape of a fan, either partly or fully extended". As determined from aerial photographs, Site 38 exhibits the characteristics of a fan due to the coalescing nature of the downstream washes as can be seen on Exhibit 5 and Figure 7. Topographic contour evidence also confirms this conclusion with contour crenulations that range from highly crenulated to smooth, radial lines indicating a loss in containment of flow.

Other morphologic evidence supports delineating Site 38 as an alluvial fan landform. The slope downstream of the possible fan apex is approximately 1.5% and upstream of the apex 2% to 4% which is much steeper than nearly all valley riverine drainage systems in central Arizona, which typically have slopes of less than one percent. Steep slopes are characteristic of alluvial fan landforms, which provide a transition from steep mountain slopes to flatter axial valley streams. In addition, Site 38 exhibits areas of distributary channels with evidence of avulsion and

stream piracy as can be seen on the aerial photography. Additionally there is little topographic relief between separate washes with young soils in between indicating alluvial fan landform. Similarly, many of the washes decrease in channel widths and capacity in the downstream direction and there are examples of perched channels.

In addition, Ayres Associates found field evidence of the various landforms. As explained in Chapter 5 of the Final Report, eight sites within the Buckeye/Sun Valley watershed were investigated in detail. Sites 1, 5, and 6 are located in the general area of Fan 38 and photos and soils conditions are elaborated for these areas in sections 5.1, 5.3, 5.4, and 5.5 of the report.

Based on the aerial photography evidence and wash characteristics, it is concluded that the shape of Site 38 meets the *PFHAM/FEMA Guidelines* definition of an alluvial fan landform.

6B.5.1.4 Location

The NRC definition of an alluvial fan landform states that "alluvial fan landforms are located at a topographic break where long-term channel migration and sediment accumulation becomes markedly less than upstream of the break". Site 38 is in the vicinity of the steep mountain front of the White Tank Mountains as indicated by the change in the topographic contour density as shown on Figure 3. At the mountain front, the fluvial environment transitions from one of net erosion and bedrock outcrop to a depositional environment.

Topographic apices occur at the mountain front or abrupt change in slope and represent the extreme upstream extent of the alluvial fan landform. Topographic apices are identified by aerial photographic interpretation, consideration of surficial and geologic mapping, and review of topographic mapping. Hydrologic apices are located at the highest point on an alluvial fan landform where there is physical evidence of flow bifurcation and/or significant flow outside the main channel(s). The hydrographic apices have been determined by observing the location of flow bifurcations using aerial photographs in conjunction with field observations and geomorphic mapping. Site 38's topographic apex is located near the mountain front well upstream of the hydrographic apex. However it should be noted that *FEMA Guidelines* states that the hydrographic apex "....may be either coincidental with, or at a point downstream of, the topographic apex....". The topographic and hydrographic apices are shown on Figure 7 and Exhibit 5.

6B.5.1.5 Boundaries

The distal terminus, or toe, of Fan 38 was found to be the White Tanks Wash previously delineated by as part of the White Tanks Wash FDS by Alpha Engineering in January 1996. White Tanks Wash is a tributary wash system that serves as a terminus for several fans, transporting deposits downstream ultimately to the Flood Retarding Structure just upstream of Interstate 10.

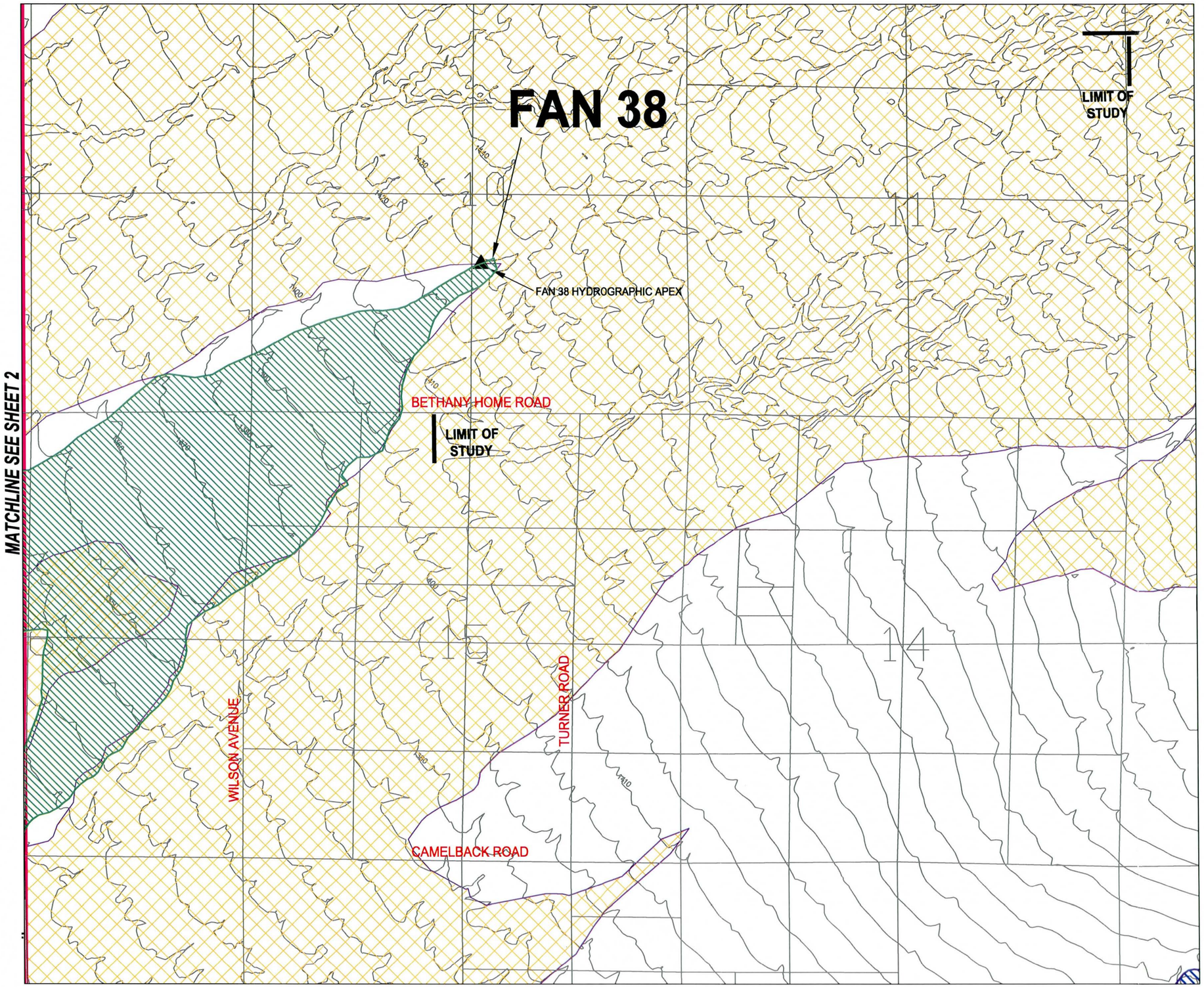
The lateral boundaries of Fan 38 fall into two categories: another adjacent fan or piedmont plains. The southern significant wash system of Fan 38 coalesces with Fan 37 to the south. The remaining two wash systems form boundaries with darker-colored, weathered deposits on piedmont plains.

The Ayres Associates report determined the boundaries for Fan 38. This boundary can also be seen on Sheets 2 of 5 and 4 of 5 on their "Stage 1 Piedmont Landform Delineation" figures in their report.

Ayres Associates used All-Terrain-Vehicles (ATV;s) during the field reconnaissance to assess and verify the piedmont landforms and boundaries. Refer to Section 4.3 within the Ayres Associates' report for the details.

6B.5.1.6 Conclusion

Data derived from the NRCS soils mapping, AZGS surficial geologic mapping, and field reconnaissance resulted in Ayres Associates to conclude that the watershed downstream of Site 38 exhibits alluvial composition. Therefore; it was concluded that Site 38 is composed of non-consolidated alluvium deposited by fluvial processes, which meets the composition criteria specified in the *PFHAM* and *FEMA Guidelines.* Figure 9, located on the following pages, depicts the results of Ayres Associates Stage 1 Landform delineation. Exhibit 7, located in the back pocket, is a 1"=600' exhibit depicting the Stage 1 results as well.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Bedrock
- Relict Fan
- 15 — Section Lines and Numbers

AFHH	Alluvial Fan High Hazard
AFUFD	Alluvial Fan Uncertain Flow Distribution
AAFF	Approximate Alluvial Fan Floodway
AFZA	Alluvial Fan Zone A Flooding
SHX	Shaded Zone X

SHEET INDEX

2 | 1
3

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FIGURE 9
STAGE 1 RESULTS
LANDFORM DELINEATION MAP

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 1 OF 3

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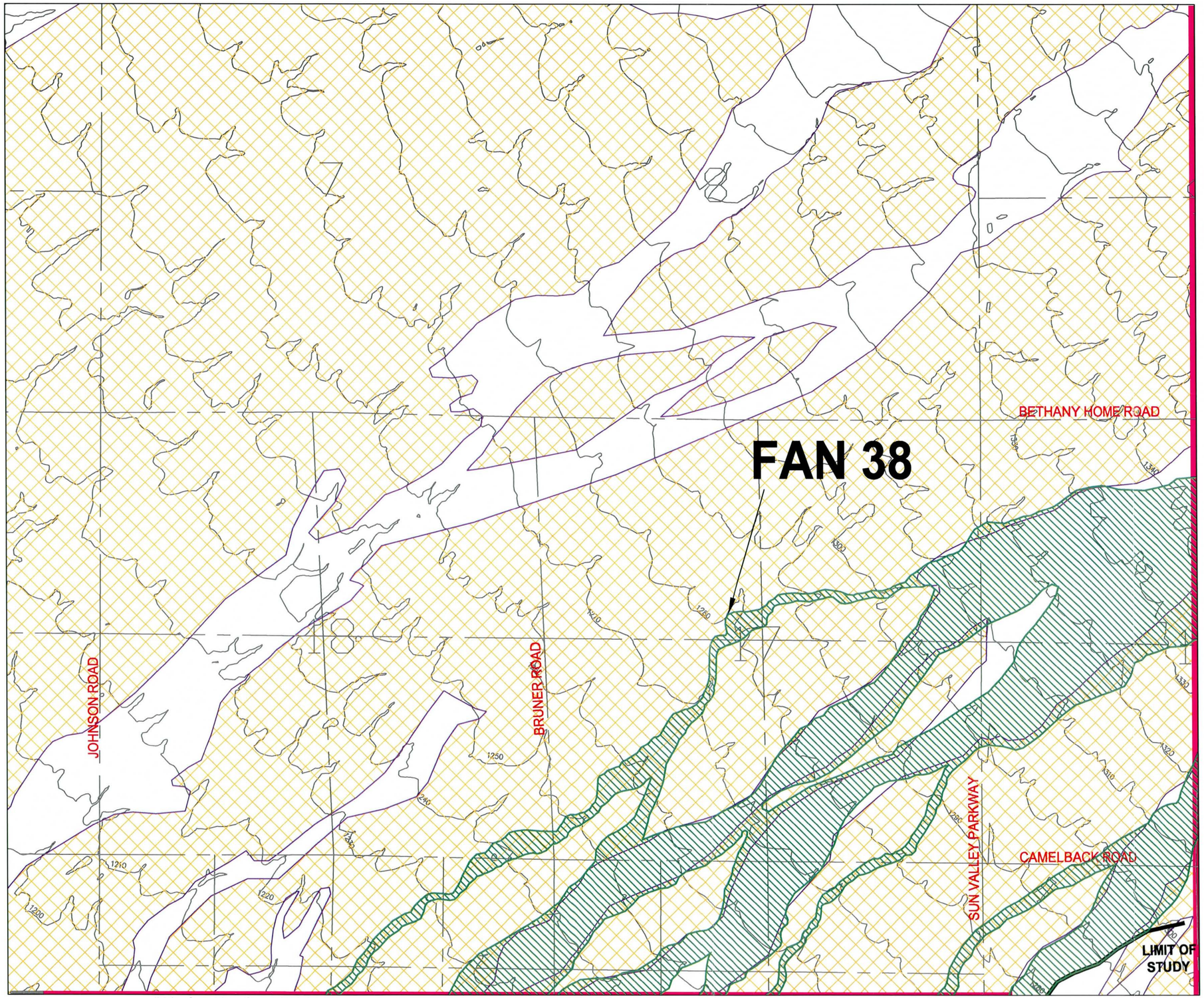

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Bedrock
- Relict Fan
- 15 — Section Lines and Numbers
- AFHH — Alluvial Fan High Hazard
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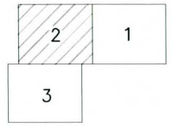
- AAFF — Approximate Alluvial Fan Floodway
- AFZA — Alluvial Fan Zone A Flooding
- SHX — Shaded Zone X

SHEET INDEX



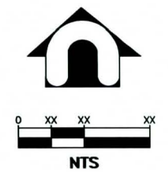


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FIGURE 9
STAGE 1 RESULTS
LANDFORM DELINEATION MAP

	BY	DATE
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DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

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SHEET 2 OF 3

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MATCHLINE SEE SHEET 2

FAN 38

INDIAN SCHOOL ROAD

LIMIT OF STUDY

JOHNSON ROAD

BRUNER ROAD

SUN VALLEY PARKWAY

THOMAS ROAD

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38
ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN
DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Bedrock
- Relict Fan
- 15 Section Lines and Numbers

AFHH	Alluvial Fan High Hazard
AFUFD	Alluvial Fan Uncertain Flow Distribution
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SHEET INDEX

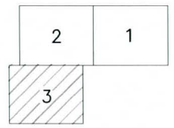

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FIGURE 9
STAGE 1 RESULTS
LANDFORM DELINEATION MAP

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

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6B.6 Stage 2: Defining Active and Inactive Areas

6B.6.1 Introduction

Stage 2 of the *PFHAM/FEMA* alluvial fan methodology consists of defining active and inactive areas within the alluvial fan landforms, as well as characterizing the nature and types of flooding that are associated with a specific hydrographic apex. Active areas on an alluvial fan consist of those portions of the landform where uncertainties about channel geometry and hydraulic conditions of water and sediment discharge cannot be realistically set aside in the assessment of the flood hazard. Active areas on alluvial fans experience sediment deposition, erosion and unstable flow paths in addition to flood inundation. Ayres Associates found areas that were determined to be active/unstable included: active alluvial fans, some multi-channel areas below the active alluvial fans, alluvial plain with active sedimentation to name a few.

Inactive alluvial fan areas are the portions of the alluvial fan landform where active fan processes do not occur. Inactive portions of the alluvial fan are those areas where flow path uncertainty can be set aside in realistic assessments of flood risk. Ayres Associates determined that areas identified as inactive/stable included relict fans, pediment, inactive alluvial fans, though flow channels with movable bed, and some sheet flow and split flow areas.

Stage 2 of the *PFHAM* alluvial fan methodology defines the nature of the piedmont landform environment, identifying unstable and stable components of the piedmont. It should be noted that the *FEMA Guidelines* uses the terms "active" and "inactive" instead of "unstable" and "stable" respectively. The unstable areas are those locations where uncertainties about channel geometry and hydraulic conditions of water and sediment discharges cannot be set aside in the realistic assessment of flood hazard. Stage 2 also identifies portions of the piedmont subject to various types of flooding such as stable riverine flooding, active alluvial fan flooding, inactive alluvial fan flooding, and sheet flooding. The Ayres Associates Stage 2 delineation of stable and unstable areas relied on the following types of information:

- Flow path movement
- Surface geology
- Desert pavement and varnish
- Surface texture
- Channel capacity
- Soils (carbonate zones)
- Soil surveys
- Surface color
- Drainage pattern
- Channel shape
- Vegetation
- Bed material size

6B.6.2 Identification of Active Areas

The limits of the active areas of Site 38 were identified through the use of NRCS soils surveys, AZGS surficial geology mapping, historical aerial photographs, interpretation of 10' contour maps, and field verifications. The Ayres Associates study found that Site 38 encompasses 466.2 acres and extends almost two miles with the unstable portion of Site 38 covering approximately 348 acres. The results of Ayres Associates' study are depicted on Figure 8 along with Exhibit 6 found in the back pocket.

6B.6.2.1 NRCS Soil Surveys

The physical characteristics of a landform surface provide clues as to its depositional history, stability, and its flood potential. If an area of the landform ceases to receive new deposits, its surface begins to age. As it ages, this process continues and the surface begins to develop physical and chemical characteristics indicative of its age. In an arid environment like that found around the Fan 38 vicinity, soils begin to develop distinctive characteristics. As the soil develops, its structure, color and chemical make up changes. Clay and calcium carbonate accumulate in the soil. Soils tend to become reddish in color due to the accumulation and weathering of clay. Accumulation of carbonate cements the soils together eventually develop a highly resistant character referred to locally as caliche.

The NRCS soils survey maps differentiate surfaces based on the types of characteristics. Therefore, this data was utilized to establish the age of the surface, stability, and potential flood hazard. Antho and Carrizo soils series are the major soils within the areas identified as active or unstable. These soils are poorly developed and exhibit little sign of age such as clay or carbonate accumulation. A copy of pertinent excerpts of the Soil Survey of Aguila-Carefree Area can be found in Appendix G.4.

The soil type in the vicinity of Fan 38 was found to be a Momoli-Carrizo complex. The main difference being that the soil is more developed in the Carrizo unit, producing a light brown material under the first inch or two of younger, pickish soil. This is consistent with Field and Pearthree's Y2 classification with regard to its surficial geology.

6B.6.2.2 AZGS Surficial Geology & Flood Hazard Mapping

The surficial geology mapping, developed by Field and Pearthree (1991) for the White Tank piedmont, differentiated areas based primarily on their relative age. Ayres Associates found that Site 38 was delineated as late Holocene with the flood hazard mapping of high and intermediates flood hazards. Refer to the Final Report for detailed discussions of how the

geologic and flood hazards maps were utilized in determining the active areas.

Fan 38 revealed surficial geology classifications of Y1 and Y2. Similarly the flood hazards were H1 and I in the area of Fan 38.

6B.6.2.3 Interpretation of Topography

Contours, specifically their degree of crenulation, are an excellent indicator of soil stability. Specifically surfaces depicted on a topographic map with a high degree of crenulation tend to be stable because it reflects a more incised surface. In contrast, smooth contour lines indicate very little incision. In addition, when smooth contour lines angle downstream, this is another indication of an active area of deposition. Refer to Figure 6 (or Exhibit 8) which includes 10' topography which shows a high degree of crenulation upstream of Fan 38 apex and smoother contour lines down fan.

Contours west of Sun Valley Parkway exhibit significant washes that serve as through-flow channels that are confined or entrenched within relict or inactive fan surfaces. These areas are not in active zones, nor associated with the fan apex. Instead they are the result of loss of conveyance, channel braiding due to changes in slope or localized aggradation, flow deflection around obstructions, a reduction in stream gradient associated with extensive shallow or exposed caliche across the floodway, or localized backwater sedimentation associated with sharp downstream bends, dense vegetation, or severe floodway constrictions. These are most easily seen on Figure 4 or Exhibit 6 which includes the 10' topography.

6B.6.2.4 Historical & Current Aerial Photograph Interpretation

Ayres Associates examined aerial photography from 1953 versus more recent photography and revealed that areas of Fan 38 still exhibits active alluvial fan processes. The areas are shown on exhibit 5 and figure 7, labeled as either AAFF, AFUFD, or AFHH areas. Field reconnaissance also confirmed the active nature in these areas of Fan 38. Refer to section 6.1.16 of the Final Report for additional detail.

6B.6.2.5 Drainage Pattern

Surfaces free from new deposition will erode. As the surface erodes, new tributary channel networks develop. These channels will also begin to entrench themselves into the surface creating a greater degree of relief between the channel bottoms and the ridges that separate them.

Flood waters flow across the middle piedmont through a number of stable channels across older surfaces before entering an area of younger Holocene sediments. Much of the lower piedmont is characterized by broad areas of relatively stable shallow sheet flooding. Islands of older sediments are also located between these broad sheet flooding area. Within these broad areas of relatively shallow sheet flooding are several more prominent washes. The more prominent washes connect to the through flow channels coming from the upper and middle piedmont in a tributary fashion.

The drainage patterns in the area of Fan 38 are fan-like, not only distributary but fan out into other fan piedmonts.

6B.6.2.6 Surficial Characteristics

Surfaces may also develop an accumulation of pebbles and cobbles at the surface as they age. These gravel coverings are known as desert pavement which is believed to form by the accumulation of windblown silt and clay between the larger gravels. Repeated wetting by rainfall events causes the fine-grained materials to swell, lifting the larger gravels to the surface. Repeated surface drying creates cracks into which more fine windblown material may accumulate. Over thousands of years these processes result in a mantle of closely packed gravels over a silt- and clay-rich soil layer. The surface pebbles and cobbles, if they contain sufficient ferromagnesian minerals, will develop a dark black patina on the top surface and an orange coating underneath known as rock varnish, locally referred to as desert varnish. The Ayres study determined that active areas appeared slightly lighter on the black and white aerial photography.

Surficial geology mapping differentiate surfaces based on the types of characteristics discussed above. Therefore, this data was utilized to establish the age of the surface, stability, and potential flood hazard. Young surfaces with little soil development are likely to continue to see runoff and variations in sediment discharges. Older surfaces are much less likely to experience inundation by runoff and sediment in the future baring human influences. Older surfaces with cemented soils and entrenched channels also tend to be stable, changing very little their location over time. Conversely, areas with loose soil and little lateral relief are more susceptible to lateral changes in channel position.

6B.6.2.7 Vegetation

The Ayres study utilized aerial photography to ascertain the vegetation patterns within the Fan 38 shadow finding that the active zones were much narrower than other USGS sites. The study found that desert trees were confined mainly to the margins of the primary channels with desert bushes more patchy and scattered in the active areas. The vegetation patterns

were identifiably different from the areas delineated at relic fans and as inactive areas that surround the active areas.

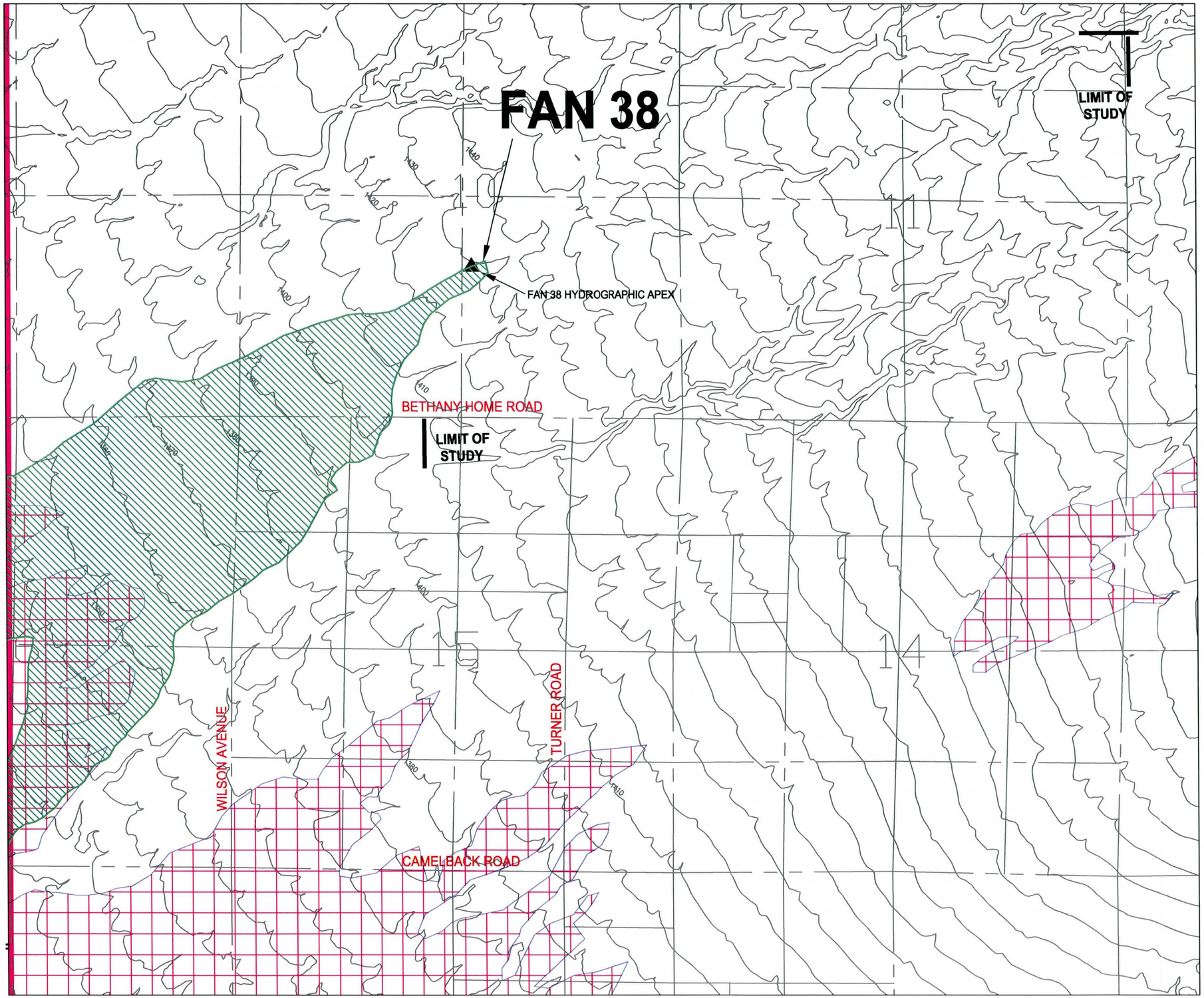
While saguaro can be found in portions of the upper unstable area, the area exhibits a generally scattered appearance of vegetation downstream of the hydrographic apex. This is in contrast to the linearly aligned vegetation seen in aerial photographs elsewhere on the piedmont. The riparian vegetation helps create as well as indicate the stability of large portions of the middle and lower piedmont within the study limits.

6B.6.2.8 Sediment Delivery Potential

Sediment delivery potential is primarily driven by particle size and stream gradient when the available soils are of a gravelly versus clayey nature. As was determined in the Ayres Associates Sediment Transport Study, the watershed containing Fan 38 has a lower gradient than the watersheds contributing to either the Buckeye Flood Retarding Structure 2 or 3 to the east; thereby, reducing the transport capability. Refer to the Ayres Associates report in Appendix F for further information.

6B.6.3 Identification of Inactive Areas

Figure 8, locating on the following pages, depicts the active areas associated with Fan 38 as "Unstable Active Alluvial Fan" and "Conditional Unstable" thereby describing the remainder of the piedmont as inactive. The discussions on the interpretation of topography, vegetation, and historical aerial photography in the previous sections reveal that large portions of the middle and lower piedmont have been and are likely to continue to be stable with respect to flooding in the future. In particular, the inactive areas are on Rillito and Gunsight soil series, on units identified as Y1 or older on the surficial geology, areas containing desert pavement, desert varnish, and tributary drainage patterns.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITES 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Highly Unstable Active Alluvial Fan
- 15 Section Lines and Numbers

SHEET INDEX

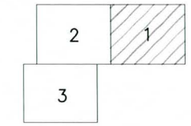


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FIGURE 8
STAGE 2 RESULTS
STABLE AND UNSTABLE BOUNDARIES FROM AYRES & ASSOCIATES

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

SUBMITTED BY: DATE:

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APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3

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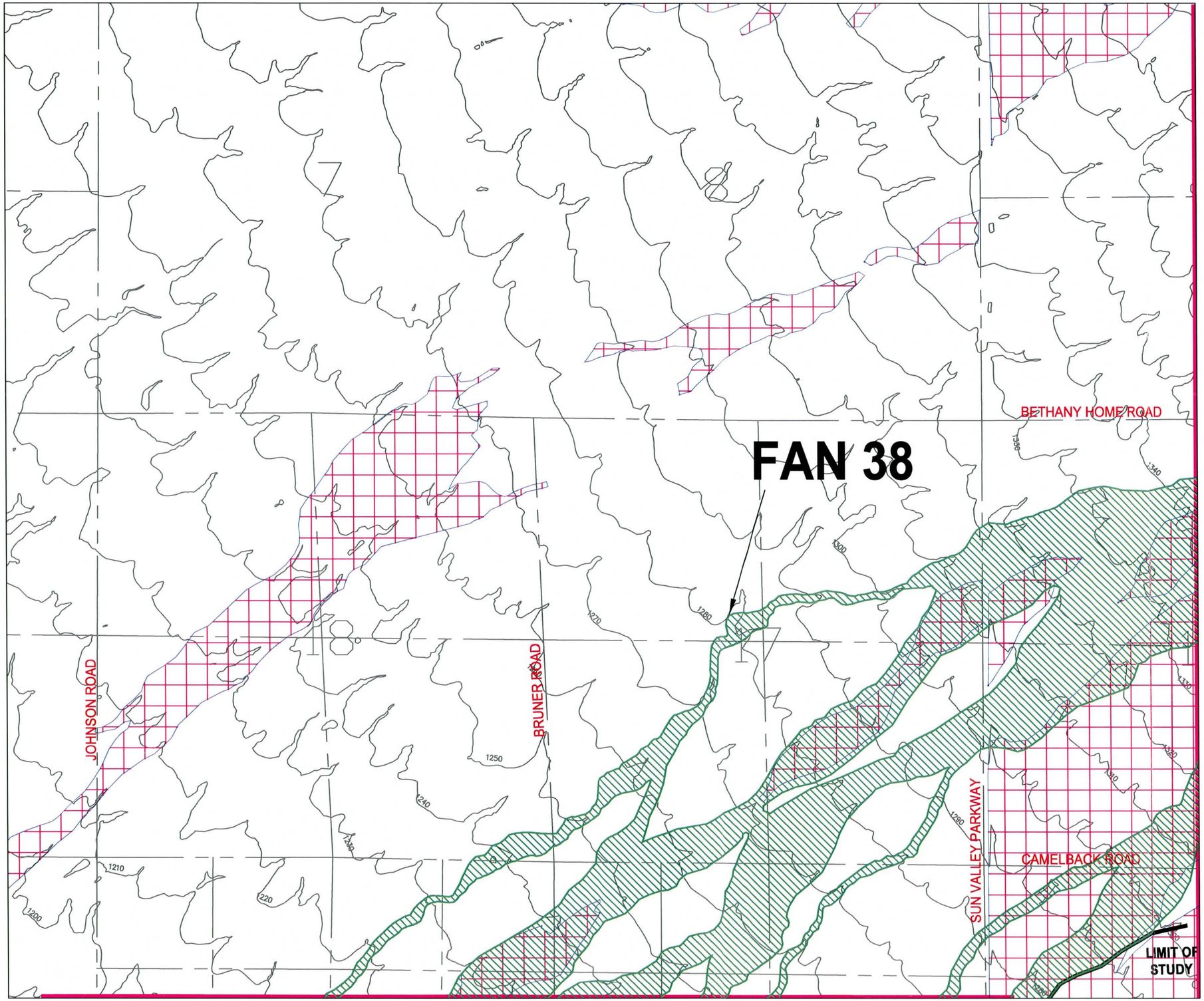

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITES 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Highly Unstable Active Alluvial Fan
- 15 — Section Lines and Numbers

SHEET INDEX

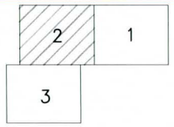

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FIGURE 8
STAGE 2 RESULTS
STABLE AND UNSTABLE BOUNDARIES FROM AYRES & ASSOCIATES

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PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

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SHEET 2 OF 3

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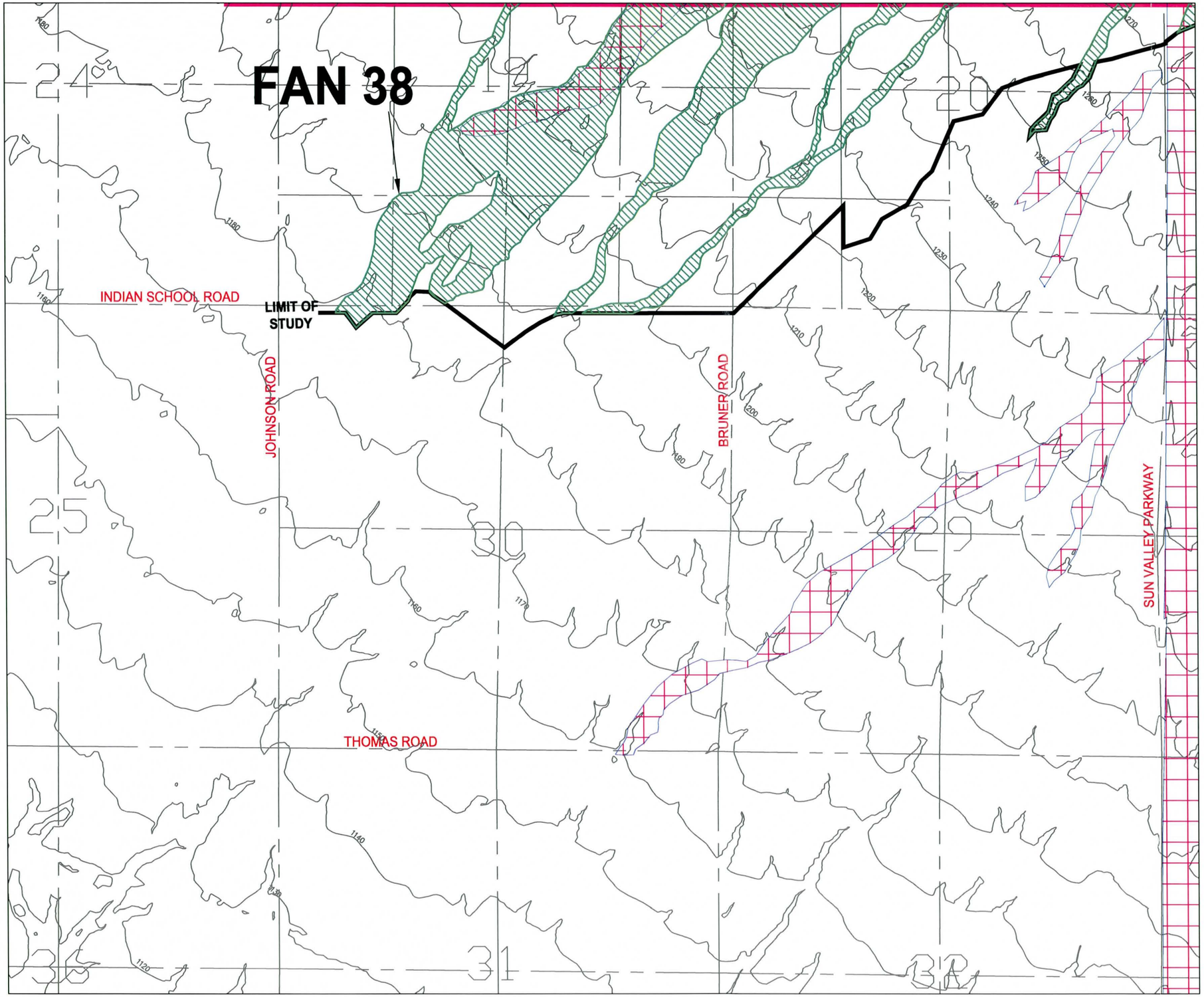

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITES 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- Highly Unstable Active Alluvial Fan
- 15 — Section Lines and Numbers

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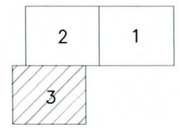

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FIGURE 8
STAGE 2 RESULTS
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	BY	DATE
DESIGN	SXW	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXW	11/07
PLANS CHK.	MIW	11/07

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

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6B.6.3.1 Inactive Areas Still Subject to Flooding

The soils data, surficial geology, topography, and historical aerial photographs indicate that large areas of the piedmont are subject to flooding, but that the nature of that flooding is within stable through flow channels or broad sheet flooding across wide stable areas. Within some of the through flow channel corridors, some channel changes can be observed over time. However, these channel changes are confined to the corridors. These corridors are bounded by higher, generally older surfaces. Channel changes occurring within these corridors may be considered analogous to changes in a braided riverine channel. That is, while channel changes do occur during flooding events, the limits of flooding for large events remain basically the same. The degree of flood hazard varies horizontally within these corridors and between floods.

Within the broad sheet flooding areas, small channels exist. The distribution of flow in these smaller channels, usually less than two feet deep, varies from flood event to flood event. It should be noted that the flood hazard within the channel themselves is great.

6B.6.3.2 Summary of Active & Inactive Areas

It takes thousands of years for these soil and surface characteristics to develop. Therefore, surfaces exhibiting well developed soils, red color, significant carbonate development, desert pavements, desert varnish, and tributary drainage networks are surfaces that have been relatively free from flooding for thousands of years. As such, these areas can be viewed as having a low flood hazard potential.

Figure 8 shows the limits of the active (Unstable Active Alluvial Fan) and inactive acres of Fan 38 which form an important foundation in the evaluation of the 100-year flood hazard in Stage 3. Exhibit 6, located in the back pocket, is a 1"=600' exhibit depicting the Stage 2 results as well.

6B.7 Stage 3: Defining the Approximate 100-year Floodplain

The assessment of the 100-year flood hazard on the White Tank Fan, Site 38 piedmont follows the procedures outlined in the *PFHAM* and FEMA 2002. The 100-year flood hazard assessment is an outgrowth of the information and results identified and generated in the Stage 1 and Stage 2 evaluation levels, as prepared by Ayres Associates.

The method chosen to identify the areas subject to flooding from the 100-year flood hazard limits was one utilizing geomorphic data and historical information. A geomorphic approach was the method used for the flood hazard delineation downstream of the hydrographic apex for Fan 38. The geomorphic evidence from aerial photography,

surficial geology maps, and field observations were the primary tools for refining the flood hazard boundary within the active portions of the piedmont.

Island areas smaller than approximately 10 acres were not separated out from the surrounding flood hazard zones; instead they were included in the adjacent flood hazard zone.

Upstream of the hydrographic apex, geomorphic methodology was used to delineate the flood hazards with conventional normal-depth methods used to refine the delineation.

6B7.1 Types of Flooding

6B.7.1.1 Alluvial Fan

The *PFHAM* and FEMA 2002 define alluvial fan flooding as "The flooding that occurs on an alluvial fan....encompasses both active alluvial fan flooding and inactive alluvial fan flooding. Alluvial fan flooding can include distributary flow, sheet flow and sheet flooding." Alluvial fan flooding has been identified to occur east of Sun Valley Parkway and within Fan 38 west of Sun Valley Parkway. The flood hazard designation is either AFHH or AFUFD and has been identified as a Floodway District due to the active nature of this part of the piedmont and the extreme need for flood mitigation if this area were to be developed. Development within this boundary will require appropriate engineering solutions based on the active nature of this part of the piedmont.

6B.7.1.2 Sheet Flow

The *PFHAM* and Arizona State Standard 4-95, as it relates to sheet flow on alluvial plains of piedmonts, define sheet flow as "any form of unconfined runoff that occurs over a broad, expansive area."

The potential for sheet flow exists in several areas of the Fan 38 piedmont. Where the potential is more likely, a flood hazard designation of AFZA has been determined, specifically between the AAFF zones west of Sun Valley Parkway. This is the case where local drainage and small channels periodically connect to larger systems by wide sheet flooding. Site specific design in order to mitigate flood hazards will be required as these areas develop. Where the likelihood is much lower due to topographic conditions and aerial evidence, a Shaded Zone X was determined.

6B.7.1.3 Stable Distributary

There are several locations within the Fan 38 piedmont that exhibit a distributary flow pattern; however, they are located in older, more stable geology. Flow distribution over this stable surface can be set aside in

realistic assessments of flood risk. The AAFF zones which include floodway districts provide the width to safely convey flood flows in a stable reach, although the manner and alignment within the corridor can change with each flood event. This is particularly evident in the lower portions of the piedmont as the flows join those of the White Tanks Wash.

6B.7.2 Description of Mapping Issues

The topographic mapping for this study was based on ten foot contouring. The 2000 aerial photography and the topographic mapping, which was taken at 1" equals 500' scale, results in limitations when mapping "islands" smaller than 10 acres.

6B.7.3 Verification of Results

It should be noted that all results were verified based on actual field reconnaissance and as a secondary check, by reviewing aerial photography. This review and refinement led to some very minor areas of discrepancy with what either the Ayres Stage 1 & 2, AZGS Surficial Geology & Flood Hazard Mapping, NRCS Soils Map, or current Topographical data suggest. These minor nuances may be the result of engineering judgment, limits in the precision of the available data and combinations of the two. In the end these areas were delineated to match the flood hazard zones that were actually present on the site and may be in minor conflict with some of the previously gathered data. The flood hazard zones are all delineated from the best available data and minor differences are within an appropriate and acceptable tolerance level.

Exhibit 3 (Figure 5) shows the relationship of the Field and Pearthree surficial geology mapping (1991) to the results of the Stage 3 analysis. The surficial geology maps were used to identify which corridors have experienced recent, from a geological timeframe, flooding but aerial photography, topography, and field reconnaissance were the primary tools to delineate the approximate floodplain. Zone A - Active Alluvial Fan with Administrative Floodway (AAFF) typically are characterized by surficial geology labels of Y1 or Y2 and Stage 2 classification as active or unstable. This is the case within Fan 38 where Y1 and Y2 were present and both areas had been determined to be active based on Ayres Associates Stage 2 study. There were two "islands" of M1b classification east of Sun Valley Parkway that showed a likely potential of flow overtopping, becoming sheet flow and with time, new avenues for fan flow. Zone A - Inactive Alluvial Fan with Administrative Floodway (AAFF) typically were characterized by surficial geology labels of Y2 and M1b and Stage 2 classification of stable. The Zone X Shaded typically is characterized by M1b surficial geology label.

Exhibit 4 (Figure 6) shows a comparison of the results of the Stage 3 analysis with the flood hazard evaluation by Field and Pearthree (1992). In general, everything shown by Field and Pearthree as an H1 surface has been mapped as within one of the various 100-year flood hazard areas. H1 surfaces are characterized by "very high flood potential". H1 surfaces included areas with the "potential for localized,

high-velocity, relative deep, channelized flows and sheet flooding" with "some potential for drastic shifts in channel position". H1 surfaces were evaluated as having a "high flood potential" characterized by "predominately shallow sheet flooding; channelized flow very limited in extent" with "broad areas probably inundated in large flood". The H1 areas largely correspond with the Active Alluvial Fan zones.

The Field and Pearthree flood hazard evaluation differs from the Stage 3 results where approximate alluvial fan floodways cross I, L1, and L2 surfaces. Specifically, just downstream of the apex, the Field and Pearthree evaluation classified this as an I surface. The I surface is described as "intermediate flood potential; areas not flooded recently; near or within distributary drainage systems, and little topographic relief separates these areas from active alluvial fans or channels; could become flood prone with relatively modest changes in channel configurations". A detailed look at the existing topography reveals a significant potential for this area becoming active should changes in the main channel continue to occur

Similarly, downstream of Sun Valley Parkway, an Administrative Floodway District was determined along the Field and Pearthree "Channel bottoms of larger drainages heading in the White Tank Mountains" contained within a L2 classification. L2 surfaces are described as "very low flood potential; areas not flooded for at least 10,000 years or long; spatially or topographically separate from distributary drainage networks". The inactive alluvial fan floodway corridors follow stable channels or channels confined between older surfaces from the active fan upstream to the broad areas of sheet flooding downstream. Significant corridors were classified as "Floodway Districts" to allow continued conveyance of flow and sediment down the piedmont. But generally the remaining L2 areas were classified as Shaded Zone X or AFZA for the larger "islands".

L1 surfaces are described as "relatively low flood potential; areas not flooded for at least 10,000 years, but near or within distributary drainage networks and typically with little topographic relief separating L1 from I, H1, or H2 surfaces".

As a result, the 100-year flood hazard assessment of the Fan 38 piedmont and alluvial fan is believed to be reasonable, sound, and defensible based on the data presented in this Technical Data Notebook. However, revisions to the mapping presented here could be justified based on more detailed topographic mapping, hydrologic, and hydraulic analyses in the future.

6B.4 Work Study Maps

Figure 7, located on the following pages, includes an aerial photograph, contour mapping along with the Fan 38 flood hazard boundaries. An estimated floodplain delineation was developed in the office using surficial geology and flood hazard mapping developed by AZGS, soils mapping, aerial photography, and contour mapping. Then a field reconnaissance was performed to verify or refine the

floodplain boundary. The photo numbers shown on the exhibit correspond to field photos. These ground shots can be found in Appendix H. Generally these photo shots were taken at the edge of the floodplain based on field observations with reference to the previously determined office delineation. Field verification of the "boundary" was aided by GPS technology to display the boundaries. Island areas smaller than ten acres in size were not separated out. They were included in the surrounding flood hazard zone. In addition, areas adjacent to geologically young surfaces where uncertainties associated with alluvial fan flooding were included in the fan hazard designation. Similar to the FEMA guideline (Example 4), approximate floodway corridors were identified to allow for conveyance of flood waters and sediment down the piedmont. Exhibit 5, located in the back pocket, is a 1"=1000' scale version of Figure 7.

Table 6-4, on the following page, lists and describes the flood hazard zones identified and shown on Figure 7. These zones have been defined for use in the delineation of piedmont flood hazards in Maricopa County, Arizona by the Flood Control District of Maricopa County. The map designations are similar to those used in Example 4 (Figure G-9) of the FEMA guidelines, Appendix G.

The unstable areas from the Stage 2 results have been identified as AFHH and AFUFD using Local Community terminology. AFHH will be found immediately downstream of the Fan 38 apex whereas AFUFD is further downstream, where flow becomes more distributary, coalescing flow paths creating an uncertain flow distribution area without the characteristic evidence of a fan.

Downstream of the AFUFD zones are AFZA – Administrative Floodway (Inactive Alluvial Fan) or AAFF Local Community Zone corridors which traverse the inactive (or stable) portions of the alluvial fan landform. These areas represent the primary corridors that convey the flow and sediment that is released from Site 38 drainage basin. These corridors can be considered similar to riverine environments in that they are areas that are required for conveyance of the 100-year flood. Although these corridors do not necessarily contain the entire limits of the 100-year flood across the middle and lower piedmont under the existing condition due to small breakouts and sheet flow, they are adequate in size and continuity to convey floodwaters across the piedmont if flow was restricted to them. Reserving these corridors will allow for engineered flood protection and mitigation within other flood prone but stable areas of the inactive alluvial fan.

The method for determining the location of the approximate alluvial fan floodways (AAFF) was determined first by identifying the most significant, continuous wash systems which connect the active alluvial fan upstream to the inactive portion lower on the piedmont.

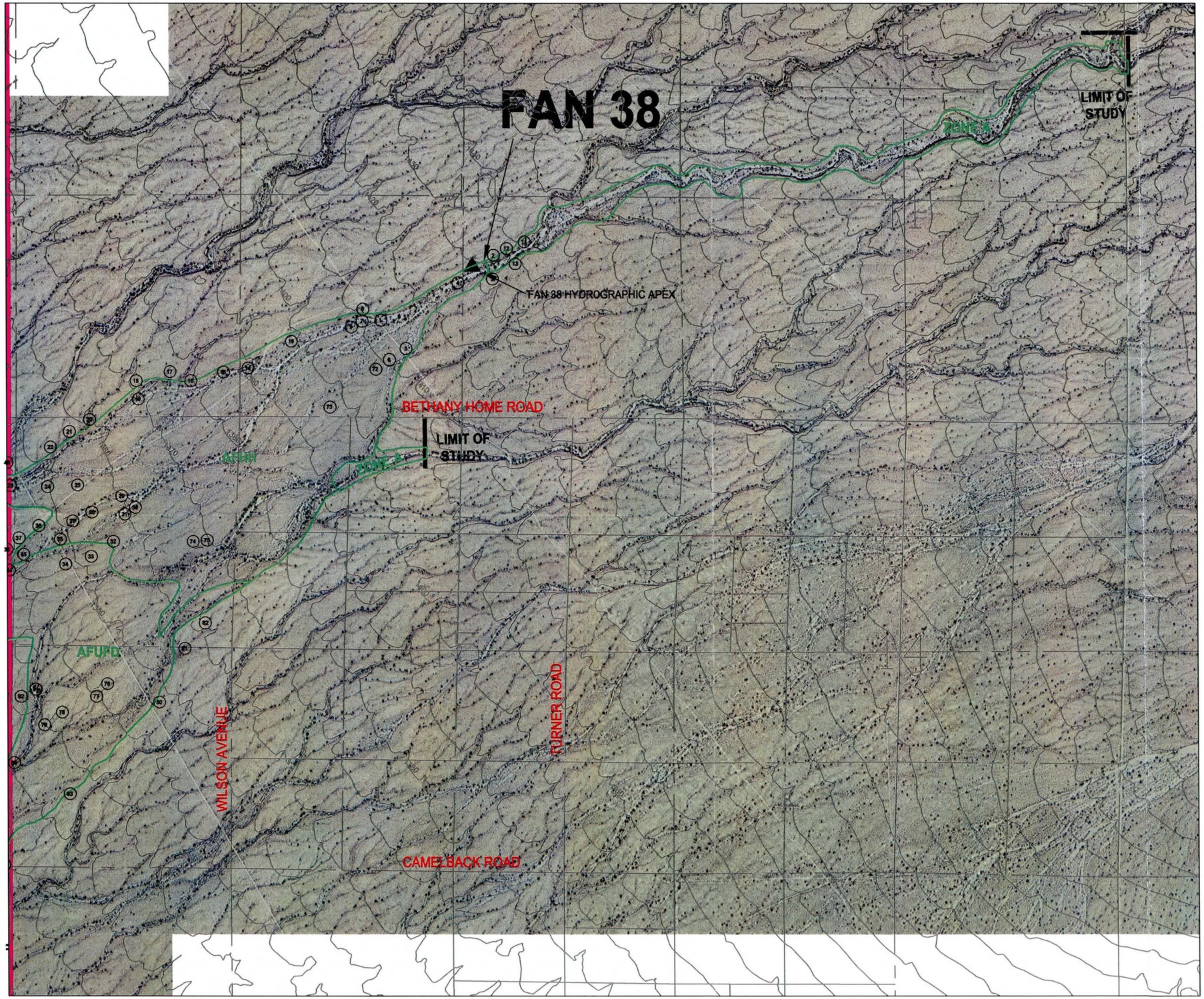
Flood prone areas in inactive areas outside the active alluvial fan floodways are identified in Figure 7 as AFZA due to these areas being subject to over bank flow and local runoff. Engineering would be required to mitigate sheet flooding and over bank flow during major events in these areas. Development within these

areas would be allowed given an adequately engineered site specific evaluation of the flood hazard and flood mitigation measures. AFZA areas are generally characterized by sheet flooding and flooding within relatively small stable channels. These small channels may either represent small distributary drainages connected to the primary floodways, small local drainages, or various paths where broad sheet flooding recollects as it flows down the piedmont in an effort to reorganize itself. Consequently, the magnitude and frequency of flood hazards within AFZA's should not be considered equal at every location.

Between the AAFF area at the downstream extent of this study is a large island of old, stable geomorphic surfaces. The area has been given a flood hazard designation of Zone X (shaded). This zone includes areas of possible flood hazards from local drainage areas smaller than one square mile as well as stable areas potentially flooded by event less frequent than the 100-year flood (e.g. the 500-year flood event).

In certain instances, the Stage 1 & 2 results to not correspond with their aforementioned Stage 3 Flood Zone Hazard classifications. This is because extensive field research and current aerial interpretation shows that the flood hazard classifications needed to deviate from the Stage 1 & 2 delineations to reflect the best available data. A typical instance of this scenario would include the AFZA island that spans the Sun Valley Parkway. The Stage 2 analysis shows that the relict alluvial fan stops at the Parkway and does not extend to the east, as our AFZA delineation does. It is clearly shown by field reconnaissance, aerial photography, and the AZGS Surficial Geology workmap (area Qi2) that the AFZA area should extend to our full delineation boundary.

The Fan 38 flood hazard boundary has been tied into the flood hazard boundary established for Fan 37 which is currently in for review with Maricopa County Flood Control District. The two studies, Fan 37 and Fan 38, are proceeding concurrently; therefore, if revisions occur to Fan 37 boundaries in the location of the end of study for Fan 38, minor modifications will be required. However at this point the line work ties in well as do the hazard classifications i.e. both are AAFF.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

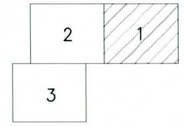
WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- (7) Photo Locations
- 15 Section Lines and Numbers

AFHH	Alluvial Fan High Hazard
AFUFD	Alluvial Fan Uncertain Flow Distribution
AAFF	Approximate Alluvial Fan Floodway
AFZA	Alluvial Fan Zone A Flooding
SHX	Shaded Zone X

SHEET INDEX



DAVID EVANS AND ASSOCIATES INC.
2141 East Highland Avenue, Suite 200
Phoenix, Arizona 85016
Phone: 602.678.5151

FIGURE 7
STAGE 3 RESULTS
AERIAL PHOTOGRAPHY

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3

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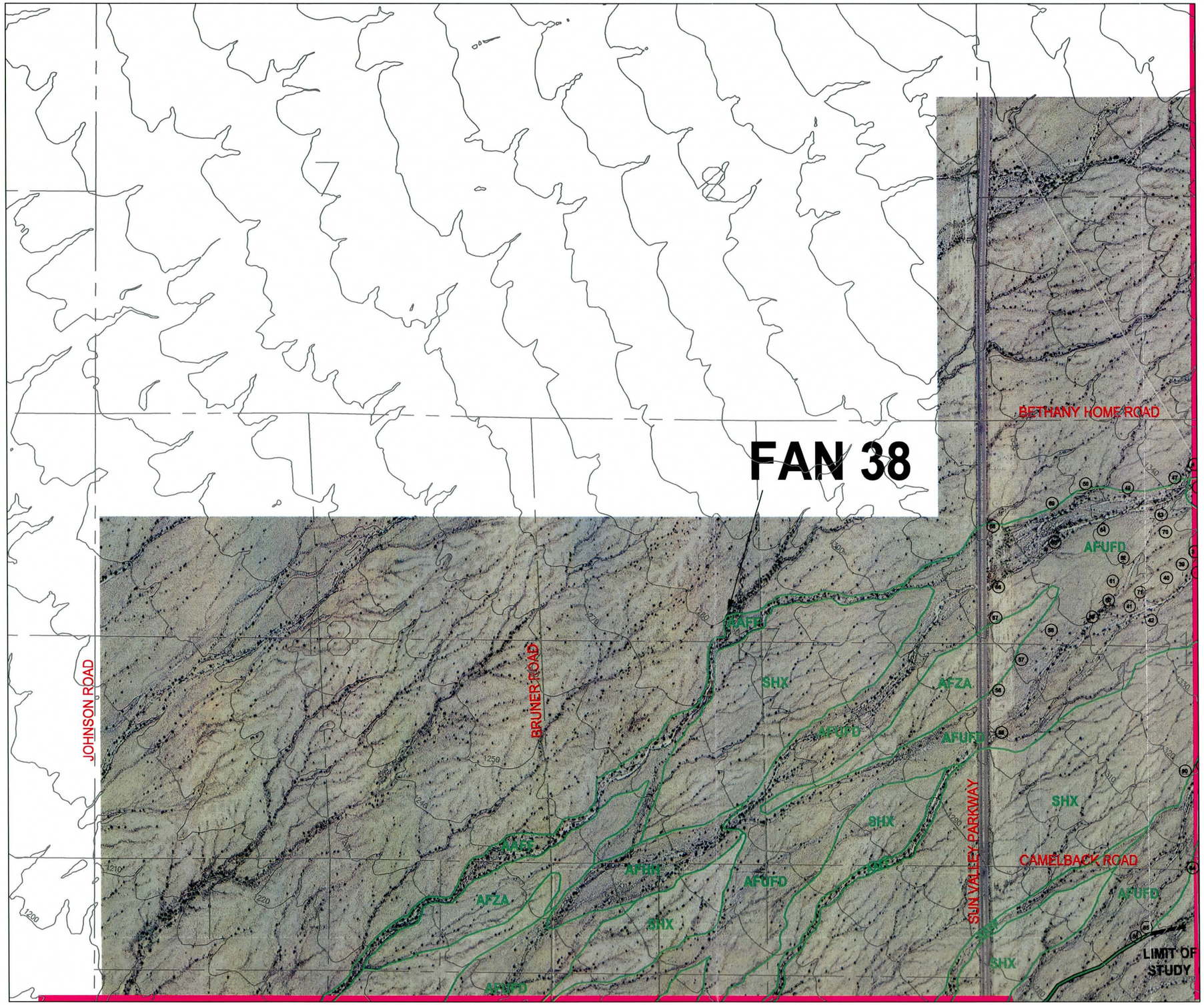

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

LEGEND

- Fan 38 Flood Hazard Boundary
- (7) Photo Locations
- 15 Section Lines and Numbers

AFHH	Alluvial Fan High Hazard
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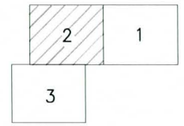
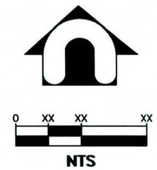
AFZA	Alluvial Fan Zone A Flooding
SHX	Shaded Zone X

SHEET INDEX





DAVID EVANS AND ASSOCIATES INC.
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Phoenix, Arizona 85016
Phone: 602.678.5151

FIGURE 7
STAGE 3 RESULTS
AERIAL PHOTOGRAPHY

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER
SHEET 2 OF 3

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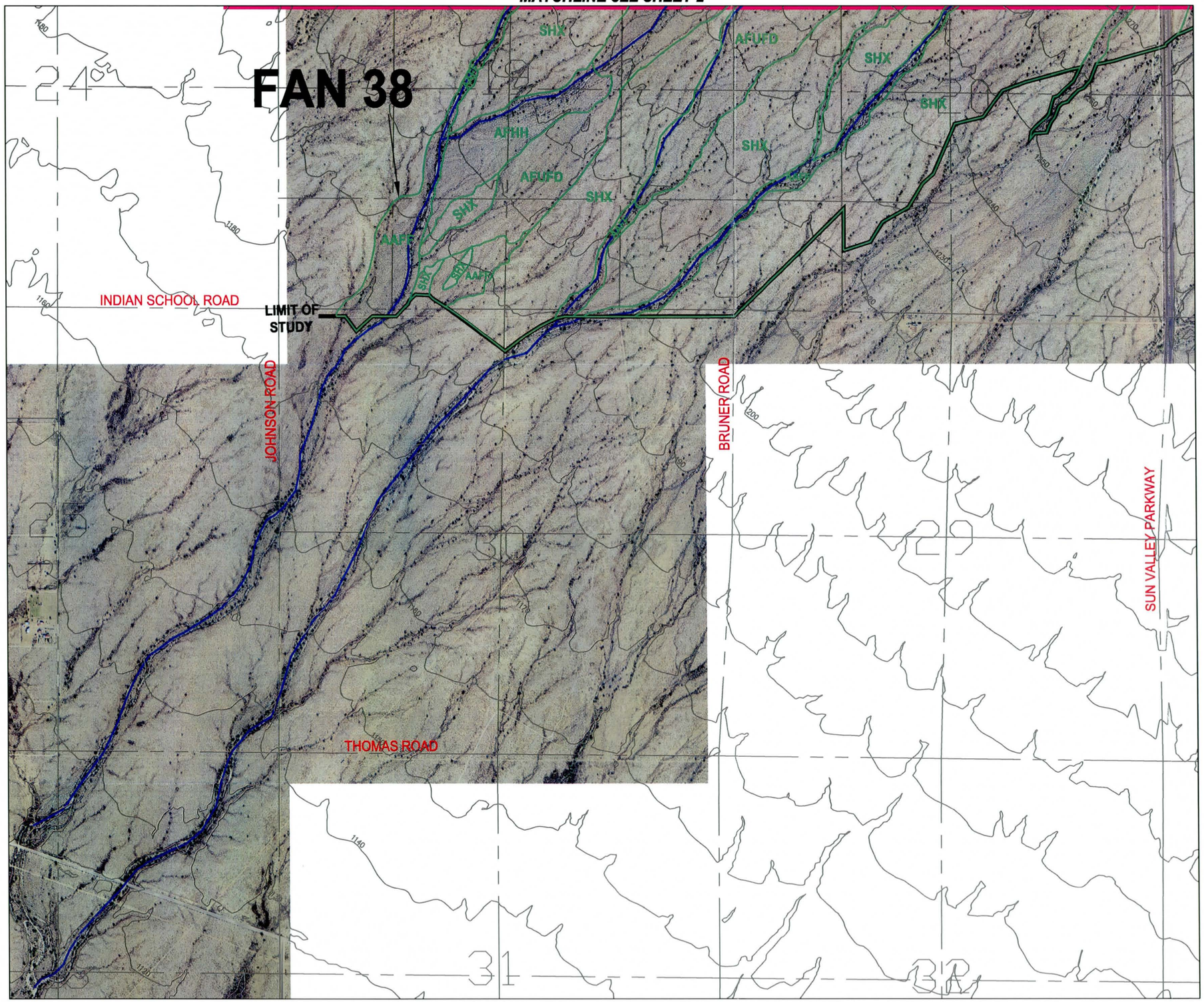

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WHITE TANK MOUNTAINS SITE 38 ALLUVIAL FAN
APPROXIMATE FLOOD PLAIN DELINEATION STUDY

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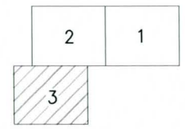
SHEET INDEX



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DAVID EVANS AND ASSOCIATES INC.
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FIGURE 7
STAGE 3 RESULTS
AERIAL PHOTOGRAPHY

	BY	DATE
DESIGN	SXWI	11/07
DESIGN CHK.	MIW	11/07
PLANS	SXWI	11/07
PLANS CHK.	MIW	11/07

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

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Piedmont Flood Hazard Zones
Table 6-4

FEMA Zone Name	Local Community Zone Designation	Description
Zone A – Active Alluvial Fan Flooding; Administrative Floodway	AFHH – Administrative Floodway	Alluvial Fan High Hazard, community to treat as a Floodway District.
Zone A – Active Alluvial Fan Flooding; Administrative Floodway	AFUFD - Administrative Floodway	Alluvial Fan Uncertain Flow Distribution Area, transitional area downstream of High Hazard zone characterized by channelized and sheet flooding generally becoming more stable and less uncertain with increasing downstream distance from High Hazard zone; community to treat as a Floodway District.
Zone A – Inactive Alluvial Fan Flooding, Administrative Floodway	AAFF - Administrative Floodway	Approximate Alluvial Fan Floodway; corridors for conveyance of water and sediment on a stable alluvial fan surface downstream of High Hazard or Uncertain Flow Distribution zones; community to treat as a Floodway District.
Zone A – Inactive Alluvial Fan	AFZA	Alluvial Fan Zone A; areas within the 100-year floodplain on an inactive alluvial fan characterized by shallow channelized flow and sheet flooding in stable channels; zone is considered approximate because no base flood elevation are provided; flood hazards within this zone are not necessarily equal throughout, frequency and magnitude of flooding with respect to depth and velocity of flow may vary within this zone; floodplain managers should consult available aerial photographs and topographic maps for more detailed evaluation of site specific flood hazard within this zone; development will be allowed in this zone given demonstration of adequacy of site and/or design which addresses safety from inundation and sedimentation hazards.
Zone A	Zone A	Approximate 100-year floodplain; riverine reaches upstream of hydrologic apex
X (shaded)	X (shaded)	Areas flooded between 100-year and 500-year discharge; or areas of flooding with depth of 100-year flood less than 1 foot; or drainage area less than 1 square mile.
X (unshaded)	X (unshaded)	Areas outside the 500-year floodplain.

Section 7: DRAFT FIS REPORT DATA

7.1 Summary of Discharges

Table 7-1 Floodplain Discharge Rates

	Drainage Area	Peak Discharges (cfs)			
Flooding Source and Location	(Square Miles)	10-Year	50-year	100-Year	500-Year
White Tank Fan Site 38 Wash above hydrographic apex	3.5	--1	--1	1858 cfs	--1
--1 Not computed					

The discharge listed above was taken from previous Buckeye/Sun Valley Area Drainage Master Study by PBS & J Engineering

7.2 Floodway Data

No typical floodway data is provided as this was not a detailed study. However, administrative floodways are presented and are intended to serve as corridors to maintain the continuity of the through flow of water and sediment discharges along the alluvial fan landform. Management of these floodway corridors will be performed by the local community.

7.3 Annotated Flood Insurance Rate Maps

The area of flood hazard delineation includes portions of three FIRM panels in unincorporated Maricopa County and Buckeye, Arizona. A map showing the new floodplain limits along with the existing floodplain limits and FIRM panel boundaries is included in a pocket following this page.

7.4 Flood Profiles

There are no flood profiles as part of this non-detailed study.

NOTES TO USERS

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

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

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

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

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

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

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

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

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

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

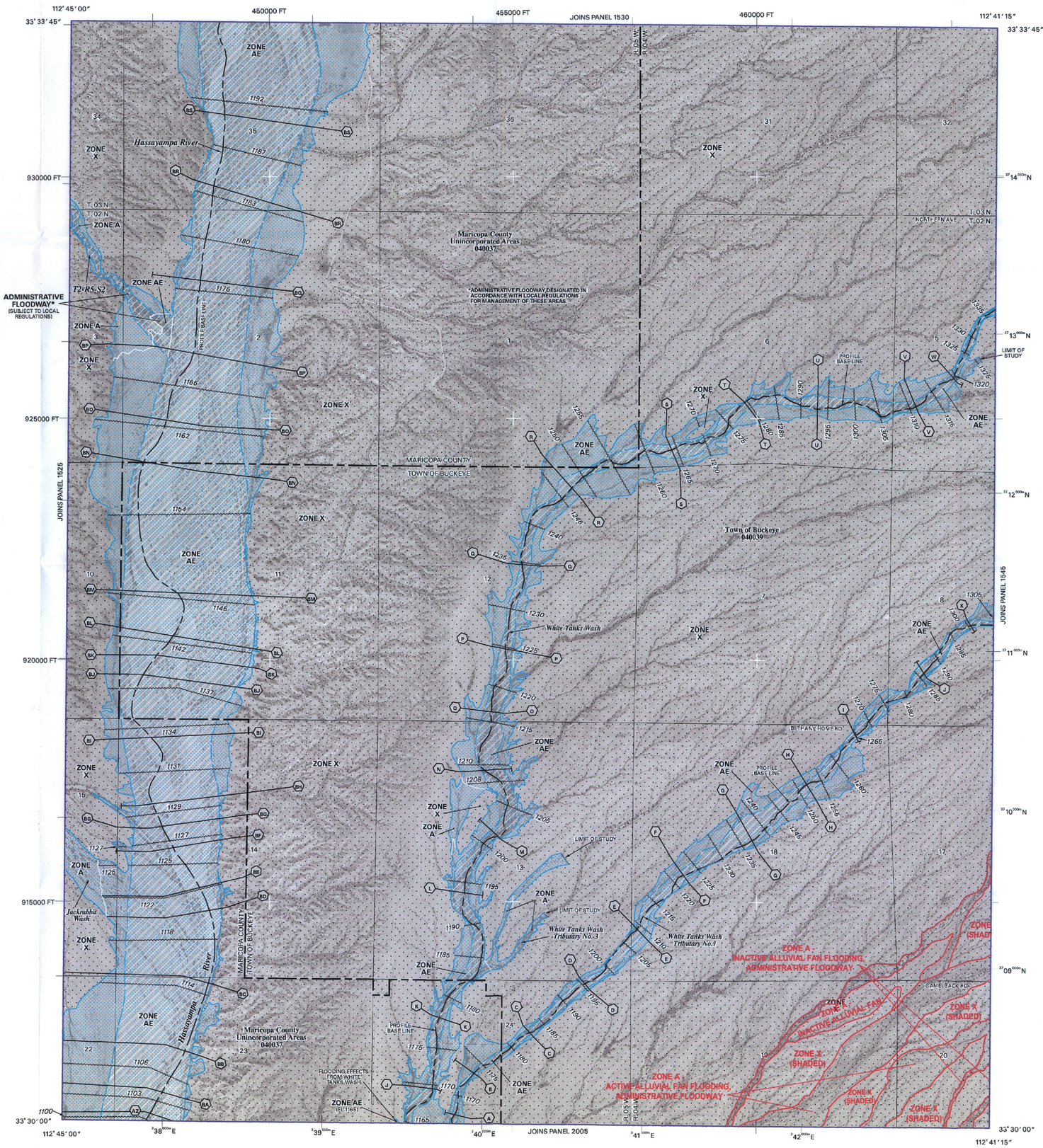
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were **transferred** from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As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

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

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

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

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

* Referenced to the National Geodetic Vertical Datum of 1929

- A — A — Cross section line
- 2 — 2 — Transect line
- 112° 07' 08", 33° 25' 41" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.
- 3°76 000mE — 1000-meter Universal Transverse Mercator grid tick values zone 12.
- 875000 FT — 5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)
- X DV2313 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

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

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 4, 1991, December 3, 1993, July 19, 2001

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

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

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-9620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1540H

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

PANEL 1540 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BUCKEYE, TOWN OF	040039	1540	H
MARICOPA COUNTY	040037	1540	H

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

MAP NUMBER
04013C1540H
MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

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NOTES TO USERS

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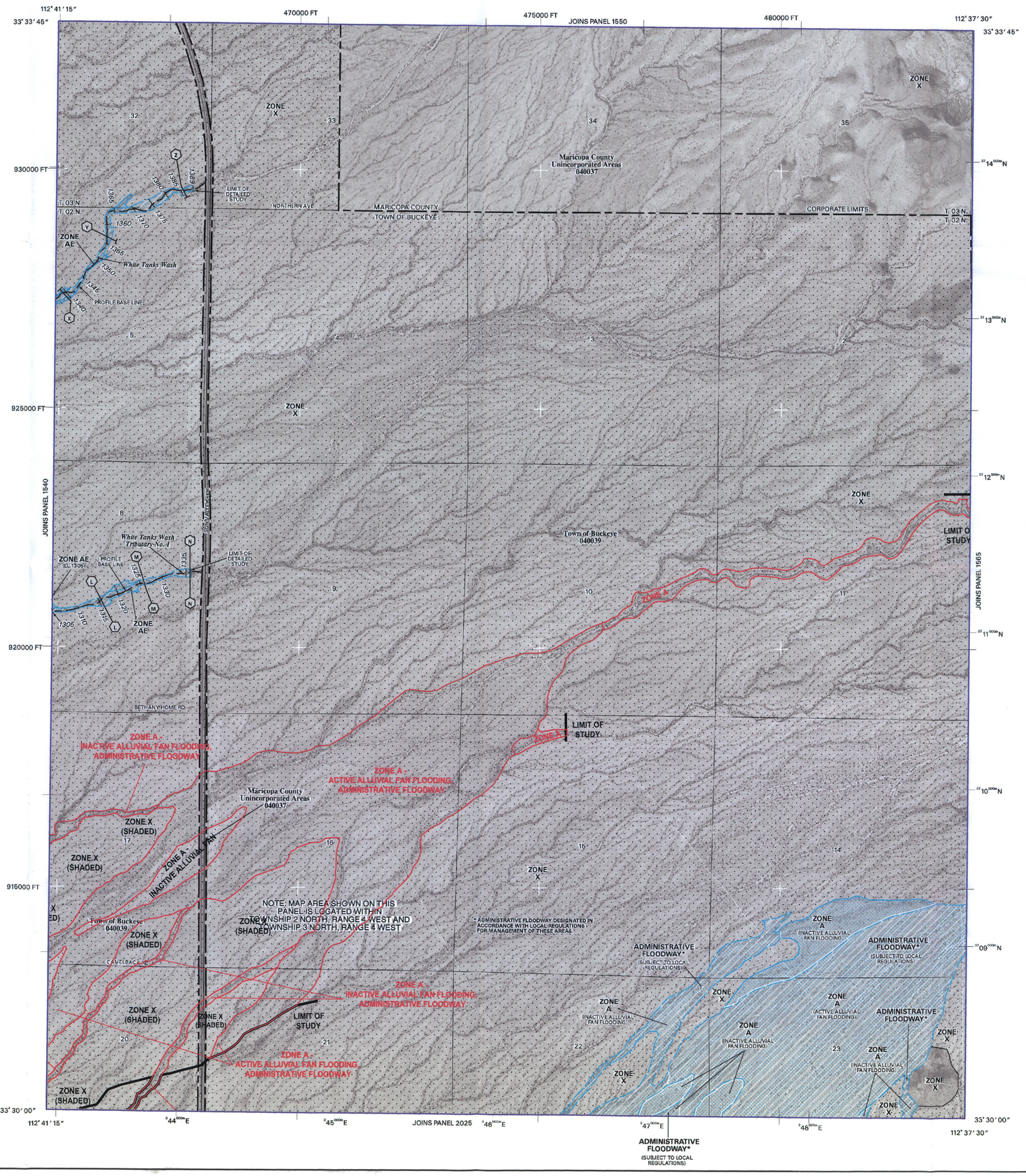

LEGEND

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

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

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

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

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

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

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

- 1% annual chance floodplain boundary
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- Floodway boundary
- Zone D boundary
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- 513 — Base Flood Elevation line and value; elevation in feet.*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet.*

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

4376000mE — 1000-meter Universal Transverse Mercator grid tick values zone 12.

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

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

M1.5 — River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
April 16, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 4, 1991, December 3, 1993, July 19, 2001

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

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500 0 1000 2000 FEET
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NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1545H

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

PANEL 1545 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BUCKEYE, TOWN OF	040039	1545	H
MARICOPA COUNTY	040037	1545	H

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

MAP NUMBER
04013C1545H
MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

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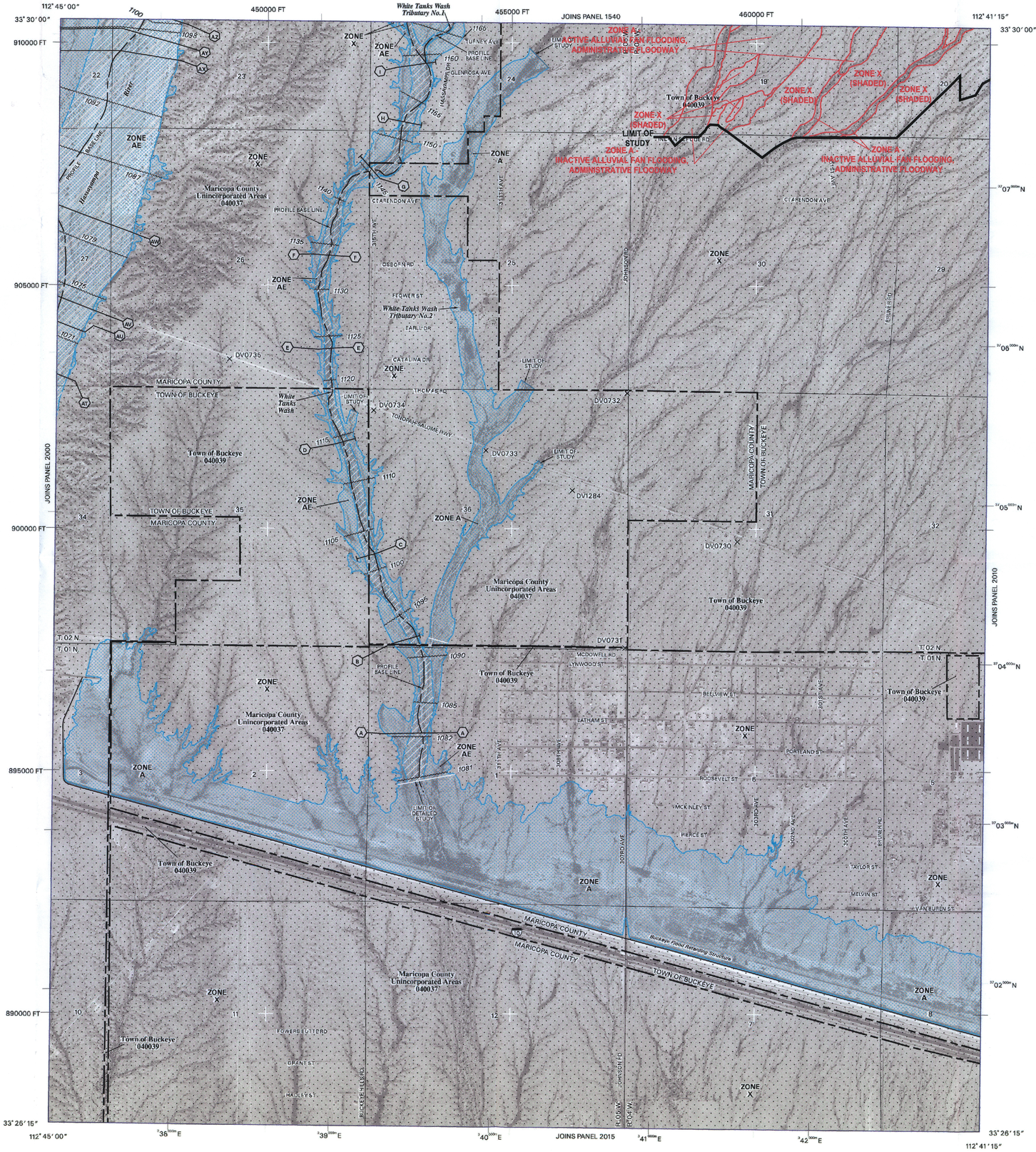

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NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2005H

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

PANEL 2005 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

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MARICOPA COUNTY	040037	2005	H

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MAP NUMBER
04013C2005H
MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

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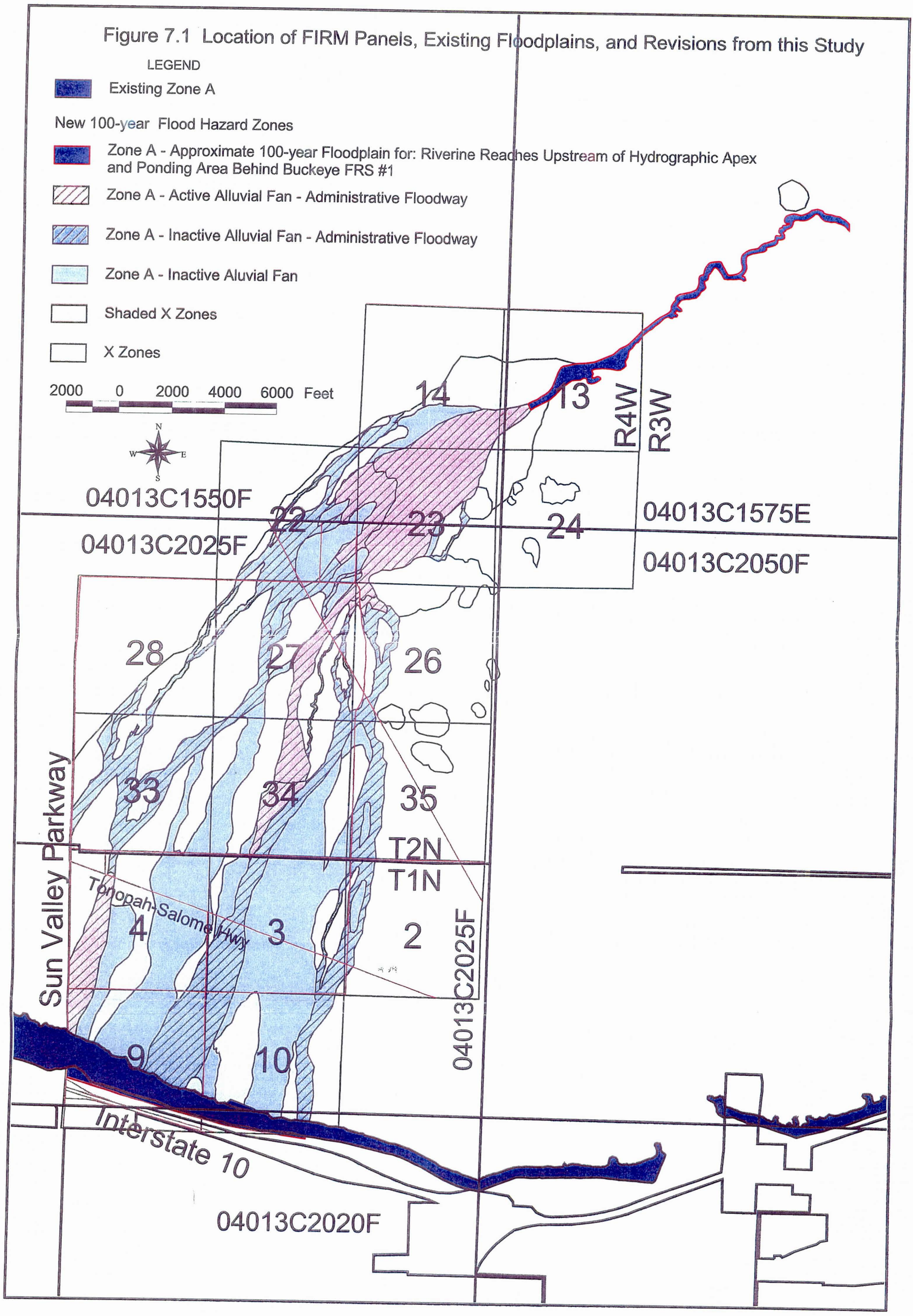
APPENDIX A
REFERENCES

A.1 Data collection summary

- *Piedmont Hazard Assessment Manual for Maricopa County* (Hjalmarson, 2003)
- *Guidelines and Specifications for Flood Hazard Mapping partners Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping* February 2002
- *Guidelines for Determining Flood Hazards on Alluvial Fans* FEMA 2000
- *Approximate Floodplain Delineation Study for White Tank Fan (Site 36)* prepared by Wood Patel & Associates, Inc. in association with JE Fuller Hydrology & Geomorphology.
- *Buckeye/Sun Valley Area Drainage Master Study* prepared for FCDMC by PBS & J Engineering (2005).
- *Surficial Geology around the White Tank Mountains, Central Arizona,* AZGS Open File Report 91-8 (1991), prepared by Field & Pearthree
- Geologic Mapping of Flood Hazards in Arizona: An Example from the White Tank Mountain, Maricopa County. AZGS Open File Report 91-10 (1992), prepared by Field & Pearthree
- Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona (Camp 1986).
- Topographic mapping and aerial photography prepared by Landata Airborne Systems of Irvine California, 12/16/00, 12/17/00, and 12/27/00.
- Survey ground control prepared by RBF Consulting of Phoenix, Arizona, North American Datum of 1983 (NAD 83)
- *Flood Hazards of Distributary-flow Areas in Southwestern Arizona:* U.S. Geological Survey Water Resources Investigations Report 91-4171 (1991) prepared by Hjalmarson and Kemma
- *White Tanks Wash Flood Insurance Study, FCD No. 90-64* prepared by Alpha Engineering Group, Inc. January 1996
- *Buckeye/Sun Valley Area Drainage Master Study Technical Data Notebook, Volume VI: Sediment Transport Studies, Final* July 2005 prepared by PBSJ
- *Final Report, Geomorphic Evaluation and Landform Stability Assessment Buckeye/Sun Valley Areas Drainage Master Study* prepared by Ayres Associates (May 2005).

Figure 7.1 Location of FIRM Panels, Existing Floodplains, and Revisions from this Study



APPENDIX B
GENERAL DOCUMENTATION AND CORRESPONDENCE

B.1 Special Problem Reports

There are no additional special problems to report for this study.

B.2 Contact (telephone) Report

B.3 Meeting Minutes or Reports

B.4 General Correspondence

DAVID EVANS
AND ASSOCIATES INC.

November 09, 2007

Kathryn Gross, CFM, PPM Division
Flood Control District of Maricopa County
2801 W. Durango Street
Phoenix, Arizona 85009

Phone: 602-506-1501
Fax: 62-506-4601

Re: FAC06-043 (Technical Data Notebook (TDN) for White Tanks Fan #38)

Dear Miss Gross,

This letter accompanies our re-submittal of the Technical Data Notebook for White Tanks Fan #38. Also included are response to comments which briefly notes how David Evans and Associates, Inc. (DEA) has responded to the April 19, 2007 version of comments from Mr. Jon Fuller of JE Fuller and the June 29, 2007 version of comments from you.

Please recall that per discussion in a September, 2007 meeting at Flood Control District of Maricopa County (FCDMC) attended by interested private party stake holders and FCDMC staff, DEA was to make re-submittal of the FAN 38 TDN without taking further action regarding any technical aspects of the TDN. FCDMC had noted in that meeting that the TDN was sufficient from a technical standpoint for them to sign the community overview and concurrence form.

Per FCDMC recommendations DEA has polished the report and made minor text and exhibit format revisions outlined in some of the comments made by FDCMC and JE Fuller. DEA's response to particular comments are listed in italics below either the FCDMC or JE Fuller comment.

Thank you for taking time to meet and review the various comments during the entire submittal process.

Sincerely,

Michael Weinberg, P.E.

DATE OF COMMENTS: June 29, 2007

TO: Lynn Thomas, P.E., CFM, Regulatory Division

FROM: Kathryn Gross, CFM, PPM Division

SUBJECT: White Tank Fan #38 Technical Data Notebook April 2007

Response to comments by DEA are Italics beneath original FCD comment.

General

1. The District will accept the delineation as proposed in the latest submittal; however, there are still discrepancies between presented data and the final delineation.

   This was discussed again at a meeting September, 2007 held at the FCD and reconfirmed that DEA would make clean-up type changes but no further technical updates or changes were necessary for FCD approval

2. The comments provided by JEFuller Hydrology and Geomorphology dated April 19, 2007 should be addressed and incorporated into the TDN. Since the delineation is being accepted by the District, JEF comments under 5.c.v do not need to be addressed.

   JE Fuller comments were not addressed as part of this re-submittal only clean-up items were updated.

3. The District still has some reservations on how the Stage 1 and Stage 2 information is presented. Specifics are discussed below.

   This was discussed again at a meeting September, 2007 held at the FCD and reconfirmed that DEA would make clean-up type changes but no further technical updates or changes were necessary for FCD approval

4. The District will require expanded discussions to be added to the text (including location figures) to specifically address why, in certain areas, the floodplain delineation is in discrepancy with the supporting documentation provided. The engineer has provided a general explanation in the latest submittal but more detail is necessary. A meeting to discuss the specific locations should be set up with District staff.

   Per meeting held September, 2007 at FCD no action or update taken by DEA on this item. FCD will still sign the community acknowledgement form.

5. The engineer needs to add an explanation regarding why delineation ends where it does (being submitted as separate LOMR).

   No action taken on this item. Report already notes that FAN 38 delineation stops where Tartesso Unit 2 LOMR submittal starts.

6. Regarding the geologic information presented, over the course of the analysis two surficial geology products were used. Please make sure that descriptions match the updated geology product relied upon for the delineation. The latest geologic study needs to be included in Appendix G.

   Latest Study is includedat the end of Appendix G

7. Figure and Exhibit numbering is not presented in order. If possible, the engineer should evaluate if it is possible to re-number/re-order the figures and exhibits.

   Figure and Exhibit numbering has evolved and changed as part of the review process; however, given amount of time required to re work numbering and update to report no changes were made to exhibit numbering.

8. with the next submittal the engineer should include a cd with all digital data in support of the TDN (shapes files, tiff files, HEC-RAS models, HEC-1 models).

   CD included with current submittal includes all noted above and pdf version of completed report.

Stage 1 Concerns

1. If possible, a different approach/organization of the Stage 1 information may aid in meeting the concerns of the District and JEF. This approach would focus more on the Ayres "Stage 1" delineation and then discuss the detailed "verification" of the Ayres information as it relates to the Stage 1 focusing specifically for Fan 38.

   No changes to report. Item not addressed per September, 2007 meeting at FCD.

2. The figures and exhibits supporting Stage 1 need to be revised to remove the internal floodplain designation boundaries and just focus on the outer polygon of the delineation. If possible, the figure/exhibit may need to be revised to show the true topographic apex of Fan 38 (present location identified on the maps is incorrect.)

   Exhibits updated.

3. The District would recommend adding specific discussions regarding the discrepancies in the Stage 1 delineation and supporting documentation. However, whether or not this is a necessary requirement for submittal to FEMA can be further discussed with District staff.

   No changes to report. Item not addressed per September, 2007 meeting at FCD.

Stage 2 Concerns

1. If possible, a different approach/organization of the Stage 2 information may aid in meeting the concerns of the District and JEF. This approach would focus more on the Ayres "Stage 2" delineation and then discuss the detailed "verification" of the Ayres information as it relates to the Stage 2 focusing specifically for Fan 38.

   No changes to report. Item not addressed per September, 2007 meeting at FCD.

2. The figures and exhibits supporting Stage 2 need to be revised to remove the internal floodplain designation boundaries and just focus on the outer polygon of the delineation.

   Exhibits updated.

3. The figures and exhibits need to be revised to only show the highly active stability zone as determined by Ayres. If the other zones remain the District will require a detailed discussion to be provided in the TDN explaining how those zones do not relate to alluvial fan instability.

   Exhibits updated.

4. The District would recommend adding specific discussions regarding the discrepancies in the Stage 2 delineation and supporting documentation. However, whether or not this is a necessary requirement for submittal to FEMA can be further discussed with District staff.

   No changes to report. Item not addressed per September, 2007 meeting at FCD.

Stage 3 Concerns

1. The delineation in its current form is accepted.
2. The District will require the specific locations where the final delineation is in discrepancy with the supporting documentation be discussed and presented in figures in the text.

   No changes to report. Item not addressed per September, 2007 meeting at FCD.

TDN Concerns

1. Section 2 FEMA Forms. Overview and Concurrence Form. The primary signature page is missing. This page includes the engineer's seal. This will need to be included with the next submittal. A signature page with Tim Phillip's information needs to be provided as well. Presently, two copies for the Town are included in the report.

   Report Updated. Primary signature page included with engineer's seal, and separate pages for FCD and Town of Buckeye included in report.

2. Section 5.9.1, page 5-6. Rephrase the sentence regarding the impacts of Sun Valley Parkway.

   Report updated.

3. Section 6B.4 first paragraph, middle of paragraph. Remove the reference to performing traditional methods to refine the alluvial fan delineation.

   Report updated.

4. Section 6B.5.1.4, page 6-22. The topographic apex location described is incorrect. The topographic apex is located near the mountain front.

   Report updated.

5. Section 6B5.1.5. Additional discussion should be added to the text describing where and why the engineer's alluvial fan limits or designation differ from the Ayres limits.

   No changes to report. Item not addressed per September, 2007 meeting at FCD.

6. Section 6B6. Section title indented too far.

   Report updated.

7. Section 6B.6.3.1, page 6-35, third paragraph. Could this paragraph be clarified? The last sentence could be removed.

   Report updated.

8. Section 6B.7.3 provides general discussion of the discrepancies between the final delineation and the supporting documentation. However, it is easy to get lost in the text regarding how the areas are being described. A map of key sites would aid in this discussion. This can be discussed further with the District.

   No changes to report.

9. Section 6B.4, page 6-39, third paragraph. The description of AFUFD needs to be revised. The UFD zone is a transitional zone where the degree of surface instability decreases in the downstream direction where flows are either distributed into stable channels or stable sheet flow conditions.

   No changes to report.

Figures and Exhibits

1. Figure 10. Is the hydrology exhibit in this format necessary? Consider removing the figure or revising it to perhaps provide more documentation for the apex flow rather than providing hydrologic information down-fan which is unnecessary for the geomorphic method. The floodplain zones should be removed and only show the fan limits. Remove the topographic apex from the sheet.

   Figure updated.

2. Figure 3. Sheets 2 and 3 should be removed since they are not necessary as part of the geomorphic approach.

   Figure updated.

3. Figure 4. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

   Figure updated.

4. Figure 5. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

   Figure updated.

5. Figure 6. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

   Figure updated.

6. Figure 9. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

   Figure updated.

7. Figure 8. Only show the outer fan boundary. Remove the floodplain zones within the delineation and add the highly unstable-active alluvial fan zone from Ayres on these sheets. Consider adding additional figures that compare the active zone with at least the geology data.

   Figure updated. No additional figures added.

8. Figure 7. Remove the thalwegs from this figure.

   Figure updated.

9. Annotated Panels. The Administrative Floodway note text does not match the exact language. Consider updating the text of the note.

   Exhibit updated.

10. Exhibit 1. HEC-RAS Cross-Sections. Needs to be revised. Decrease the size of the exhibit and only show the delineation upstream of the apex.

    Exhibit updated.

11. Exhibit 2. Soils Map. Hard to make out the Ayres landform zones which most likely is the purpose. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

    Exhibit updated.

12. Exhibit 3. Surficial Geology Map. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

    Exhibit updated.

13. Exhibit 4. Flood Hazard Map. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

    Exhibit updated.

14. Exhibit 5. Stage 3 with Aerial Photography. Can section lines and numbers be made to more easily readable?

    Exhibit not updated.

15. Exhibit 6. Stage 2 Map. Remove all stability categories except highly unstable-active alluvial fan. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

    Exhibit updated.

16. Exhibit 7. Stage 1 Map. Only show the outer fan boundary. Remove the floodplain zones within the delineation.

    Exhibit updated.

17. Exhibit 8. Hydrology Map. Is this exhibit necessary? Consider re-scaling and only showing hydrology for the above apex.

    Exhibit updated.

no more comments at this time.

DATE OF COMMENTS: April 19, 2007

TO: Kathryn Gross/FCDMC

FROM: Jon Fuller, PE, RG, CFM

SUBJECT: Review Comments, Site 38 Alluvial Fan Floodplain Delineation
David Evans and Associates, April 2007
On-Call Contract FCD2005C024 Task 4

General Comments

1. JEF Review. My review focused on the content of the report and the accuracy of the delineation. I did not scrutinize what I consider to be minor details such as exhibit legends, line work labels, map scales, north arrows, figure numbering, report citations, etc.

   Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

Specific Comments

2. FEMA Forms
   a. Overview & Concurrence Form. There appears to be some kind of hiccup concerning Section D of this form on pages 2-3 and 2-4.

   Forms updated.

3. Section 4: Hydrology – no comments.
4. Section 5: Hydraulics
   a. P.5-1. Typo in last line of Section 5.3.1. N=0.04 to 0.055.

   Report updated.

   b. HEC-RAS or Geomorphology? There are a number of places where the text or graphics imply that HEC-RAS ratings were used downstream of the hydrographic apex that could probably be cleaned up. These include the following:
      i. Figure 3. Sheets 2 and 3 are not needed since there are no longer any HEC-RAS cross sections shown on them.

      Report updated Sheets 2 and 3 removed.

ii. Section 5.5, 1st paragraph. The second and third sentences imply that HEC-RAS ratings were used to check capacity in areas where floodplains were delineated using geomorphic techniques. It is my understanding from reviewing Appendix E that HEC-RAS was only used upstream of the hydrographic apex, and that HEC-RAS was the sole basis of the delineation in that reach.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

iii. Section 6B.4. Geomorphic methodology was the "primary method."

Report updated.

c. Section 5.9.1. The third sentence described "six miles" of floodplain downstream of the apex. Section 1.5 describes 2.9 mi^2 of new floodplain. Section 6B.4 mentions 5.3 mi^2 of area downstream of the apex. Is that six miles of "thalwegs" or something else?

Report updated. Linear references are noted as Thalweg.

d. P. 5-6. Sun Valley Parkway. You might consider re-wording the first paragraph. It appears to imply that Sun Valley Parkway impacts the delineation but you have ignored the impact. Perhaps a better wording would be that the geomorphic modeling approach selected conservatively assumes minimal impact on alluvial fan flooding at Sun Valley Parkway.

Report updated

e. Section 5.9.2. The second sentence is incomplete.

Report updated.

5. Section 6B: Geomorphology

a. Stage 1 Delineation.

i. The Stage 1 Delineation map (Figure 9 & Exhibit 7) should show the landform boundaries. The Stage 3 delineation should not be shown on the Stage 1 map.

Figure 9 and Exhibit 7 updated.

ii. It would be helpful to remove the Stage 3 zones from Figures 4, 5, and 6 as well and show only the landform boundaries. Separate figures should be provided to show the AZGS and SCS mapping relative to the Stage 1, 2 and 3 delineations.

Figures updated.

iii. Why are Figures 7 (Stage 2 Map) and 8 (Stage 3 Map) numbered that way if they come after Figure 9 (Stage 1 Map) in the text?

No action taken.

iv. Table 6-2. The map units in Table 6-2 do not match those in Figures 5 or 6 and are missing some of those shown on Figure 5.

No action taken

v. P. 6-22. Just to clarify, the hydrographic apex is not necessarily the point where there is "physical evidence of flow bifurcation." The hydrographic apex is the point where flooding become unconfined (See PFHAM Section 2.1.3.3 for the definition). There may or may not be an actual channel bifurcation. The point is important where no physical channel split exists, but the bounding surfaces are geologically recent and therefore subject to avulsion. There are several such locations near secondary (inset) apexes on Fan 38.

No action taken.

vi. P. 6-23, 2nd paragraph. The piedmont plain is defined as "transition areas between mountains and base-level plains" (PFHAM, p. A1). Therefore, the description of the landform boundary being an adjacent fan or a piedmont plain is not adequate; neither is it consistent with the Ayres Stage 1 delineation.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

vii. Most importantly, if the delineation is based on the Ayres Stage 1 landform mapping, then a more detailed explanation of why the mapped floodplain extends outside the Ayres landform limits is warranted (see Figure A below). In addition, an explanation of why the downstream limit of study (at Tartesso) was selected and how that boundary related to the landform boundary. The landform is a broad geologic feature that extends beyond the DEA limit of study.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

b. Stage 2 Delineation.

i. The Stage 1 Delineation map (Figure 8 & Exhibit 6) should show the stable/unstable zones. The Stage 3 delineation should not be shown on the Stage 2 map.

Figure 8 and Exhibit 6 updated.

ii. It would be helpful to provide figures showing the SCS and AZGS mapping superimposed on the Stage 2 delineations.

No action taken.

iii. Figure 8. When I asked in the last review comment memorandum if the other Ayres stability zones (highly unstable, moderately unstable) be shown on the maps, I should have specified that some explanation be provided as well. There are apparent conflicts between areas Ayres mapped as "highly" or "moderately" unstable that are mapped by DEA as Shaded Zone X or AFZA, which imply stability (inactive fans). Keep in mind that FEMA does not recognize the classifications of "highly" or "moderately" unstable and is likely to interpret them as simply unstable (i.e., active).

Figure updated.

iv. Section 6B.6.2.4. Discussion of Stage 3 zones should be deferred to Section 6B.7.

No action taken.

v. P. 6-30. The meaning of the sentence in this paragraph is unclear.

No action taken.

vi. Section 6B.6.2.8. Since there is no specific information or results relating to the delineation provided in this section, I recommend that it be revised or deleted. If the sediment delivery rate is lower than the watersheds draining to the Buckeye FRS, what does that imply for the level of stability in Fan 38 relative to the fans to the south? Does this mean that Fan 38 is not active?

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

vii. Section 6B.6.3.1, 3rd paragraph. I believe the "portion between the hydrographic and hydrologic apices" should say "between the topographic and hydrographic apexes." However, note that he topographic apex shown on the Figures is not at the head of the landform as mapped, at the mountain front/piedmont intersection, or at the end of the HEC-RAS modeling reach. Some clarification is needed.

Report updated.

viii. There is not a 1:1 correspondence between the Ayres Stage 2 delineation and the DEA Stage 3 delineation, which may be problematic for FEMA reviewers. However, like the problems with the Stage 1 delineation, the real crux of the delineation is the Stage 3 delineation. Therefore, the District should consider focusing any remaining review iterations on the Stage 3 delineation.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

c. Stage 3 Delineation.

i. Section 6B.7.1.1, last sentence. DEA may wish to rethink the statement that development in AFHH and AFUFD zones requires a regional solution. There may be appropriate engineering solutions that are not regional in scope, and the statement may come back to haunt them during the CLOMR phase.

Report updated.

ii. It remains unclear to me how the DEA Stage 3 delineation can rely on and contradict the Ayres Stage 2 delineation. Areas of discrepancies were noted in the last round of review comments as well as in subsequent communications between submittals. There should be a 1:1 correspondence between Stage 2 unstable area boundaries (whatever type) and Stage 3 AFHH/AFUFD zones.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

iii. P. 6-39, 3rd paragraph. The first sentence states that some unstable zones were mapped as AAFF. Zone AAFF is reserved for stable flow corridors.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

iv. P. 6-39. 4th paragraph. Zone AFZA is described as "floodway" and as "throughflow corridors." Neither is correct.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

v. Specific comments on the Stage 3 delineation were provided digitally previously as a shapefile (JEF_line_comments_3-16-07 & JEF_comments_10-06.) The following comments have not been adequately addressed and remain points of disagreement between DEA and myself.

1. JEF_comments_10-06

    a. FID 6 – the floodplain limit matches neither the Ayres or AZGS zones, nor is there any apparent surficial or topographic difference between the AFUFD and the surface mapped as non-floodplain to the southeast.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

    b. FID 13 – this area has the same characteristics as the AFUFD zone downstream of the primary apex and is mapped as Qy1 by the AZGS, but is mapped by DEA as AFZA.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

    c. FID 18 – the AZGS maps this area as Qy1 and H1, i.e. active floodplain. DEA maps it as Shaded Zone X, i.e. not floodplain.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

2. JEF_line_comments_3-16-07

    a. FID 3. Same comment as (b) above.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

    b. FID 4. Same comment as (c) above.

Per September, 2007 meeting at FCD, JE Fuller comments were not addressed as part of this re-submittal.

B.5 Contract Documents

Attachment A
White Tank Mountain Piedmont Stage III Flood Hazard Assessment
Scope of Work

Overview

The Stage III Flood Hazard Assessment of the White Tank Mountain western piedmont will be completed using the methodologies outlined in the District's most recent version (April 2003) of the Piedmont Flood Hazard Assessment Manual (PFHAM). The PFHAM methodology consists of the following three stages of flood hazard delineation:

- Stage I – identification of the landform types (pediment, alluvial fan, relict fan, alluvial plain) within the piedmont area.
- Stage II – identification of stable and unstable areas on the piedmont
- Stage III – selection and application of appropriate method(s) for delineating the regulatory floodplains. Traditional engineering methods are typically applied in stable areas, and geomorphic methods are applied in unstable areas.

Stage I and II delineations are being completed by the District's Buckeye-Sun Valley ADMS consultant team and should be finalized by the end of November 2004. The District has required that an existing conditions (pre-development) Stage III delineation be completed by consultants working on development master plans prior to design of structural flood measures. The consultants will submit the existing conditions Stage III flood hazard delineation by fan(s) to FEMA at the time they submit their CLOMR package for their development affected by the particular fan(s) to FEMA. The District will provide the Stage I & II delineations in the TDN format acceptable to FEMA. The consultants will format the Stage III delineation for submittal to FEMA in a similar TDN format. District review and approval of the existing conditions Stage III delineation and CLOMR are required prior to submittal to FEMA.

The study area consists of the watercourses located downstream of the western slopes of the White Tank Mountains outside the White Tank Mountains Regional Park, and which intersect the following master planned communities:

- Elianto (Lennar, Coe & Van Loo)
- Tartesso (Stardust, David Evans & Assoc.)
- Sun Valley South (Communities Southwest, WRG)
- Sun Valley South (Pulte, CMX))

~~The floodplains of those watercourses that are part of the alluvial fan system and that intersect the communities listed~~ above will be delineated from the hydrographic apex to their confluence with another piedmont watercourse, mapped floodplain, the Hassayampa River, or the Buckeye Flood Retarding Structure (FRS). *(Reference to 0.25 sq. mile watersheds deleted per December 14, 2004 meeting minutes.)*

The District will provide the following base engineering information at no cost to the consultant team:

1. HEC-1 model and hydrologic modeling report from the Buckeye-Sun Valley ADMS. All hydrologic information used in the Stage III delineation will be obtained or derived from the District's HEC-1 model. Status: The ADMS HEC-1 model is in draft form pending final review by District, with only minor changes expected.
2. Stage I & II piedmont flood hazard assessment and all relevant documentation in a FEMA approved format prepared by Ayres & Associates for the Buckeye-Sun Valley ADMS. Status: Draft, pending review by District, with possible minor revisions and additional review possible. Stage III work will begin utilizing the Stage I & II data available to the consultants as of January 3. If significant changes are made to the data by the District subsequent to the start of the work, costs to modify or extend the analysis will be additional to this scope of work.
3. 2004 color digital orthophotography of the study area in workable file(s) size and quality.
4. Section corners in GIS format.
5. 10-foot contour interval digital topographic mapping of the study area.
6. Technical Documentation Notebook (TDN) and HIS layers for the Fan 36 Approximate Method Alluvial Fan Floodplain Delineation.

Scope of Work

1. Prepare Map of Watercourses to be Delineated. The consultant shall prepare a map of the watercourses to be delineated using the Stage III piedmont flood hazard assessment techniques. The map will show the thalweg of each watercourse, a designated name for each watercourse and watercourse segment (using District-approved naming conventions), and the boundaries of the development affected by each proposed delineation. The watercourse map will be submitted for District approval. A two- (2) week District review period will be provided prior to commencement of Stage III analysis. A GIS coverage of watercourses will be developed and marked final upon District approval.
2. Selection of Regulatory Discharges to be used for Floodplain Delineation. In general, the full apex discharge should be used for delineation of flood hazards within the limits of unstable portions of the piedmont. The method of joins and splits outlined in the PFHAM should be used to estimate peak discharges in stable distributary flow areas, not necessarily full fan discharges (for existing conditions). In areas downstream of unstable, active alluvial fans where the magnitude of the regulatory discharge is uncertain because of the uncertainty in flow distribution, the consultant will develop a method to estimate conservative peak discharges. The method may include probability-based techniques advanced by French (2001), simple double counting, or application of geomorphic mapping techniques that circumvent the need for determining a precise estimate of the regulatory discharge. In all cases, regulatory discharges should default to, or be consistent with, the values determined in the Buckeye Sun Valley ADMS, except within the unstable piedmont areas.
3. Assignment of Mapping Responsibility. The consultant team will meet to determine which watercourses will be delineated by each team member. Contiguous watercourses should be mapped by a single team member wherever possible.
4. The existing conditions floodplain delineation will consider the impacts of the existing culverts along Sun Valley Parkway.
5. Selection of Delineation Methodology for Stable Areas of the Piedmont. Approximate methods will be used to delineate the existing condition piedmont flood hazard zones in stable areas, as determined in the Stage I and II analyses. Approximate method delineations consist of using geomorphic verification of flood limits determined using single-section Manning's ratings (spaced at 1-3 sections per mile). Delineation of floodplains using detailed methods is not part of this scope. No hydraulically-defined floodways will be modeled as part of the existing conditions delineation due to the broad, shallow nature of the floodplains and likely modification of the floodplain by structural measures associated with future development. Administrative floodways will be defined as dictated by the PFHAM methodology.
6. Selection of Delineation Methodology for Unstable Areas of the Piedmont. Approximate methods will be used to delineate the existing condition piedmont flood hazard zones in unstable areas, as determined in the Stage I, II, and III analyses. Approximate method delineations consist of using geomorphic methods for unstable portions of the piedmont. Unstable areas, as defined in the PFHAM, are considered floodway areas.
7. Submittal of Draft Mapping Plan. A map showing the proposed discharges, recommended methodology, firm name, development boundaries (subdivision name), and schedule will be prepared for submittal to the District. Acceptance of the peak flows will be required prior to delineation. The District will commit to two (2) week review period if the consultant schedule is met, and if no more than two submittals are made within a two week period.
8. Floodplain Delineation. Floodplains will be delineated for the watercourses defined in Task 1 using the methodologies outlined in Tasks 5 and 6. The District's alluvial fan flood zones described in the PFHAM will be assigned to the floodplains delineated in Tasks 5 and 6, and will include designation of floodway.
9. Technical Documentation Notebook (TDN). The consultant will prepare a FEMA-submittal-ready TDN using the guidelines provided in State Standard 1-97 and FEMA guidelines, and the TDN modifications noted in the April 2003 version of the PFHAM.
10. District Review. The consultants will respond to District review comments and make revisions as needed.
11. Address one set of comments from both the District and FEMA on the Stage III analysis and resultant Zone A floodplains.
12. Modifications to the District's HEC-1 model are not included in this scope as the extent and scope of modifications cannot be determined until the model is delivered by the District.

13. Some reassignment of fans occurred with WRG analyzing Fan 6; CMX analyzing Fan 39; DEA analyzing Fans 7, 8, 12 and 38; and CVL analyzing Fan 37 as well as the remaining portion of Fan 36. The fan assignments were rearranged subsequent to the December 14th discussions to insure those firms with the most pressing schedules would be working on the fans that impacted their developments.

The outcome of discussions at the December 14, 2004 meeting with the Consultants and the District are also incorporated as a part of this scope to assist in the clarification of tasks and responsibilities.

Attachment C

Memorandum

DATE: January 18, 2005

TO: Kathryn Gross, MS, CFM/FCDMC

FROM: Jon Fuller, PE

RE: FCD2004 C025 Task 5 - White Tank Piedmont Stage III Analysis
12/14/04 Coordination Meeting Notes

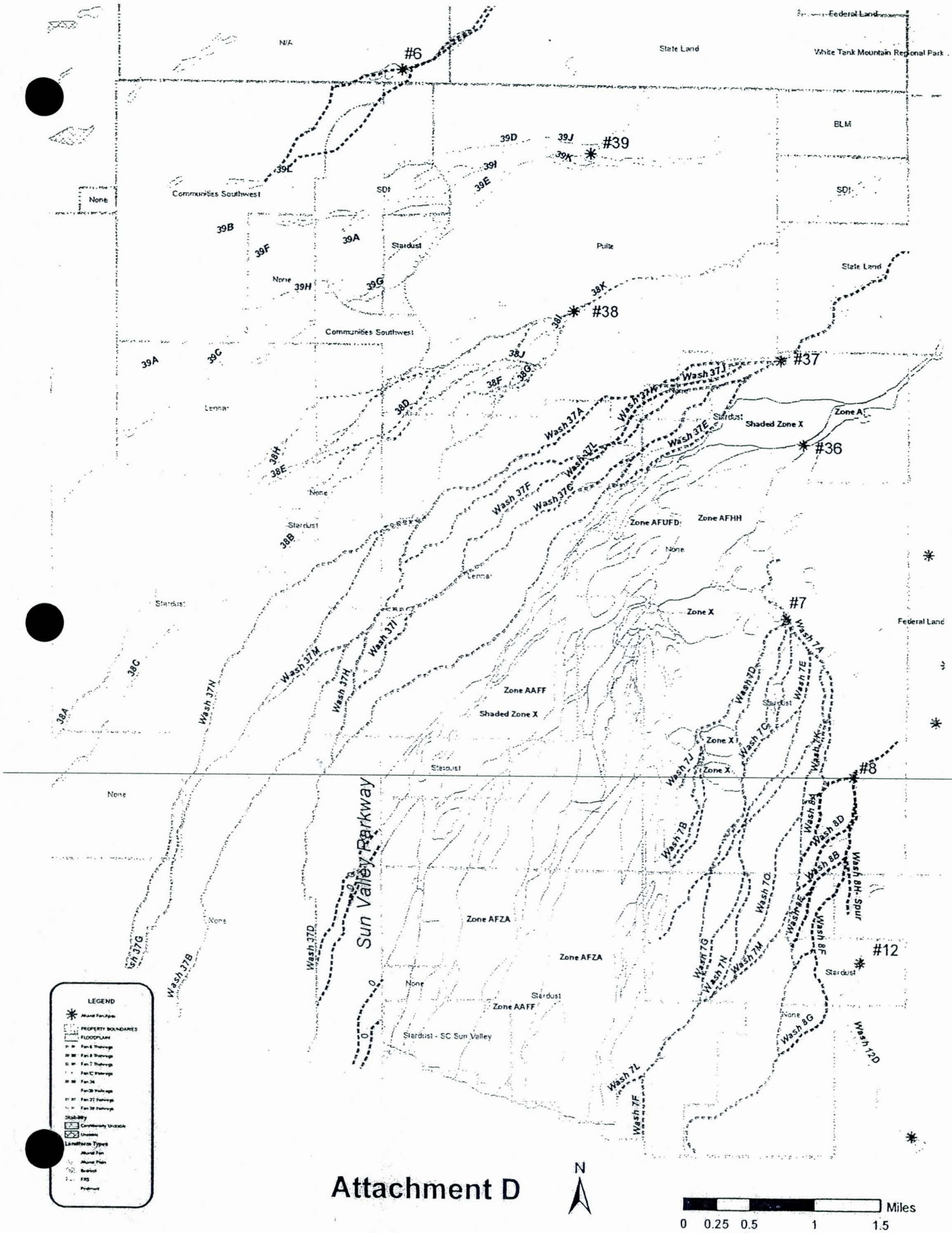
CC: Valerie Swick, PE/FCDMC
Developer Consultant Team

The following summarizes key issues and action items[1] discussed at the White Tank Piedmont Stage III Analysis coordination meeting held today at the District:

1. Sun Valley Parkway culvert analyses. Approximate method floodplain delineations will be completed considering the potential impacts of the existing culverts. A worst-case analysis may be required if the culverts divert flow from the natural flow path. Entellus, Inc. is completing a preliminary culvert analysis as part of the Sun Valley Buckeye ADMS. MCDOT had indicated in earlier meetings that Entellus was modifying their scope and budget ($8,000) to look at culvert flows along the entire length of the Sun Valley Parkway. This level of effort will likely not identify flow through these culverts that would provide guidance to a design approach to capacity or identify overtopping at individual locations. Jon Fuller indicated that approximate methods could be used as long as the assumptions are documented and are reasonable. Kathryn Gross and Jon Fuller both indicated that a well-documented conservative approach to identify the limits of the Zone A delineation would be the most successful path through FEMA.
2. Stage I-II Piedmont analysis.
    a. Ayres & Associates has not submitted the revised Stage I-II delineation. **Kathryn Gross will** check with Ayres to determine their estimated submittal date. Kathryn indicated that the draft Ayres delineation information could be used and she would provide the most recent shape files for the consultant team to work from so that they can begin the Stage 3 as soon as possible.
    b. The format of the Ayres report may or may not be directly compatible with the FEMA TDN format. **Jon Fuller will** review the draft Ayres Report to determine how and if it can be incorporated by simple reference in the consultant CLOMR TDNs. **Kathryn Gross will** provide a copy of the draft Ayres report to Jon Fuller. If simple reference is not feasible, **Valerie Swick will** obtain an cost estimate & schedule from Ayres to revise their report into the required format.
    c. The engineer of record for each CLOMR submittal will either accept the sealed Ayres delineation and report as submitted, or will be responsible for sealing any revisions.
    d. Additional guidance is available in FEMA guidelines, Appendix E & G, available at http://www.fema.gov/fhm/dl_cgs.shtm.

[1] Action items are denoted by bold, underlined text.

3. FEMA TDN.
   a. **Kathryn Gross will** provide the most recent revision of the PFHAM to the Developer Consultant Team (DCT) and Jon Fuller. The most recent revision is dated April, 2003.
   b. **Jon Fuller will** provide a PDF or MSWord version of the Fan 36 TDN for use a template for CLOMR submittals. Note that the Fan 36 TDN was an existing conditions analysis and did not include structural or CLOMR elements.
   c. Administrative floodways (existing conditions) will be delineated for the alluvial fan areas per the PFHAM guidelines.
4. Hydrology. Valerie Swick will determine when the revised HEC-1 model will be available from PBSJ. Valerie estimated that the HEC-1 model should be available by December 31, 2004. Valerie will distribute the HEC-1 file and associated GIS to the Developer Consultant Team (DCT) and Jon Fuller.
   a. Existing condition hydrologic modeling provided by the District from the Sun Valley Buckeye ADMS must be submitted with the CLOMR packages, per FEMA rules, though later submittals may be able to reference earlier submittals. **The consultants should** immediately review the hydrologic modeling when it is provided by the District. Errors found by the consultants will be corrected by the District. If no errors are identified by the consultants, but are later caught by FEMA reviewers after the CLOMR is submitted, errors will be corrected at the consultant/developer expense.
   b. The District HEC-1 model will contain peak discharge estimates at apexes of Fans 6, 7, 8 & 12.
   c. Discharge values other than those at the fan apexes and at junction points within the existing condition Sun Valley Buckeye ADMS HEC-1 model will be the responsibility of the consultants.
5. Additional Subdivisions. No new subdivisions/engineers need to be added to the group. Specifically, the Trillium or Sun Valley Projects will not be added to the study area.
6. Scope of Work. Each consultant should fine tune the generic scope of work to suit their individual site(s) and needs. Of particular concern is identifying the assumptions of what work products will be directly usable from the District's Sun Valley Buckeye ADMS consultant team (e.g., Ayres Stage I-II report, PBSJ HEC-1 model), and what level of modification of those products will be required. The 0.25 square mile drainage criteria referenced on page one of the generic scope may be deleted from individual scopes.
7. Next Steps. The Developer Consultant Team (DCT) will prepare the following:
   a. Map showing which fans are being delineated by which consultant. As it stands today, CMX will perform delineation on Fan 39, CVL will perform delineation for Fan 38, and DEA will perform Fan 37. Kathryn had identified additional fans (6, 7, 8, & 12) she would like to see addressed. These additional fans have not been assigned.
   b.
   c. Map showing discharges at concentration points obtained from the PBSJ HEC-1 model, and concentration points along subdivision boundaries where design discharges are needed.
   d. **Kathryn Gross will** email the powerpoint presentation used at today's meeting to the DCT.
   e. **Jon Fuller will** add Gary Freeman/CVL and Tami Norton/DEA to the distribution list.
   f. **Jon Fuller will** keep the DCT updated on bibliographic findings relating to structural measures on alluvial fans.



Attachment D

B.6 Public Notification

Flood Control District
of Maricopa County

Board of Directors
Fulton Brock, District 1
Don Stapley, District 2
Andrew Kunasek, District 3
Max Wilson, District 4
Mary Rose Wilcox, District 5

www.fcd.maricopa.gov
2801 West Durango Street
Phoenix, Arizona 85009
Phone: 602-506-1501
Fax: 602-506-4601
TT: 602-505-5897

WHITE TANK MOUNTAIN ALLUVIAL FAN No. 38
FLOODPLAIN DELINEATION STUDY

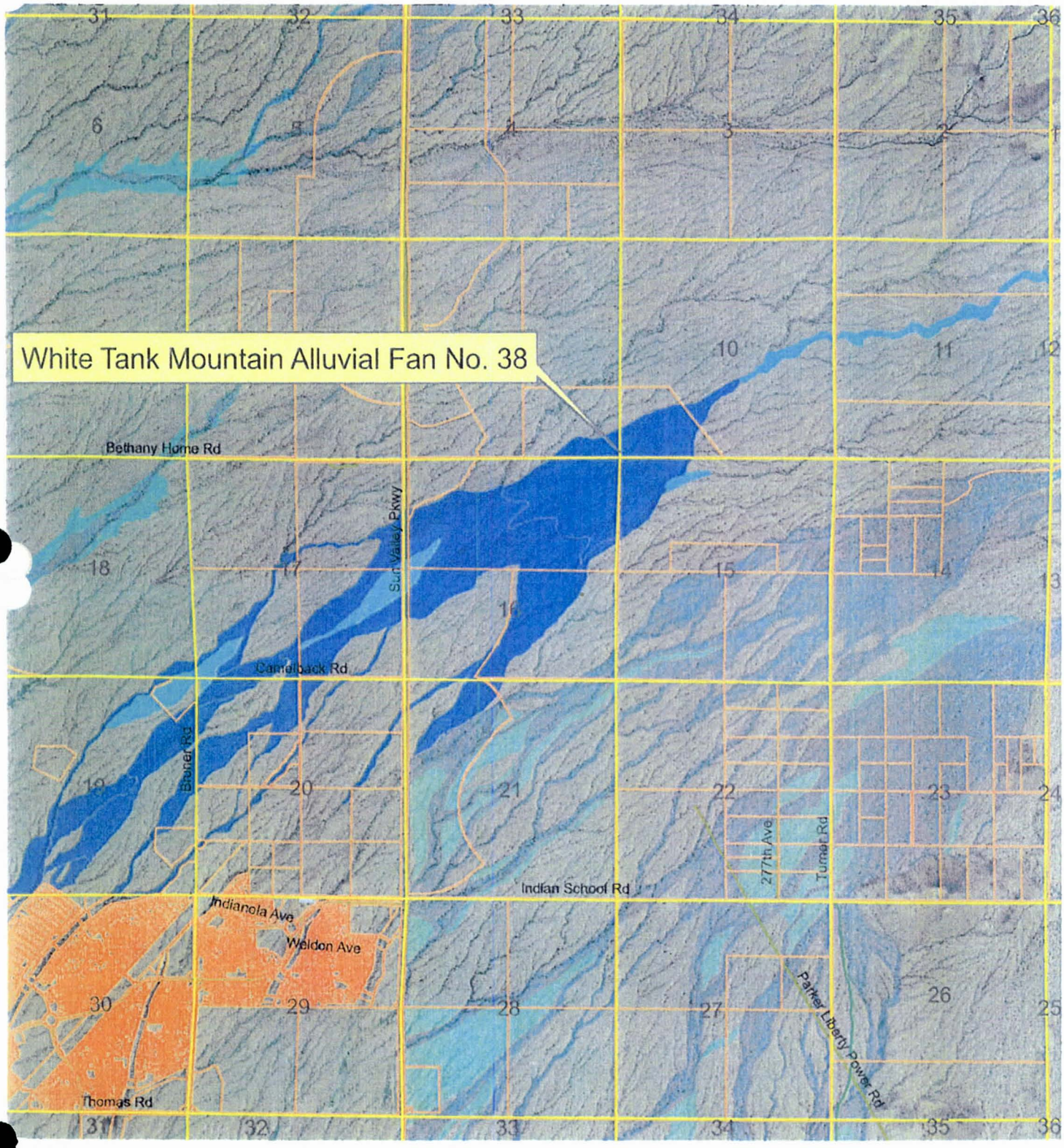
Based on property ownership records, your property is near or within a recently completed floodplain delineation study for White Tank Mountain Alluvial Fan No. 38. The delineation study area is generally bounded by Bethany Home Road on the north and Indian School Road on the south, Johnson Road on the west, and Turner Road on the east.

The delineation resulted in 2.9 square miles of Approximate Zone A Alluvial Fan floodplains (shown in light blue on attached exhibit) and Approximate Zone A Alluvial Fan Administrative floodways (shown in dark blue on attached exhibit). Alluvial fans are fan-shaped deposits of sediment and debris formed by the flow of water and sediment over time. Alluvial fan flooding is a special flood hazard area that occurs on alluvial fans and is characterized by unstable channels and changeable flow patterns. A Zone A floodplain is subject to inundation by a 100-year event (an event with a one-percent chance of occurring in a given year) and mandatory flood insurance requirements may apply for structures located within the floodplain.

The delineation study will be submitted to the Federal Emergency Management Agency (FEMA) for adoption. The approval process may take one year or longer. Affected homeowners will not be required to pay flood insurance until after the floodplain is adopted by FEMA and the Flood Insurance Rate Maps are updated. The new floodplain delineation will also be used to regulate future development in the area.

Specific information about the White Tank Mountain Alluvial Fan No. 38 floodplain delineation study can be obtained by contacting Ms. Lynn Thomas of the Floodplain Management and Services Division at (602) 506-4779 or by email at lmt@mail.maricopa .gov; or Ms. Kathryn Gross of the Planning and Project Management Division at (602) 506-4837 or by email at kag@mail.maricopa.gov.

White Tank Mountain Alluvial Fan No. 38
Approximate Zone A Alluvial Fan Floodplains and Administrative Floodways



N
W E
S

Zone A - Alluvial Fan Floodplains are shown in light blue
Zone A - Alluvial Fan Administrative Floodways are shown in dark blue

Legend

APN	OWN_ADDR1	OWN_ADDR2	OWN_CITY	OWN_STATE	OWN_ZIP	PROP_ADDR1	PROP_SUITE	PROP_CITY	PROP_ZIP
50404005F	2525 E BROADWAY BLVD STE 111		TUCSON	AZ	85716	31906 W CAMELBACK RD			85396
50404006E	4963 E ROCKRIDGE RD		PHOENIX	AZ	85018	31906 W CAMELBACK RD			85396
50406019A	21050 N PIMA RD STE 100		SCOTTSDALE	AZ	85255	31906 W CAMELBACK RD			85396
50404002D	5275 S DURANGO DR		LAS VEGAS	NV	89113				
50404002C	5275 S DURANGO DR		LAS VEGAS	NV	89113				
50404006C	21944 N 69TH DR		GLENDALE	AZ	85310	31906 W CAMELBACK RD			85396
50406020C	10025 E DYNAMITE BLVD STE 140		SCOTTSDALE	AZ	85252	31906 W CAMELBACK RD			85396
50404007D	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253				
50404007F	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253				
50404007B	2865 S JONES BLVD		LAS VEGAS	NV	89146	31906 W CAMELBACK RD			85396
50404014B	1855 W BASELINE RD 101		MESA	AZ	85202	31906 W CAMELBACK RD			85396
50404003A	1855 W BASELINE RD 101		MESA	AZ	85202	31906 W CAMELBACK RD			85396
50404003B	1855 W BASELINE RD 101		MESA	AZ	85202	31906 W CAMELBACK RD			85396
50406020E	1150 W GROVE PARKWAY NO 105		TEMPE	AZ	85283	31906 W CAMELBACK RD			85396
50406019B	1150 W GROVE PARKWAY NO 105		TEMPE	AZ	85283	31906 W CAMELBACK RD			85396
50473012C	4801 E WASHINGTON 100		PHOENIX	AZ	85034	31524 W YUMA RD			85326
50473012F	4801 E WASHINGTON 100		PHOENIX	AZ	85034	31524 W YUMA RD			85326
50473009C	4801 E WASHINGTON 100		PHOENIX	AZ	85034	31524 W YUMA RD			85326
50476022	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476025	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476024	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476028	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476029	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476027	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476021	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476023	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50476026	4250 N DRINKWATER BLVD STE 360		SCOTTSDALE	AZ	85251	31524 W YUMA RD			85326
50404005D	4334 E BOULDER RIDGE		PHOENIX	AZ	85044	31906 W CAMELBACK RD			85396
50404007E	4334 E BOULDER RIDGE		PHOENIX	AZ	85044				
50404005J	4334 E BOULDER RIDGE		PHOENIX	AZ	85044	31906 W CAMELBACK RD			85396
50476470	830 W ELLIOT RD		GILBERT	AZ	85233	31524 W YUMA RD			85326
50476471	830 W ELLIOT RD		GILBERT	AZ	85233	31524 W YUMA RD			85326
50476469	830 W ELLIOT RD		GILBERT	AZ	85233	31524 W YUMA RD			85326
50405009D	15111 N PIMA RD STE 100		SCOTTSDALE	AZ	85260	31906 W CAMELBACK RD			85396
50473011A	15111 N PIMA RD STE 100		SCOTTSDALE	AZ	85260	31524 W YUMA RD			85326
50406020D	15111 N PIMA RD STE 100		SCOTTSDALE	AZ	85260	31906 W CAMELBACK RD			85396
50404005E	5275 S DURANGO RD		LAS VEGAS	NV	89113	31906 W CAMELBACK RD			85396
50404017E	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253	31906 W CAMELBACK RD			85396
50404019B	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253	31906 W CAMELBACK RD			85396
50407005B	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253	31906 W CAMELBACK RD			85396
50404004A	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253	31906 W CAMELBACK RD			85396
50407003R	6730 N SCOTTSDALE RD STE 230		SCOTTSDALE	AZ	85253	31906 W CAMELBACK RD			85396
50477466	6303 S RURAL RD STE 3		TEMPE	AZ	85283	31524 W YUMA RD			85326
50477475	6303 S RURAL RD STE 3		TEMPE	AZ	85283	31524 W YUMA RD			85326
50477465	6303 S RURAL RD STE 3		TEMPE	AZ	85283	31524 W YUMA RD			85326
50477476	6303 S RURAL RD STE 3		TEMPE	AZ	85283	31524 W YUMA RD			85326
50404016A	16611 N 91ST ST STE 105		SCOTTSDALE	AZ	85260	31906 W CAMELBACK RD			85396

B.7 FEMA Correspondence

APPENDIX C
SURVEY FIELD NOTES

C.1 Survey field notes for aerial mapping control

No aerial mapping for topography was required as part of this study.

C.2 Survey field notes for hydrologic modeling

No additional field survey was required for the hydrologic modeling

C.3 Survey field notes for hydraulic modeling

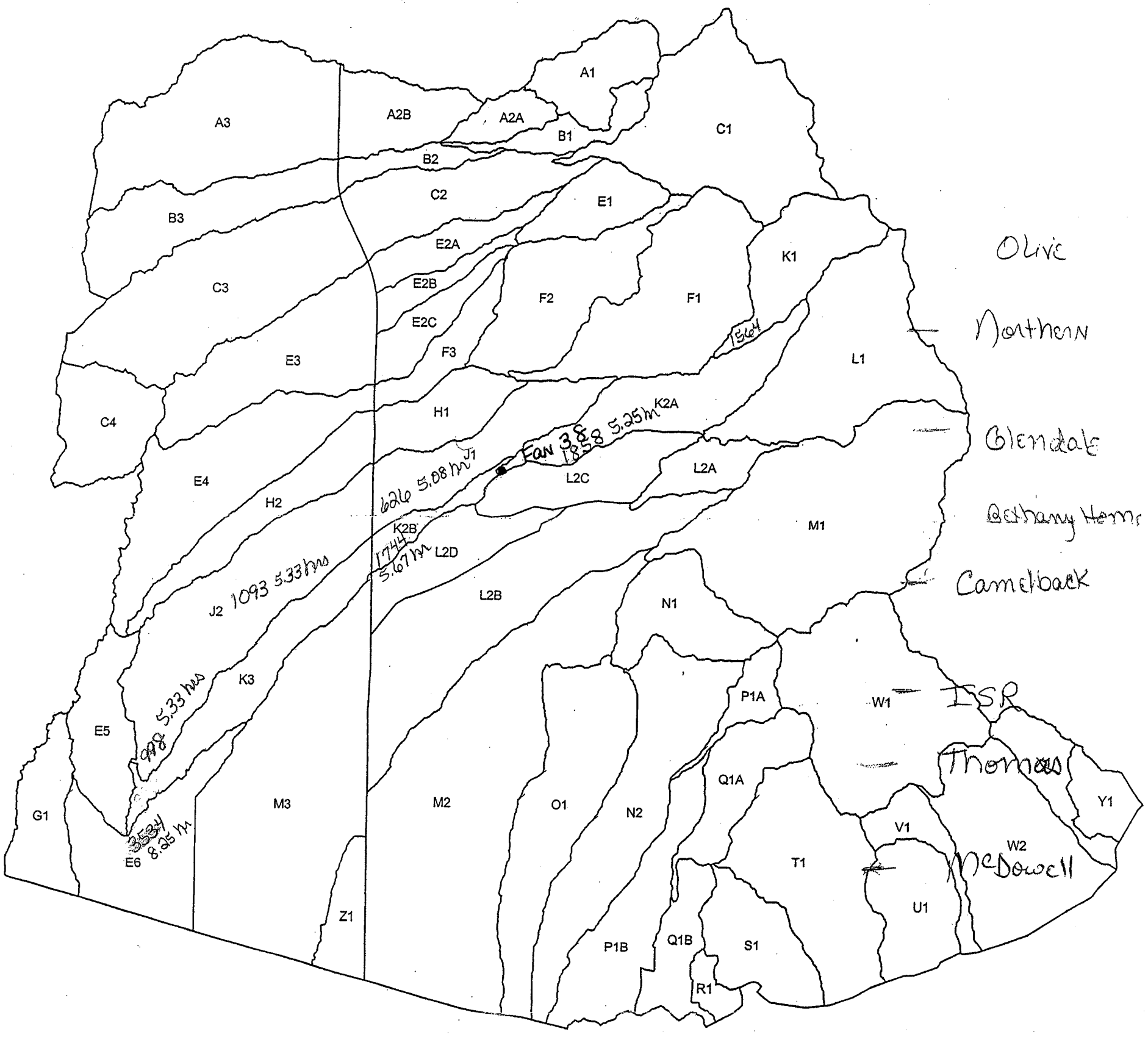
No additional field survey was required for the hydraulic modeling.

APPENDIX D
HYDROLOGIC ANALYSES SUPPORTING DOCUMENTATION
FOR REFERENCE ONLY

Buckeye/Sun Valley Area Drainage Master Study
Sub-basins E-K
HEC-1 Model
100 year, 6 hour

Buckeye SunValley ADMS 4/27/05

UPDATED HEC-1 BOUNDARIES



```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              MAY  1991                *
*            VERSION 4.0.1E             *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
```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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET             *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX          XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT PAGE 1

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LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

   1          ID  Buckeye/Sun Valley ADMS - May 2005
   2          ID  Michael Baker Jr., Inc. - Modeler: Jacob Lesue
   3          ID  basins E-K with Aluvial Fan updates
   4          ID  100-year 6-hour
   5          ID  Existing Conditions
   6          ID  Area 3 - Sub-basins E-K (Aluvial Fan updates)
   7          ID  Rainfall Loss Method - Green & Ampt
   8          ID  Unit Hydrograph Method - FCDMC S-Graph
   9          ID  Channel Routing Method - Normal Depth
  10          ID  Land Use - FCDMC GIS Data: mag_landuse (2000)
  11          ID  Soil Data - USDA SCS Soil Survey (1972 & 1981)
  12          ID  Units - L(mi)   Lca(mi)   S(ft/mi)   LAG(min)
              *DIAGRAM
  13          IT       5 01JAN94       0    2000
  14          IO       3
  15          IN      15 01JAN94       0
  16          JD    3.23    0.01
              * 6-hour distribution, pattern 1.0
  17          PC     0.0   0.008   0.016   0.025   0.033   0.041    0.05   0.058   0.066   0.074
  18          PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931    0.95
  19          PC   0.962   0.972   0.983   0.991     1.0
  20          IN      15 01JAN94       0
  21          JD   3.211     0.5
              * 6-hour distribution, pattern 1.0
  22          PC     0.0   0.008   0.016   0.025   0.033   0.041    0.05   0.058   0.066   0.074
  23          PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931    0.95
  24          PC   0.962   0.972   0.983   0.991     1.0
  25          IN      15 01JAN94       0
  26          JD   3.188     1.0
              * 6-hour distribution, pattern 1.4
  27          PC     0.0  0.0084   0.016   0.025  0.0334  0.0414  0.0504  0.0584  0.0664  0.0748
  28          PC   0.087  0.0994  0.1188   0.148  0.2304  0.4067  0.7778  0.8813  0.9186  0.9452
  29          PC  0.9572  0.9684  0.9798  0.9898     1.0
  30          IN      15 01JAN94       0
  31          JD   3.101     5.0
              * 6-hour distribution, pattern 2.3
  32          PC     0.0   0.011  0.0173  0.0267  0.0387   0.049  0.0593  0.0693  0.0797  0.0903
  33          PC   0.103  0.1173  0.1383  0.1827  0.2693   0.458   0.686  0.8233  0.8893  0.9293
  34          PC  0.9487   0.962  0.9743  0.9877     1.0
  35          IN      15 01JAN94       0
  36          JD   3.036    10.0
              * 6-hour distribution, pattern 2.7
  37          PC     0.0  0.0134  0.0189  0.0287  0.0443  0.0574  0.0694  0.0818  0.0949  0.1076
  38          PC  0.1223  0.1382  0.1604  0.2063  0.2902  0.4664  0.6764  0.8069  0.8765  0.9189
  39          PC  0.9471  0.9608  0.9735  0.9873     1.0
  40          IN      15 01JAN94       0
  41          JD   2.939    20.0
              * 6-hour distribution, pattern 3.1
  42          PC     0.0  0.0158   0.022  0.0329  0.0511  0.0663  0.0799  0.0948  0.1102  0.1246
  43          PC   0.141  0.1587  0.1828    0.23  0.3122  0.4758  0.6684  0.7929  0.8643  0.9087
  44          PC  0.9434   0.958  0.9718  0.9863     1.0
  45          IN      15 01JAN94       0
  46          JD   2.875    30.0
              * 6-hour distribution, pattern 3.4
  47          PC     0.0  0.0172  0.0256  0.0378  0.0565  0.0719  0.0868   0.103  0.1191  0.1342
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HEC-1 INPUT PAGE 2

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LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  48          PC  0.1513  0.1702  0.1961  0.2439  0.3263  0.4824  0.6655  0.7875   0.858  0.9031
  49          PC   0.939  0.9544  0.9697  0.9851     1.0
  50          IN      15 01JAN94       0
  51          JD    2.81    40.0
              * 6-hour distribution, pattern 3.5
  52          PC     0.0  0.0182  0.0281  0.0413  0.0604  0.0759  0.0916  0.1088  0.1254   0.141
  53          PC  0.1586  0.1783  0.2056  0.2537  0.3362   0.487  0.6636  0.7836  0.8535  0.8991
  54          PC  0.9358  0.9519  0.9682  0.9843     1.0
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IN      15 01JAN94       0
JD   2.584   100.0
* 6-hour distribution, pattern 4.1
PC     0.0  0.0212  0.0355  0.0515  0.0715  0.0877   0.106  0.1261  0.1443  0.1618
PC  0.1812  0.2036  0.2347  0.2837   0.367   0.501  0.6559  0.7704  0.8392  0.8864
PC  0.9256   0.944  0.9633  0.9817     1.0

KK      G1
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=2.38     Lca=1.08     S=33.76     Kn=0.045     LAG=47.1
KM   S-GRAPH TYPE=DES RNGLND
KO       0       0     0.0       1      22
BA   1.119
LG    0.35    0.35    4.68   0.299     0.0
* G1
UI     0.0   80.16   80.16  213.17  354.95   484.3  602.66  698.84  750.22  768.22
UI  735.63  666.98  553.71  458.04  381.89  318.75  263.34   222.2  176.93  151.12
UI  124.96  103.28   84.96   70.59   54.87   54.87   43.58   19.51   19.51   19.51
UI   19.51   19.51   19.51   19.51   19.51     0.0

KK      1R   CNAME       G
KO       0       0     0.0       0      22
RN      1R

KK      K1
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=3.23     Lca=1.84     S=681.00     Kn=0.050     LAG=40.4
KM   S-GRAPH TYPE=PHX MNT
KO       0       0     0.0       1      22
BA   1.543
LG   0.112   0.255   4.365   0.366  21.277
* K1
UI     0.0  129.88  168.84  442.11  706.31  896.38 1061.91 1457.77 1111.25  821.11
UI  726.82  641.11  561.31  488.34  403.67  331.29  304.06  271.41  213.37  169.75
UI  154.58  142.25  108.11   99.57   85.17   63.56   63.56   63.56   38.81   24.89
UI   24.89   24.89   24.89   24.89   24.89   24.89   24.89     0.0

KK  K1-K2A   CNAME    K2AR
KO       0       0     0.0       0      22
RS       9    FLOW     0.0     0.0
RC    0.05   0.048   0.0519434.11   0.017     0.0
* K1-K2A
RX     0.0    20.0    55.0    85.0   235.0   259.0   289.0   309.0
RY    22.0    21.0    20.0    10.0    10.0    20.0    21.0    22.0
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HEC-1 INPUT PAGE 3

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

KK      K2A
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=5.29     Lca=2.72     S=126.78     Kn=0.055     LAG=87.2
KM   S-GRAPH TYPE=DES RNGLND
KO       0       0     0.0       1      22
BA   1.949
LG   0.341   0.347   4.907   0.278   1.288
* K2A
UI     0.0   75.43   75.43   75.43   75.43  216.57  263.63  333.08  400.43  470.31
UI  527.14  583.18  638.37  674.27  692.72  722.84  722.84  721.83  689.53  671.99
UI  627.55  556.08  517.43  456.81  416.13  375.78  341.84  309.53  280.25  253.48
UI  229.53  206.53  183.27  168.43  146.97   142.2  123.74  115.66  112.61   79.95
UI   79.95   79.95   71.18   51.63   51.63   51.63   51.63   51.63   36.22   18.36
UI   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36
UI   18.36   18.36   18.36   18.36     0.0

KK    K2BR   CNAME  K2A-2B
KO       0       0     0.0       0      22
HC       2

KK  K2A-2B   CNAME    K2BR
KO       0       0     0.0       0      22
RS       6    FLOW     0.0     0.0
RC    0.05   0.048   0.0510602.71   0.0115     0.0
* K2A-K2B
RX     0.0    20.0    55.0    85.0   235.0   259.0   289.0   309.0
RY    22.0    21.0    20.0    10.0    10.0    20.0    21.0    22.0

KK      K2B
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=2.01     Lca=0.83     S=60.78     Kn=0.055     LAG=43.5
KM   S-GRAPH TYPE=DES RNGLND
KO       0       0     0.0       1      22
BA   0.416
LG    0.35    0.35   2.708   0.961     0.0
* K2B
UI     0.0   32.57   33.92  104.78  161.25  216.88  267.55  297.02  312.16  302.35
UI  276.72  225.58  183.68  151.33  123.31   99.92    81.2   65.94    55.1   45.93
UI   34.52    29.7    22.3    22.3   15.04    7.93    7.93    7.93    7.93    7.93
UI    7.93    7.93     0.0

KK    K3RA   CNAME  K2B-K3
KO       0       0     0.0       0      22
HC       2

KK  K2B-K3   CNAME    K3RA
KO       0       0     0.0       0      22
RS      19    FLOW     0.0     0.0
RC    0.05   0.048   0.0525950.11   0.0084     0.0
* K2B-K3
RX     0.0   390.0   490.0   502.0   520.0   532.0   632.0  1022.0
RY    20.0    14.5    11.5    10.0    10.0    11.5    14.5    20.0
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← Fan 38

HEC-1 INPUT PAGE 4

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
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134          KK     E2A
135          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
136          KM   L=2.90      Lca=1.20      S=100.83      Kn=0.055      LAG=52.4
137          KM   S-GRAPH TYPE=DES RNGLND
138          KO       0         0     0.0         1       22
139          BA   0.797
140          LG    0.35    0.38     5.6    0.21     0.0
             * E2A
141          UI     0.0    51.6    51.6  110.43  196.83  277.44  347.94  413.76  460.03   489.1
142          UI  494.55   472.6  438.77  369.81  310.92  263.99  224.69  190.62  158.99  135.09
143          UI  112.23   97.29   80.97   70.86    54.7   53.12   35.32   35.32   35.32   21.96
144          UI   12.56   12.56   12.56   12.56   12.56   12.56   12.56   12.56   12.56     0.0

145          KK  E2A-E3   CNAME    E3RA
146          KO       0         0     0.0         0       22
147          RS      13      FLOW     0.0       0.0
148          RC   0.052    0.046  0.05219626.03  0.0093     0.0
             * E2A-E3
149          RX     0.0    133.0   173.0   213.0   223.0   263.0   303.0   403.0
150          RY    22.0     17.0    14.0    10.0    10.0    15.0    18.0    22.0

151          KK     E2C
152          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
153          KM   L=2.38      Lca=1.01      S=92.90      Kn=0.055      LAG=46.0
154          KM   S-GRAPH TYPE=DES RNGLND
155          KO       0         0     0.0         1       22
156          BA   0.716
157          LG    0.35    0.35   4.343   0.357     0.0
             * E2C
158          UI     0.0   55.12   55.12  154.82  250.83  342.33  421.22  487.29  519.92  527.55
159          UI  498.61  439.15  363.83   300.5  250.15  205.65  169.32  139.69  114.34   97.44
160          UI   84.51   59.64   58.42   38.62   37.73   37.73   16.68   13.41   13.41   13.41
161          UI   13.41   13.41   13.41   13.41     0.0

162          KK  E2C-E3   CNAME    E3RC
163          KO       0         0     0.0         0       22
164          RS      12      FLOW     0.0       0.0
165          RC   0.052    0.046   0.052 17293.5  0.0082     0.0
             * E2C-E3
166          RX     0.0    133.0   173.0   213.0   223.0   263.0   303.0   403.0
167          RY    22.0     17.0    14.0    10.0    10.0    15.0    18.0    22.0

168          KK      E1
169          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
170          KM   L=2.51      Lca=1.13      S=178.34      Kn=0.055      LAG=43.3
171          KM   S-GRAPH TYPE=PHX MNT
172          KO       0         0     0.0         1       22
173          BA   0.956
174          LG    0.35   0.378   5.377   0.222    0.69
             * E1
175          UI     0.0   74.86   77.94  239.17  368.29  486.24  570.86   714.2  832.85  536.73
176          UI  451.19  405.28  360.54  317.72  278.78  233.78  192.26  176.85  160.99  130.76
177          UI  107.56   95.43   81.98   76.82   57.39   57.39   44.31   36.63   36.63   36.63
178          UI   23.53   14.35   14.35   14.35   14.35   14.35   14.35   14.35   14.35   14.35
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LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

179          UI     0.0

180          KK  E1-E2B   CNAME     E2R
181          KO       0         0     0.0         0       22
182          RS       5      FLOW     0.0       0.0
183          RC    0.05    0.047   0.04610992.72   0.016     0.0
             * E1-E2B
184          RX     0.0    65.0   140.0   170.0   185.0   200.0   270.0   340.0
185          RY    24.0    21.0    17.0    10.0    10.0    14.0    18.0    22.0

186          KK     E2B
187          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
188          KM   L=2.08      Lca=1.07      S=87.98      Kn=0.055      LAG=45.2
189          KM   S-GRAPH TYPE=DES RNGLND
190          KO       0         0     0.0         1       22
191          BA   0.466
192          LG    0.35    0.38     5.6    0.21     0.0
             * E2B
193          UI     0.0    32.1    32.1   94.97  150.03  204.82  250.49  285.24   306.5  304.84
194          UI  285.73  244.25   203.0  165.28   137.3  113.17   92.95    75.5   62.33   52.17
195          UI   43.31   34.02   28.77   21.97   21.97   16.14    7.81    7.81    7.81    7.81
196          UI    7.81    7.81    7.81    7.81

197          KK    E3RB    CNAME  E2B-E3
198          KO       0         0     0.0         0       22
199          HC       2

200          KK  E2B-E3   CNAME    E3RB
201          KO       0         0     0.0         0       22
202          RS      11      FLOW     0.0       0.0
203          RC   0.052    0.046   0.05219617.83  0.0088     0.0
             * E2B-E3
204          RX     0.0   133.0   173.0   213.0   223.0   263.0   303.0   403.0
205          RY    22.0    17.0    14.0    10.0    10.0    15.0    18.0    22.0

206          KK      E3
207          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
208          KM   L=3.87      Lca=1.99      S=49.65      Kn=0.050      LAG=74.5
209          KM   S-GRAPH TYPE=DES RNGLND
210          KO       0         0     0.0         1       22
211          BA   2.488
212          LG    0.35    0.35   4.362   0.346     0.0
             * E3
213          UI     0.0  111.69  111.69  111.69  226.88  361.12  481.81  599.56  708.99  795.91
214          UI  924.44  981.52 1023.08 1070.39 1070.39 1054.33 1012.16  958.83  843.16   765.0
```

```
215          UI  671.82  595.75  537.55  476.38  423.35  378.09  335.18  305.82   252.8  234.07
216          UI  210.57  188.36  171.26  154.61  118.38  118.38  115.87   76.46   76.46   76.46
217          UI   76.46   75.47   27.18   27.18   27.18   27.18   27.18   27.18   27.18   27.18
218          UI   27.18   27.18   27.18   27.18   27.18   27.18
```



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LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

219          KK    E4RA   CNAME   E3-E4
220          KO       0       0     0.0       0      22
221          HC       4

222          KK   E3-E4   CNAME    E4RA
223          KO       0       0     0.0       0      22
224          RS      14    FLOW     0.0     0.0
225          RC   0.056   0.049 0.05613854.98  0.0048     0.0
             * E3-E4
226          RX     0.0   570.0   650.0   690.0   705.0   735.0   810.0  1200.0
227          RY    21.0    14.0    13.0    10.0    10.0    12.5    14.5    21.0

228          KK      F1
229          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
230          KM   L=5.07      Lca=2.57      S=369.39      Kn=0.050      LAG=61.9
231          KM   S-GRAPH TYPE=PHX MNT
232          KO       0       0     0.0       1      22
233          BA   3.103
234          LG   0.297   0.329   4.244   0.378  12.997
             * F1
235          UI     0.0  168.51  168.51  215.27  509.66  699.18  943.72 1090.63 1237.28 1359.21
236          UI  1651.0 2027.63 1459.34 1157.38 1028.29  961.49  882.67  818.34   750.5  687.24
237          UI  625.11  552.31  479.89  429.51  404.49  384.89  352.34  298.58  276.84  216.79
238          UI  215.32  192.43  184.56  176.81  129.19  129.19  129.19  109.56   82.46   82.46
239          UI   82.46   82.46   82.46   52.76    32.3    32.3    32.3    32.3    32.3    32.3
240          UI    32.3    32.3    32.3    32.3    32.3    32.3    32.3    32.3     0.0

241          KK   F1-F2   CNAME    F2R
242          KO       0       0     0.0       0      22
243          RS       1    FLOW     0.0     0.0
244          RC   0.053   0.045   0.055 3313.03  0.0106     0.0
             * F1-F2
245          RX     0.0    60.0   120.0   146.0   178.0   208.0   268.0   328.0
246          RY    27.0    26.0    25.0    10.0    10.0    24.0    26.0    28.0

247          KK      F2
248          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
249          KM   L=3.88      Lca=1.80      S=161.60      Kn=0.050      LAG=57.0
250          KM   S-GRAPH TYPE=PHX MNT
251          KO       0       0     0.0       1      22
252          BA   2.209
253          LG    0.35    0.35   4.375   0.362   3.346
             * F2
254          UI     0.0  130.48  130.48  222.96  433.41  610.23   794.3  912.18 1015.11 1202.18
255          UI  1548.4 1176.04  896.54  790.99  735.01  667.95  615.82  555.86  511.22  447.69
256          UI  388.02  337.31  314.94  297.77  272.83  224.19  203.12  166.73  162.35  142.91
257          UI  142.91  109.04  100.04  100.04   86.65   63.85   63.85   63.85   63.85   63.39
258          UI   25.01   25.01   25.01   25.01   25.01   25.01   25.01   25.01   25.01   25.01
259          UI   25.01   25.01   25.01     0.0
```



```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

260          KK     F3R   CNAME   F2-F3
261          KO       0       0     0.0       0      22
262          HC       2

263          KK   F2-F3   CNAME     F3R
264          KO       0       0     0.0       0      22
265          RS       4    FLOW     0.0     0.0
266          RC    0.05   0.047   0.048 7056.98    0.01     0.0
             * F2-F3
267          RX     0.0   350.0   425.0   455.0   472.0   499.0   569.0   900.0
268          RY    20.0    15.0    13.0    10.0    10.0    12.0    14.0    20.0

269          KK      F3
270          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
271          KM   L=2.71      Lca=1.26      S=81.34      Kn=0.055      LAG=54.2
272          KM   S-GRAPH TYPE=DES RNGLND
273          KO       0       0     0.0       1      22
274          BA   0.736
275          LG    0.35    0.35   3.284    0.64     0.0
             * F3
276          UI     0.0   45.89   45.89   90.29  163.16  236.62   300.0   352.3  401.58  427.19
277          UI  439.78  431.51  405.77  355.07  304.27  256.06  219.26  187.54  158.37  134.34
278          UI  113.67   96.02   85.11   70.36   60.22   48.64   46.52   31.41   31.41   31.41
279          UI    21.4   11.17   11.17   11.17   11.17   11.17   11.17   11.17   11.17   11.17
280          UI     0.0

281          KK    E4RB   CNAME   F3-E4
282          KO       0       0     0.0       0      22
283          HC       2

284          KK   F3-E4   CNAME    E4RB
285          KO       0       0     0.0       0      22
286          RS      20    FLOW     0.0     0.0
287          RC    0.05   0.044  0.0527650.48  0.0072     0.0
             * F3-E4
288          RX     0.0   570.0   650.0   690.0   705.0   735.0   810.0  1200.0
289          RY    20.0    14.0    13.0    10.0    10.0    12.5    14.5    20.0

290          KK      H1
291          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
292          KM   L=2.41      Lca=1.09      S=64.59      Kn=0.055      LAG=51.2
```

```
293          KM   S-GRAPH TYPE=DES RNGLND
294          KO       0       0     0.0       1      22
295          BA   1.066
296          LG    0.35    0.35   2.733   0.945     0.0
             * H1
297          UI     0.0   70.38   70.38  156.67  277.53  386.09  481.01   579.0   629.6  674.43
298          UI  672.95  639.66  573.48  484.85  407.01  343.97  290.32  244.62  205.27   171.4
299          UI  143.72  125.14  107.91   82.11   74.59   59.78   48.17   48.17   44.03   17.13
300          UI   17.13   17.13   17.13   17.13   17.13   17.13   17.13   17.13     0.0
```



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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

301          KK   H1-H2   CNAME     H2R
302          KO       0       0     0.0       0      22
303          RS      19    FLOW     0.0     0.0
304          RC   0.053    0.05 0.05321739.03  0.0082     0.0
             * H1-H2
305          RX     0.0   330.0   430.0   465.0   495.0   530.0   630.0   960.0
306          RY    17.0    14.0    12.0    10.0    10.0    12.0    14.0    17.0

307          KK      H2
308          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
309          KM   L=4.41     LCa=2.60     S=44.71     Kn=0.050     LAG=88.9
310          KM   S-GRAPH TYPE=DES RNGLND
311          KO       0       0     0.0       1      22
312          BA     1.4
313          LG    0.35    0.35   3.222   0.664     0.0
             * H2
314          UI     0.0   52.96   52.96   52.96   52.96  142.93  178.39   226.9  274.71  319.58
315          UI  365.35   394.2  441.12  466.71   479.3  507.56  507.56  507.56  494.47  478.59
316          UI  456.68  413.58  373.47  343.47  306.13  279.54  254.31  232.29  208.19  189.77
317          UI  169.44  155.74  145.02  121.24  117.25   99.85   99.85   83.38   81.21   75.85
318          UI   56.14   56.14   56.14   49.15   36.25   36.25   36.25   36.25   36.25    27.6
319          UI   12.89   12.89   12.89   12.89   12.89   12.89   12.89   12.89   12.89   12.89
320          UI   12.89   12.89   12.89   12.89   12.89   12.89     0.0

321          KK      E4
322          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
323          KM   L=5.36     LCa=2.81     S=38.26     Kn=0.050     LAG=101.9
324          KM   S-GRAPH TYPE=DES RNGLND
325          KO       0       0     0.0       1      22
326          BA   3.042
327          LG    0.35    0.35   3.816   0.439     0.0
             * E4
328          UI     0.0  100.41  100.41  100.41  100.41   158.4  288.69  358.15  433.82  515.05
329          UI  586.72  661.74  710.91  802.48  849.78  890.67  905.99   962.3   962.3   962.3
330          UI  958.07  920.61  904.77  855.38  781.14  712.32  671.29  604.26   557.2  512.12
331          UI  469.45  435.76   392.7  363.69  334.37  307.94  277.85  264.88  224.23  220.83
332          UI  189.31  189.31  167.81  153.97  153.97   127.9  106.43  106.43  106.43  101.85
333          UI   68.74   68.74   68.74   68.74   68.74   68.74    56.9   24.44   24.44   24.44
334          UI   24.44   24.44   24.44   24.44   24.44   24.44   24.44   24.44   24.44   24.44
335          UI   24.44   24.44   24.44   24.44   24.44   24.44

336          KK     E5R   CNAME    E4-E5
337          KO       0       0     0.0       0      22
338          HC       5

339          KK   E4-E5   CNAME     E5R
340          KO       0       0     0.0       0      22
341          RS      16    FLOW     0.0     0.0
342          RC    0.06    0.05  0.0615206.17  0.0051     0.0
             * E4-E5
343          RX     0.0  1010.0  1080.0  1090.0  1110.0  1120.0  1190.0  2200.0
344          RY    27.0    16.0    15.0    10.0    10.0    14.0    16.0    27.0
```



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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

345          KK      J1
346          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
347          KM   L=4.09     LCa=1.78     S=70.82     Kn=0.055     LAG=74.8
348          KM   S-GRAPH TYPE=DES RNGLND
349          KO       0       0     0.0       1      22
350          BA   1.734
351          LG    0.35    0.35    3.25   0.652     0.0
             * J1
352          UI     0.0   77.84   77.84   77.84  158.12  251.68   335.8  417.86  494.13  554.71
353          UI  644.28  684.07  713.03   746.0   746.0  734.81  705.42  668.25  587.63  533.16
354          UI  468.22   415.2  374.64  332.01  295.05  263.51  233.61  213.14  176.18  163.13
355          UI  146.75  131.28  119.36  107.75   82.51   82.51   80.75   53.29   53.29   53.29
356          UI   53.29    52.6   18.95   18.95   18.95   18.95   18.95   18.95   18.95   18.95
357          UI   18.95   18.95   18.95   18.95   18.95   18.95

358          KK   J1-J2   CNAME     J2R
359          KO       0       0     0.0       0      22
360          RS      28    FLOW     0.0     0.0
361          RC   0.055    0.04   0.055 24097.0  0.0086     0.0
             * J1-J2
362          RX     0.0   161.0   247.0   254.0   271.0   279.0   393.0   660.0
363          RY    17.0    12.5    12.2    10.8    10.0    12.1    12.9    17.0

364          KK      J2
365          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
366          KM   L=5.18     LCa=2.51     S=45.01     Kn=0.050     LAG=93.2
367          KM   S-GRAPH TYPE=DES RNGLND
368          KO       0       0     0.0       1      22
369          BA   3.638
370          LG   0.349   0.348   3.621   0.496   0.281
             * J2
371          UI     0.0  131.71  131.71  131.71  131.71  310.01   410.2  529.51  653.09  756.38
372          UI  857.33  932.04 1064.81 1131.31 1183.05 1211.21 1262.21 1262.21 1262.21 1218.54
```

```
373          UI  1189.1 1123.19 1016.15  925.91  854.62  766.36  699.93  639.84  585.79  530.33
374          UI  484.44   441.0  403.56  360.63  330.99  294.11  269.84   248.3  236.22  201.95
375          UI  201.95  172.61   139.6   139.6   139.6  118.12   90.16   90.16   90.16   90.16
376          UI   90.16   79.42   32.06   32.06   32.06   32.06   32.06   32.06   32.06   32.06
377          UI   32.06   32.06   32.06   32.06   32.06   32.06   32.06   32.06   32.06     0.0

378          KK    K3RB   CNAME    J2-K3
379          KO       0       0     0.0       0      22
380          HC       2

381          KK    J2-K3   CNAME    K3RB
382          KO       0       0     0.0       0      22
383          RS       4    FLOW     0.0     0.0
384          RC    0.05   0.048    0.05 4071.93  0.0059     0.0
             * J2-K3
385          RX     0.0   390.0   490.0   502.0   520.0   532.0   632.0  1022.0
386          RY    20.0    14.5    11.5    10.0    10.0    11.5    14.5    20.0
```

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HEC-1 INPUT PAGE 10

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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

387          KK      K3
388          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
389          KM   L=4.92     Lca=2.65     S=44.16     Kn=0.050     LAG=93.6
390          KM   S-GRAPH TYPE=DES RNGLND
391          KO       0       0     0.0       1      22
392          BA   1.636
393          LG    0.35    0.35   3.421   0.582     0.0
             * K3
394          UI     0.0    58.6    58.6    58.6    58.6  132.87  178.79  231.72  287.22  333.42
395          UI  374.63  416.06  465.04   498.4  523.32  535.26  561.57  561.57  561.57  546.52
396          UI  528.98  508.31  466.83  418.22  391.32  351.35  318.32  291.61  266.72  243.82
397          UI   222.2   205.3   179.7  166.92  157.94  130.85  127.83  110.47  110.47   92.85
398          UI   89.85   88.89   62.11   62.11   62.11   62.11    41.1   40.11   40.11   40.11
399          UI   40.11   40.11   23.61   14.26   14.26   14.26   14.26   14.26   14.26   14.26
400          UI   14.26   14.26   14.26   14.26   14.26   14.26   14.26   14.26   14.26   14.26

401          KK      E5
402          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
403          KM   L=3.01     Lca=1.41     S=28.56     Kn=0.050     LAG=65.8
404          KM   S-GRAPH TYPE=DES RNGLND
405          KO       0       0     0.0       1      22
406          BA   1.308
407          LG   0.347   0.344    3.94   0.429   0.968
             * E5
408          UI     0.0   66.73   66.73   66.73  187.33  261.54  342.37  416.83  480.54  556.36
409          UI  598.07  622.96  639.46  636.14  605.78  574.36  496.51  443.91  383.22  336.88
410          UI  298.49  258.94  227.11  198.14  176.39   149.0   129.8   120.7  102.31   94.82
411          UI   70.72   70.72   61.39   45.68   45.68   45.68   45.68   18.08   16.24   16.24
412          UI   16.24   16.24   16.24   16.24   16.24   16.24   16.24   16.24   16.24     0.0

413          KK     E6R   CNAME    E5-E6
414          KO       0       0     0.0       0      22
415          HC       5

416          KK    E5-E6   CNAME     E6R
417          KO       0       0     0.0       0      22
418          RS       7    FLOW     0.0     0.0
419          RC   0.063   0.051   0.063  5105.8  0.0037     0.0
             * E5-E6
420          RX     0.0   850.0   980.0   990.0  1030.0  1040.0  1230.0  2020.0
421          RY    25.0    13.0    13.0    10.0    10.0    12.0    12.0    25.0

422          KK      E6
423          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
424          KM   L=3.04     Lca=1.06     S=34.17     Kn=0.050     LAG=57.1
425          KM   S-GRAPH TYPE=DES RNGLND
426          KO       0       0     0.0       1      22
427          BA   2.038
428          LG   0.343   0.336   4.356   0.367   0.711
             * E6
429          UI     0.0  120.38  120.38   205.7  403.51   574.9  733.36  874.59  1019.0 1083.61
430          UI  1153.6 1153.67  1100.2 1038.99  882.77  767.24  653.83  562.64  487.32  412.46
431          UI  353.67  303.21  257.92  226.95  190.12   175.5  127.59  127.59   96.61    82.4
432          UI    82.4    82.4   36.99    29.3    29.3    29.3    29.3    29.3    29.3    29.3
```

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HEC-1 INPUT PAGE 11

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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

433          UI    29.3    29.3     0.0

434          KK       E   CNAME      2R
435          KO       0       0     0.0       0      22
436          HC       2

437          KK      2R   CNAME       E
438          KO       0       0     0.0       0      22
439          RN      2R
440          ZZ
```

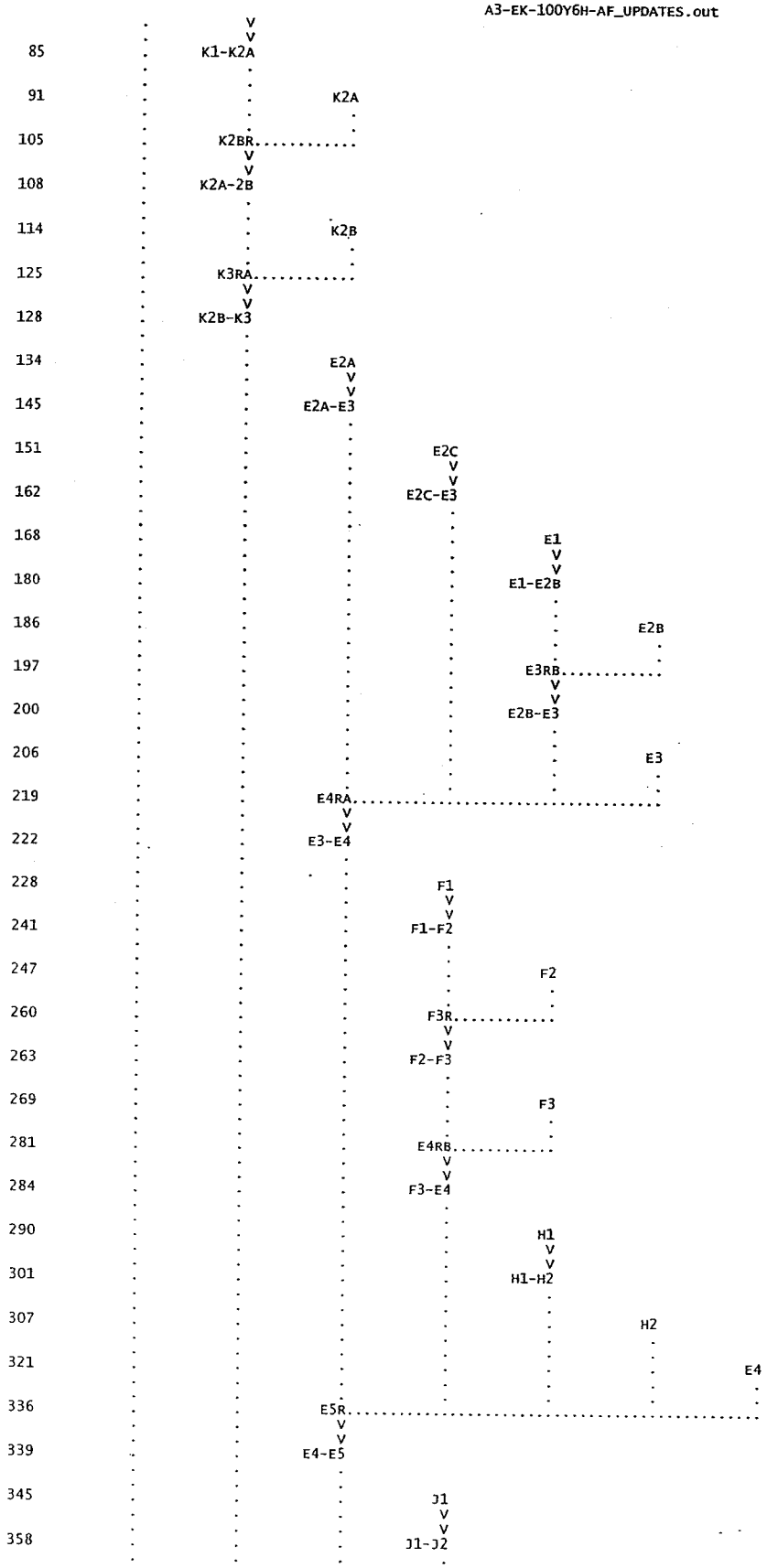
0

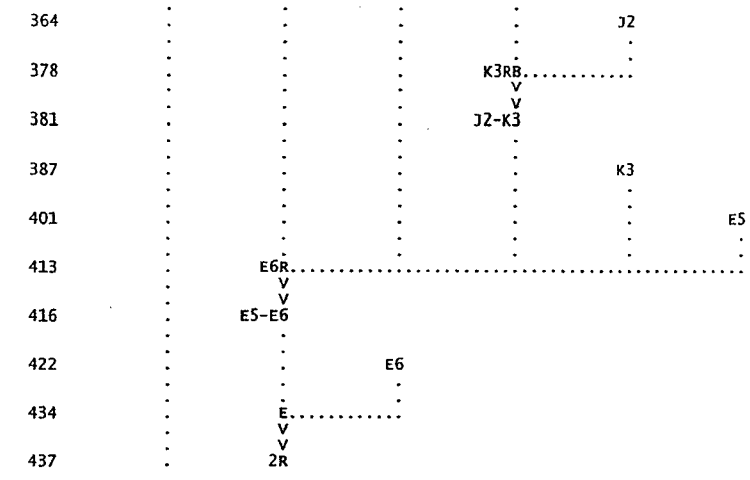
SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   60         G1
               V
               V
   71         1R
               .
               .
   74          .          K1
```


K1-K2A
K2A
K2BR
K2A-2B
K2B
K3RA
K2B-K3
E2A
E2A-E3
E2C
E2C-E3
E1
E1-E2B
E2B
E3RB
E2B-E3
E3
E4RA
E3-E4
F1
F1-F2
F2
F3R
F2-F3
F3
E4RB
F3-E4
H1
H1-H2
H2
E4
E5R
E4-E5
J1
J1-J2



(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY  1991                 *
*          VERSION 4.0.1E               *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

Buckeye/Sun Valley ADMS - May 2005
Michael Baker Jr., Inc. - Modeler: Jacob Lesue
basins E-K with Aluvial Fan updates
100-year 6-hour
Existing Conditions
Area 3 - Sub-basins E-K (Aluvial Fan updates)
Rainfall Loss Method - Green & Ampt
Unit Hydrograph Method - FCDMC S-Graph
Channel Routing Method - Normal Depth
Land Use - FCDMC GIS Data: mag_landuse (2000)
Soil Data - USDA SCS Soil Survey (1972 & 1981)
Units - L(mi) Lca(mi) S(ft/mi) LAG(min)

```
 14 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

 15 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 20 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 25 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 30 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 35 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 40 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 45 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 50 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
                     JXTIME           0  STARTING TIME

 55 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE      1JAN94  STARTING DATE
```

```
      JXTIME          0  STARTING TIME

IT    HYDROGRAPH TIME DATA
        NMIN          5  MINUTES IN COMPUTATION INTERVAL
       IDATE      1JAN94  STARTING DATE
       ITIME        0000  STARTING TIME
         NQ,        2000  NUMBER OF HYDROGRAPH ORDINATES
      NDDATE      7JAN94  ENDING DATE
      NDTIME        2235  ENDING TIME
       ICENT          19  CENTURY MARK

    COMPUTATION INTERVAL     0.08 HOURS
       TOTAL TIME BASE   166.58 HOURS

ENGLISH UNITS
    DRAINAGE AREA          SQUARE MILES
    PRECIPITATION DEPTH    INCHES
    LENGTH, ELEVATION      FEET
    FLOW                   CUBIC FEET PER SECOND
    STORAGE VOLUME         ACRE-FEET
    SURFACE AREA           ACRES
    TEMPERATURE            DEGREES FAHRENHEIT

16 JD   INDEX STORM NO. 1
          STRM        3.23  PRECIPITATION DEPTH
          TRDA        0.01  TRANSPOSITION DRAINAGE AREA

17 PI     PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.03
          0.03  0.03  0.05  0.05  0.05  0.15  0.15  0.15  0.03  0.03
          0.03  0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00

21 JD   INDEX STORM NO. 2
          STRM        3.21  PRECIPITATION DEPTH
          TRDA        0.50  TRANSPOSITION DRAINAGE AREA

22 PI     PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.03
          0.03  0.03  0.05  0.05  0.05  0.15  0.15  0.15  0.03  0.03
          0.03  0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00

26 JD   INDEX STORM NO. 3
          STRM        3.19  PRECIPITATION DEPTH
          TRDA        1.00  TRANSPOSITION DRAINAGE AREA

27 PI     PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.03
          0.03  0.03  0.06  0.06  0.06  0.12  0.12  0.12  0.03  0.03
          0.03  0.01  0.01  0.01  0.01  0.01  0.01  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00

31 JD   INDEX STORM NO. 4
          STRM        3.10  PRECIPITATION DEPTH
          TRDA        5.00  TRANSPOSITION DRAINAGE AREA

32 PI     PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.03
          0.03  0.03  0.06  0.06  0.06  0.08  0.08  0.08  0.05  0.05
          0.05  0.02  0.02  0.02  0.01  0.01  0.01  0.01  0.01  0.01
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00

36 JD   INDEX STORM NO. 5
          STRM        3.04  PRECIPITATION DEPTH
          TRDA       10.00  TRANSPOSITION DRAINAGE AREA

37 PI     PRECIPITATION PATTERN
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.01
          0.01  0.01  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.01  0.01  0.01  0.01  0.01  0.01  0.02  0.02  0.02  0.03
          0.03  0.03  0.06  0.06  0.06  0.07  0.07  0.07  0.04  0.04
          0.04  0.02  0.02  0.02  0.01  0.01  0.01  0.01  0.01  0.01
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00

41 JD   INDEX STORM NO. 6
          STRM        2.94  PRECIPITATION DEPTH
          TRDA       20.00  TRANSPOSITION DRAINAGE AREA

42 PI     PRECIPITATION PATTERN
          0.01  0.01  0.01  0.00  0.00  0.00  0.00  0.00  0.00  0.01
          0.01  0.01  0.01  0.01  0.01  0.00  0.00  0.00  0.00  0.00
          0.00  0.01  0.01  0.01  0.00  0.00  0.00  0.01  0.01  0.01
          0.01  0.01  0.01  0.01  0.01  0.01  0.02  0.02  0.02  0.03
          0.03  0.03  0.05  0.05  0.05  0.06  0.06  0.06  0.04  0.04
          0.04  0.02  0.02  0.02  0.01  0.01  0.01  0.01  0.01  0.01
          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
          0.00  0.00
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 46 JD          INDEX STORM NO. 7
                      STRM        2.88  PRECIPITATION DEPTH
                      TRDA       30.00  TRANSPOSITION DRAINAGE AREA

 47 PI            PRECIPITATION PATTERN
                    0.01      0.01      0.01      0.00      0.00      0.00      0.00      0.00      0.00      0.01
                    0.01      0.01      0.01      0.01      0.01      0.00      0.00      0.00      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.02      0.02      0.02      0.03
                    0.03      0.03      0.05      0.05      0.05      0.06      0.06      0.06      0.04      0.04
                    0.04      0.02      0.02      0.02      0.02      0.02      0.02      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.00
                    0.00      0.00

 51 JD          INDEX STORM NO. 8
                      STRM        2.81  PRECIPITATION DEPTH
                      TRDA       40.00  TRANSPOSITION DRAINAGE AREA

 52 PI            PRECIPITATION PATTERN
                    0.01      0.01      0.01      0.00      0.00      0.00      0.00      0.00      0.00      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.02      0.02      0.02      0.03
                    0.03      0.03      0.05      0.05      0.05      0.06      0.06      0.06      0.04      0.04
                    0.04      0.02      0.02      0.02      0.02      0.02      0.02      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01

 56 JD          INDEX STORM NO. 9
                      STRM        2.58  PRECIPITATION DEPTH
                      TRDA      100.00  TRANSPOSITION DRAINAGE AREA

 57 PI            PRECIPITATION PATTERN
                    0.01      0.01      0.01      0.00      0.00      0.00      0.01      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.02      0.02      0.02      0.03
                    0.03      0.03      0.04      0.04      0.04      0.05      0.05      0.05      0.04      0.04
                    0.04      0.02      0.02      0.02      0.02      0.02      0.02      0.01      0.01      0.01
                    0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01      0.01
                    0.01      0.01

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 60 KK      *     G1     *
            *            *
            **************
                      THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                      L=2.38     Lca=1.08     S=33.76     Kn=0.045     LAG=47.1
                      S-GRAPH TYPE=DES RNGLND

 64 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          1  PUNCH COMPUTED HYDROGRAPH
                      IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2       2000  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT      0.083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

 65 BA          SUBBASIN CHARACTERISTICS
                     TAREA,       1.12  SUBBASIN AREA

 66 LG          GREEN AND AMPT LOSS RATE
                     STRTL       0.35  STARTING LOSS
                       DTH       0.35  MOISTURE DEFICIT
                      PSIF       4.68  WETTING FRONT SUCTION
                     XKSAT       0.30  HYDRAULIC CONDUCTIVITY
                     RTIMP       0.00  PERCENT IMPERVIOUS AREA

 65 UI          INPUT UNITGRAPH,  35 ORDINATES,  VOLUME = 1.00
                    0.0      80.2      80.2     213.2     355.0     484.3     602.7     698.8     750.2     768.2
                  735.6     667.0     553.7     458.0     381.9     318.8     263.3     222.2     176.9     151.1
                  125.0     103.3      85.0      70.6      54.9      54.9      43.6      19.5      19.5      19.5
                   19.5      19.5      19.5      19.5      19.5
                                                                  ***

     ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION       G1
                      TRANSPOSITION AREA      0.0 SQ MI

    TOTAL RAINFALL =    3.23, TOTAL LOSS =    1.73, TOTAL EXCESS =    1.50

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                (CFS)
+    1081.      4.67                  180.         45.         15.          6.
                (INCHES)            1.495       1.495       1.495       1.495
                (AC-FT)              89.         89.         89.         89.

                CUMULATIVE AREA =    1.12 SQ MI
```

TRANSPOSITION AREA 0.5 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	9020.	7.75	4381.	1176.	392.	169.
			(INCHES) 1.304	1.400	1.400	1.400
			(AC-FT) 2172.	2333.	2333.	2333.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 1.0 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	7871.	7.83	3891.	1051.	350.	151.
			(INCHES) 1.158	1.251	1.251	1.251
			(AC-FT) 1929.	2085.	2085.	2085.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 5.0 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	5817.	8.00	2929.	805.	268.	116.
			(INCHES) 0.872	0.958	0.958	0.958
			(AC-FT) 1453.	1597.	1597.	1597.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 10.0 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	4963.	8.08	2531.	702.	234.	101.
			(INCHES) 0.753	0.836	0.836	0.836
			(AC-FT) 1255.	1392.	1392.	1392.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 20.0 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	4023.	8.08	2084.	586.	195.	84.
			(INCHES) 0.620	0.697	0.697	0.697
			(AC-FT) 1034.	1162.	1162.	1162.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 30.0 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	3503.	8.25	1827.	519.	173.	75.
			(INCHES) 0.544	0.617	0.617	0.617
			(AC-FT) 906.	1029.	1029.	1029.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 40.0 SQ MI

	PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
+	(CFS)	(HR)	(CFS)			
+	3114.	8.33	1612.	462.	154.	67.
			(INCHES) 0.480	0.550	0.550	0.550
			(AC-FT) 799.	917.	917.	917.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 2R
TRANSPOSITION AREA 100.0 SQ MI

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR
(CFS)	(HR)	(CFS)				
1962.	8.50		961.	288.	96.	42.
		(INCHES)	0.286	0.343	0.343	0.343
		(AC-FT)	476.	571.	571.	571.

CUMULATIVE AREA = 31.24 SQ MI

*** *** *** *** ***

INTERPOLATED HYDROGRAPH AT 2R

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR
(CFS)	(HR)	(CFS)				
3448.	8.25		1797.	511.	170.	74.
		(INCHES)	0.535	0.608	0.608	0.608
		(AC-FT)	891.	1013.	1013.	1013.

CUMULATIVE AREA = 31.24 SQ MI

0

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	G1	927.	4.67	160.	40.	13.	1.12		
ROUTED TO	1R	927.	4.67	160.	40.	13.	1.12		
HYDROGRAPH AT	K1	1564.	4.50	291.	73.	24.	1.54		
ROUTED TO	K1-K2A	1208.	5.25	289.	73.	24.	1.54		
HYDROGRAPH AT	K2A	894.	5.25	269.	68.	23.	1.95		
2 COMBINED AT	K2BR	1858.	5.25	517.	131.	44.	3.49		
ROUTED TO	K2A-2B	1750.	5.67	515.	131.	44.	3.49		
HYDROGRAPH AT	K2B	309.	4.58	45.	11.	4.	0.42		
2 COMBINED AT	K3RA	1744.	5.67	529.	135.	45.	3.91		
ROUTED TO	K2B-K3	1420.	7.17	517.	134.	45.	3.91		
HYDROGRAPH AT	E2A	680.	4.67	127.	32.	11.	0.80		
ROUTED TO	E2A-E3	561.	5.67	126.	32.	11.	0.80		
HYDROGRAPH AT	E2C	658.	4.58	108.	27.	9.	0.72		
ROUTED TO	E2C-E3	523.	5.50	108.	27.	9.	0.72		
HYDROGRAPH AT	E1	894.	4.50	148.	37.	12.	0.96		
ROUTED TO	E1-E2B	794.	4.83	148.	37.	12.	0.96		
HYDROGRAPH AT	E2B	450.	4.58	72.	18.	6.	0.47		
2 COMBINED AT	E3RB	1053.	4.83	205.	51.	17.	1.42		
ROUTED TO	E2B-E3	833.	5.67	203.	51.	17.	1.42		
HYDROGRAPH AT	E3	1149.	5.08	301.	75.	25.	2.49		
4 COMBINED AT	E4RA	1978.	5.67	608.	154.	51.	5.42		

Fan 38

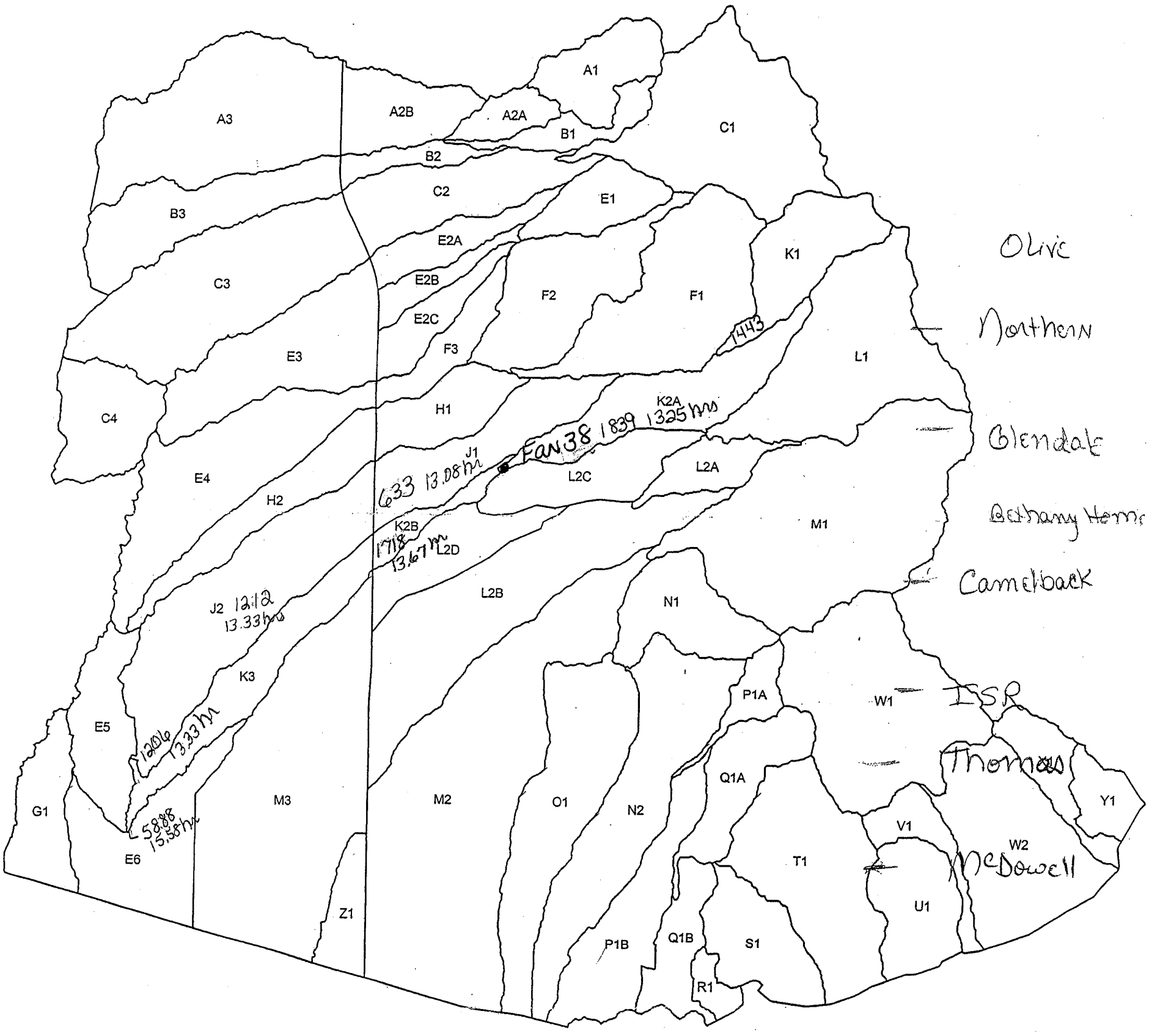
+	ROUTED TO E3-E4	1737.	6.67	601.	154.	51.	5.42
+	HYDROGRAPH AT F1	1773.	4.83	444.	113.	38.	3.10
+	ROUTED TO F1-F2	1739.	4.83	443.	113.	38.	3.10
+	HYDROGRAPH AT F2	1306.	4.75	280.	70.	23.	2.21
+	2 COMBINED AT F3R	2573.	4.83	655.	166.	55.	5.31
+	ROUTED TO F2-F3	2432.	5.08	654.	166.	55.	5.31
+	HYDROGRAPH AT F3	454.	4.75	84.	21.	7.	0.74
+	2 COMBINED AT E4RB	2569.	5.08	692.	176.	59.	6.05
+	ROUTED TO F3-E4	2151.	6.67	685.	176.	59.	6.05
+	HYDROGRAPH AT H1	497.	4.75	86.	22.	7.	1.07
+	ROUTED TO H1-H2	323.	6.33	85.	22.	7.	1.07
+	HYDROGRAPH AT H2	446.	5.25	134.	33.	11.	1.40
+	HYDROGRAPH AT E4	923.	5.42	319.	80.	27.	3.04
+	5 COMBINED AT E5R	3330.	6.67	1300.	341.	114.	16.98
+	ROUTED TO E4-E5	3088.	7.92	1294.	341.	114.	16.98
+	HYDROGRAPH AT J1	626.	5.08	160.	40.	13.	1.73
+	ROUTED TO J1-J2	488.	7.33	158.	40.	13.	1.73
+	HYDROGRAPH AT J2	1093.	5.33	349.	87.	29.	3.64
+	2 COMBINED AT K3RB	998.	5.33	434.	110.	37.	5.37
+	ROUTED TO J2-K3	979.	5.58	433.	110.	37.	5.37
+	HYDROGRAPH AT K3	520.	5.33	165.	41.	14.	1.64
+	HYDROGRAPH AT E5	713.	4.92	165.	41.	14.	1.31
+	5 COMBINED AT E6R	3596.	7.83	1780.	487.	162.	29.20
+	ROUTED TO E5-E6	3534.	8.25	1773.	487.	162.	29.20
+	HYDROGRAPH AT E6	1228.	4.75	253.	63.	21.	2.04
+	2 COMBINED AT E	3535.	8.25	1845.	523.	174.	31.24
+	ROUTED TO 2R	3448.	8.25	1797.	511.	170.	31.24

*** NORMAL END OF HEC-1 ***

Buckeye/Sun Valley Area Drainage Master Study
Sub-basins E-K
HEC-1 Model
100 year, 24 hour

Buckeye SunValley ADMS 4/27/05

UPDATED HEC-1 BOUNDARIES



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1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY  1991                 *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
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*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT PAGE 1

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
    1     ID  Buckeye/Sun Valley ADMS - May 2005
    2     ID  Michael Baker Jr., Inc. - Modeler: Jacob Lesue
    3     ID  basins E-K with Aluvial Fan updates
    4     ID  100-year 24-hour
    5     ID  Existing Conditions
    6     ID  Area 3 - Sub-basins E-K (Aluvial Fan updates)
    7     ID  Rainfall Loss Method - Green & Ampt
    8     ID  Unit Hydrograph Method - FCDMC S-Graph
    9     ID  Channel Routing Method - Normal Depth
   10     ID  Land Use - FCDMC GIS Data: mag_landuse (2000)
   11     ID  Soil Data - USDA SCS Soil Survey (1972 & 1981)
   12     ID  Units - L(mi)   Lca(mi)   S(ft/mi)   LAG(min)
          *DIAGRAM
   13     IT       5 01JAN94       0    2000
   14     IO       3
   15     IN      15 01JAN94       0
   16     JD    4.16    0.01
          * 24-hour distribution
   17     PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
   18     PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
   19     PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
   20     PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
   21     PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
   22     PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
   23     PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
   24     PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
   25     PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
   26     PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
   27     IN      15 01JAN94       0
   28     JD   3.952    10.0
          * 24-hour distribution
   29     PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
   30     PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
   31     PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
   32     PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
   33     PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
   34     PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
   35     PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
   36     PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
   37     PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
   38     PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
   39     IN      15 01JAN94       0
   40     JD   3.819    20.0
          * 24-hour distribution
   41     PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
   42     PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
   43     PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
   44     PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
   45     PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
   46     PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
   47     PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
   48     PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
   49     PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
   50     PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
   51     IN      15 01JAN94       0
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HEC-1 INPUT PAGE 2

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
   52     JD    3.69    40.0
          * 24-hour distribution
   53     PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
   54     PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
   55     PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
   56     PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
   57     PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
   58     PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
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59          PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
60          PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
61          PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
62          PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
63          IN      15 01JAN94       0
64          JD   3.565    80.0
            * 24-hour distribution
65          PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
66          PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
67          PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
68          PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
69          PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
70          PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
71          PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
72          PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
73          PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
74          PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0

75          KK      K1
76          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
77          KM    L=3.23      Lca=1.84      S=681.00      Kn=0.050      LAG=40.4
78          KM    S-GRAPH TYPE=PHX MNT
79          KO       0       0     0.0       1      22
80          BA    1.543
81          LG   0.112   0.255   4.365   0.366  21.277
            * K1
82          UI     0.0  129.88  168.84  442.11  706.31  896.38 1061.91 1457.77 1111.25  821.11
83          UI  726.82  641.11  561.31  488.34  403.67  331.29  304.06  271.41  213.37  169.75
84          UI  154.58  142.25  108.11   99.57   85.17   63.56   63.56   63.56   38.81   24.89
85          UI   24.89   24.89   24.89   24.89   24.89   24.89   24.89     0.0

86          KK  K1-K2A    CNAME     K2AR
87          KO       0        0      0.0        0      22
88          RS      10     FLOW      0.0      0.0
89          RC    0.05    0.048    0.0519434.11   0.017     0.0
            * K1-K2A
90          RX     0.0     20.0     55.0     85.0    235.0    259.0    289.0    309.0
91          RY    22.0     21.0     20.0     10.0     10.0     20.0     21.0     22.0

92          KK      K2A
93          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
94          KM    L=5.29      Lca=2.72      S=126.78      Kn=0.055      LAG=87.2
95          KM    S-GRAPH TYPE=DES RNGLND
96          KO       0       0     0.0       1      22
97          BA    1.949
98          LG   0.341   0.347   4.907   0.278   1.288
            * K2A
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LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

99          UI     0.0   75.43   75.43   75.43   75.43  216.57  263.63  333.08  400.43  470.31
100         UI  527.14  583.18  638.37  674.27  692.72  722.84  722.84  721.83  689.53  671.99
101         UI  627.55  556.08  517.43  456.81  416.13  375.78  341.84  309.53  280.25  253.48
102         UI  229.53  206.53  183.27  168.43  146.97   142.2  123.74  115.66  112.61   79.95
103         UI   79.95   79.95   71.18   51.63   51.63   51.63   51.63   51.63   36.22   18.36
104         UI   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36
105         UI   18.36   18.36   18.36   18.36     0.0

106         KK    K2BR    CNAME  K2A-2B
107         KO       0        0     0.0        0      22
108         HC       2

109         KK  K2A-2B    CNAME     K2BR
110         KO       0        0      0.0        0      22
111         RS       6     FLOW      0.0      0.0
112         RC    0.05    0.048    0.0510602.71   0.0115     0.0
            * K2A-K2B
113         RX     0.0     20.0     55.0     85.0    235.0    259.0    289.0    309.0
114         RY    22.0     21.0     20.0     10.0     10.0     20.0     21.0     22.0

115         KK      K2B
116         KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
117         KM    L=2.01      Lca=0.83      S=60.78      Kn=0.055      LAG=43.5
118         KM    S-GRAPH TYPE=DES RNGLND
119         KO       0       0     0.0       1      22
120         BA   0.416
121         LG    0.35    0.35   2.708   0.961     0.0
            * K2B
122         UI     0.0   32.57   33.92  104.78  161.25  216.88  267.55  297.02  312.16  302.35
123         UI  276.72  225.58  183.68  151.33  123.31   99.92    81.2   65.94    55.1   45.93
124         UI   34.52    29.7    22.3    22.3   15.04    7.93    7.93    7.93    7.93    7.93
125         UI    7.93    7.93     0.0

126         KK    K3RA    CNAME  K2B-K3
127         KO       0        0     0.0        0      22
128         HC       2

129         KK  K2B-K3    CNAME     K3RA
130         KO       0        0      0.0        0      22
131         RS      19     FLOW      0.0      0.0
132         RC    0.05    0.048    0.0525950.11  0.0084     0.0
            * K2B-K3
133         RX     0.0    390.0    490.0    502.0    520.0    532.0    632.0   1022.0
134         RY    20.0     14.5     11.5     10.0     10.0     11.5     14.5     20.0

135         KK      E2A
136         KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
137         KM    L=2.90      Lca=1.20      S=100.83      Kn=0.055      LAG=52.4
138         KM    S-GRAPH TYPE=DES RNGLND
139         KO       0       0     0.0       1      22
140         BA   0.797
141         LG    0.35    0.38     5.6    0.21     0.0
            * E2A
142         UI     0.0    51.6    51.6  110.43  196.83  277.44  347.94  413.76  460.03   489.1
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143   UI  494.55   472.6  438.77  369.81  310.92  263.99  224.69  190.62  158.99  135.09
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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
144   UI  112.23   97.29   80.97   70.86    54.7   53.12   35.32   35.32   35.32   21.96
145   UI   12.56   12.56   12.56   12.56   12.56   12.56   12.56   12.56   12.56     0.0

146   KK  E2A-E3   CNAME    E3RA
147   KO       0       0     0.0       0      22
148   RS      13    FLOW     0.0     0.0
149   RC   0.052   0.046  0.05219626.03  0.0093     0.0
      * E2A-E3
150   RX     0.0   133.0   173.0   213.0   223.0   263.0   303.0   403.0
151   RY    22.0    17.0    14.0    10.0    10.0    15.0    18.0    22.0

152   KK      E2C
153   KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
154   KM   L=2.38     Lca=1.01     S=92.90     Kn=0.055     LAG=46.0
155   KM   S-GRAPH TYPE=DES RNGLND
156   KO       0       0     0.0       1      22
157   BA   0.716
158   LG    0.35    0.35   4.343   0.357     0.0
      * E2C
159   UI     0.0   55.12   55.12  154.82  250.83  342.33  421.22  487.29  519.92  527.55
160   UI  498.61  439.15  363.83   300.5  250.15  205.65  169.32  139.69  114.34   97.44
161   UI   84.51   59.64   58.42   38.62   37.73   37.73   16.68   13.41   13.41   13.41
162   UI   13.41   13.41   13.41   13.41     0.0

163   KK  E2C-E3   CNAME    E3RC
164   KO       0       0     0.0       0      22
165   RS      13    FLOW     0.0     0.0
166   RC   0.052   0.046   0.052 17293.5  0.0082     0.0
      * E2C-E3
167   RX     0.0   133.0   173.0   213.0   223.0   263.0   303.0   403.0
168   RY    22.0    17.0    14.0    10.0    10.0    15.0    18.0    22.0

169   KK      E1
170   KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
171   KM   L=2.51     Lca=1.13     S=178.34     Kn=0.055     LAG=43.3
172   KM   S-GRAPH TYPE=PHX MNT
173   KO       0       0     0.0       1      22
174   BA   0.956
175   LG    0.35   0.378   5.377   0.222    0.69
      * E1
176   UI     0.0   74.86   77.94  239.17  368.29  486.24  570.86   714.2  832.85  536.73
177   UI  451.19  405.28  360.54  317.72  278.78  233.78  192.26  176.85  160.99  130.76
178   UI  107.56   95.43   81.98   76.82   57.39   57.39   44.31   36.63   36.63   36.63
179   UI   23.53   14.35   14.35   14.35   14.35   14.35   14.35   14.35   14.35   14.35
180   UI     0.0

181   KK  E1-E2B   CNAME     E2R
182   KO       0       0     0.0       0      22
183   RS       5    FLOW     0.0     0.0
184   RC    0.05   0.047  0.04610992.72   0.016     0.0
      * E1-E2B
185   RX     0.0    65.0   140.0   170.0   185.0   200.0   270.0   340.0
186   RY    24.0    21.0    17.0    10.0    10.0    14.0    18.0    22.0
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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

187   KK      E2B
188   KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
189   KM   L=2.08     Lca=1.07     S=87.98     Kn=0.055     LAG=45.2
190   KM   S-GRAPH TYPE=DES RNGLND
191   KO       0       0     0.0       1      22
192   BA   0.466
193   LG    0.35    0.38     5.6    0.21     0.0
      * E2B
194   UI     0.0    32.1    32.1   94.97  150.03  204.82  250.49  285.24   306.5  304.84
195   UI  285.73  244.25   203.0  165.28   137.3  113.17   92.95    75.5   62.33   52.17
196   UI   43.31   34.02   28.77   21.97   21.97   16.14    7.81    7.81    7.81    7.81
197   UI    7.81    7.81    7.81    7.81

198   KK    E3RB   CNAME  E2B-E3
199   KO       0       0     0.0       0      22
200   HC       2

201   KK  E2B-E3   CNAME    E3RB
202   KO       0       0     0.0       0      22
203   RS      12    FLOW     0.0     0.0
204   RC   0.052   0.046  0.05219617.83  0.0088     0.0
      * E2B-E3
205   RX     0.0   133.0   173.0   213.0   223.0   263.0   303.0   403.0
206   RY    22.0    17.0    14.0    10.0    10.0    15.0    18.0    22.0

207   KK      E3
208   KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
209   KM   L=3.87     Lca=1.99     S=49.65     Kn=0.050     LAG=74.5
210   KM   S-GRAPH TYPE=DES RNGLND
211   KO       0       0     0.0       1      22
212   BA   2.488
213   LG    0.35    0.35   4.362   0.346     0.0
      * E3
214   UI     0.0  111.69  111.69  111.69  226.88  361.12  481.81  599.56  708.99  795.91
215   UI  924.44  981.52 1023.08 1070.39 1070.39 1054.33 1012.16  958.83  843.16   765.0
216   UI  671.82  595.75  537.55  476.38  423.35  378.09  335.18  305.82   252.8  234.07
217   UI  210.57  188.36  171.26  154.61  118.38  118.38  115.87   76.46   76.46   76.46
218   UI   76.46   75.47   27.18   27.18   27.18   27.18   27.18   27.18   27.18   27.18
219   UI   27.18   27.18   27.18   27.18   27.18   27.18

220   KK    E4RA   CNAME   E3-E4
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221          KO       0       0     0.0       0      22
222          HC       4

223          KK    E3-E4   CNAME     E4RA
224          KO       0       0      0.0       0      22
225          RS      14    FLOW      0.0     0.0
226          RC   0.056   0.049  0.05613854.98  0.0048     0.0
             * E3-E4
227          RX     0.0   570.0   650.0   690.0   705.0   735.0   810.0  1200.0
228          RY    21.0    14.0    13.0    10.0    10.0    12.5    14.5    21.0
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HEC-1 INPUT PAGE 6

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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

229          KK      F1
230          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
231          KM    L=5.07      Lca=2.57      S=369.39      Kn=0.050      LAG=61.9
232          KM    S-GRAPH TYPE=PHX MNT
233          KO       0       0     0.0       1      22
234          BA   3.103
235          LG   0.297   0.329   4.244   0.378  12.997
             * F1
236          UI     0.0  168.51  168.51  215.27  509.66  699.18  943.72 1090.63 1237.28 1359.21
237          UI  1651.0 2027.63 1459.34 1157.38 1028.29  961.49  882.67  818.34   750.5  687.24
238          UI  625.11  552.31  479.89  429.51  404.49  384.89  352.34  298.58  276.84  216.79
239          UI  215.32  192.43  184.56  176.81  129.19  129.19  129.19  109.56   82.46   82.46
240          UI   82.46   82.46   82.46   52.76    32.3    32.3    32.3    32.3    32.3    32.3
241          UI    32.3    32.3    32.3    32.3    32.3    32.3    32.3    32.3     0.0

242          KK   F1-F2   CNAME     F2R
243          KO       0       0     0.0       0      22
244          RS       1    FLOW      0.0     0.0
245          RC   0.053   0.045   0.055 3313.03  0.0106     0.0
             * F1-F2
246          RX     0.0    60.0   120.0   146.0   178.0   208.0   268.0   328.0
247          RY    27.0    26.0    25.0    10.0    10.0    24.0    26.0    28.0

248          KK      F2
249          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
250          KM    L=3.88      Lca=1.80      S=161.60      Kn=0.050      LAG=57.0
251          KM    S-GRAPH TYPE=PHX MNT
252          KO       0       0     0.0       1      22
253          BA   2.209
254          LG    0.35    0.35   4.375   0.362   3.346
             * F2
255          UI     0.0  130.48  130.48  222.96  433.41  610.23   794.3  912.18 1015.11 1202.18
256          UI  1548.4 1176.04  896.54  790.99  735.01  667.95  615.82  555.86  511.22  447.69
257          UI  388.02  337.31  314.94  297.77  272.83  224.19  203.12  166.73  162.35  142.91
258          UI  142.91  109.04  100.04  100.04   86.65   63.85   63.85   63.85   63.85   63.39
259          UI   25.01   25.01   25.01   25.01   25.01   25.01   25.01   25.01   25.01   25.01
260          UI   25.01   25.01   25.01     0.0

261          KK     F3R   CNAME   F2-F3
262          KO       0       0     0.0       0      22
263          HC       2

264          KK   F2-F3   CNAME     F3R
265          KO       0       0     0.0       0      22
266          RS       4    FLOW      0.0     0.0
267          RC    0.05   0.047   0.048 7056.98    0.01     0.0
             * F2-F3
268          RX     0.0   350.0   425.0   455.0   472.0   499.0   569.0   900.0
269          RY    20.0    15.0    13.0    10.0    10.0    12.0    14.0    20.0
```

HEC-1 INPUT PAGE 7

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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

270          KK      F3
271          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
272          KM    L=2.71      Lca=1.26      S=81.34      Kn=0.055      LAG=54.2
273          KM    S-GRAPH TYPE=DES RNGLND
274          KO       0       0     0.0       1      22
275          BA   0.736
276          LG    0.35    0.35   3.284    0.64     0.0
             * F3
277          UI     0.0   45.89   45.89   90.29  163.16  236.62   300.0   352.3  401.58  427.19
278          UI  439.78  431.51  405.77  355.07  304.27  256.06  219.26  187.54  158.37  134.34
279          UI  113.67   96.02   85.11   70.36   60.22   48.64   46.52   31.41   31.41   31.41
280          UI    21.4   11.17   11.17   11.17   11.17   11.17   11.17   11.17   11.17   11.17
281          UI     0.0

282          KK    E4RB   CNAME   F3-E4
283          KO       0       0     0.0       0      22
284          HC       2

285          KK   F3-E4   CNAME    E4RB
286          KO       0       0     0.0       0      22
287          RS      19    FLOW      0.0     0.0
288          RC    0.05   0.044  0.05276 50.48  0.0072     0.0
             * F3-E4
289          RX     0.0   570.0   650.0   690.0   705.0   735.0   810.0  1200.0
290          RY    20.0    14.0    13.0    10.0    10.0    12.5    14.5    20.0

291          KK      H1
292          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
293          KM    L=2.41      Lca=1.09      S=64.59      Kn=0.055      LAG=51.2
294          KM    S-GRAPH TYPE=DES RNGLND
295          KO       0       0     0.0       1      22
296          BA   1.066
297          LG    0.35    0.35   2.733   0.945     0.0
             * H1
298          UI     0.0   70.38   70.38  156.67  277.53  386.09  481.01   579.0   629.6  674.43
```

```
299         UI  672.95  639.66  573.48  484.85  407.01  343.97  290.32  244.62  205.27   171.4
300         UI  143.72  125.14  107.91   82.11   74.59   59.78   48.17   48.17   44.03   17.13
301         UI   17.13   17.13   17.13   17.13   17.13   17.13   17.13   17.13     0.0

302         KK   H1-H2   CNAME     H2R
303         KO       0       0     0.0       0      22
304         RS      21    FLOW     0.0     0.0
305         RC   0.053    0.05 0.05321739.03  0.0082     0.0
              H1-H2
306         R      0.0   330.0   430.0   465.0   495.0   530.0   630.0   960.0
307         RY    17.0    14.0    12.0    10.0    10.0    12.0    14.0    17.0

308         KK       H2
309         KM   THE FOLLOWIN  PARAMETERS WERE PRO IDED FOR THIS  ASIN
310         KM   L 4.41     L    2.60     S 44.71     K  0.050     LA  88.9
311         KM   S- RAPH TYPE DES RN LND
312         KO       0       0     0.0       1      22
313          A     1.4
314         L     0.35    0.35   3.222   0.664     0.0
              H2
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

315         UI     0.0   52.96   52.96   52.96   52.96  142.93  178.39   226.9  274.71  319.58
316         UI  365.35   394.2  441.12  466.71   479.3  507.56  507.56  507.56  494.47  478.59
317         UI  456.68  413.58  373.47  343.47  306.13  279.54  254.31  232.29  208.19  189.77
318         UI  169.44  155.74  145.02  121.24  117.25   99.85   99.85   83.38   81.21   75.85
319         UI   56.14   56.14   56.14   49.15   36.25   36.25   36.25   36.25   36.25    27.6
320         UI   12.89   12.89   12.89   12.89   12.89   12.89   12.89   12.89   12.89   12.89
321         UI   12.89   12.89   12.89   12.89   12.89   12.89     0.0

322         KK       E4
323         KM   THE FOLLOWIN  PARAMETERS WERE PRO IDED FOR THIS  ASIN
324         KM   L 5.36     L    2.81     S 38.26     K  0.050     LA  101.9
325         KM   S- RAPH TYPE DES RN LND
326         KO       0       0     0.0       1      22
327          A   3.042
328         L     0.35    0.35   3.816   0.439     0.0
              E4
329         UI     0.0  100.41  100.41  100.41  100.41   158.4  288.69  358.15  433.82  515.05
330         UI  586.72  661.74  710.91  802.48  849.78  890.67  905.99   962.3   962.3   962.3
331         UI  958.07  920.61  904.77  855.38  781.14  712.32  671.29  604.26   557.2  512.12
332         UI  469.45  435.76   392.7  363.69  334.37  307.94  277.85  264.88  224.23  220.83
333         UI  189.31  189.31  167.81  153.97  153.97   127.9  106.43  106.43  106.43  101.85
334         UI   68.74   68.74   68.74   68.74   68.74   68.74    56.9   24.44   24.44   24.44
335         UI   24.44   24.44   24.44   24.44   24.44   24.44   24.44   24.44   24.44   24.44
336         UI   24.44   24.44   24.44   24.44   24.44   24.44

337         KK     E5R   CNAME   E4-E5
338         KO       0       0     0.0       0      22
339         HC       5

340         KK   E4-E5   CNAME     E5R
341         KO       0       0     0.0       0      22
342         RS      14    FLOW     0.0     0.0
343         RC    0.06    0.05  0.0615206.17  0.0051     0.0
              E4-E5
344         R      0.0  1010.0  1080.0  1090.0  1110.0  1120.0  1190.0  2200.0
345         RY    27.0    16.0    15.0    10.0    10.0    14.0    16.0    27.0

346         KK       1
347         KM   THE FOLLOWIN  PARAMETERS WERE PRO IDED FOR THIS  ASIN
348         KM   L 4.09     L    1.78     S 70.82     K  0.055     LA  74.8
349         KM   S- RAPH TYPE DES RN LND
350         KO       0       0     0.0       1      22
351          A   1.734
352         L     0.35    0.35    3.25   0.652     0.0
              1
353         UI     0.0   77.84   77.84   77.84  158.12  251.68   335.8  417.86  494.13  554.71
354         UI  644.28  684.07  713.03   746.0   746.0  734.81  705.42  668.25  587.63  533.16
355         UI  468.22   415.2  374.64  332.01  295.05  263.51  233.61  213.14  176.18  163.13
356         UI  146.75  131.28  119.36  107.75   82.51   82.51   80.75   53.29   53.29   53.29
357         UI   53.29    52.6   18.95   18.95   18.95   18.95   18.95   18.95   18.95   18.95
358         UI   18.95   18.95   18.95   18.95   18.95   18.95
```



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LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

359         KK    1- 2   CNAME      2R
360         KO       0       0     0.0       0      22
361         RS      28    FLOW     0.0     0.0
362         RC   0.055    0.04 0.055 24097.0  0.0086     0.0
              1- 2
363         R      0.0   161.0   247.0   254.0   271.0   279.0   393.0   660.0
364         RY    17.0    12.5    12.2    10.8    10.0    12.1    12.9    17.0

365         KK       2
366         KM   THE FOLLOWIN  PARAMETERS WERE PRO IDED FOR THIS  ASIN
367         KM   L 5.18     L    2.51     S 45.01     K  0.050     LA  93.2
368         KM   S- RAPH TYPE DES RN LND
369         KO       0       0     0.0       1      22
370          A   3.638
371         L    0.349   0.348   3.621   0.496   0.281
              2
372         UI     0.0  131.71  131.71  131.71  131.71  310.01   410.2  529.51  653.09  756.38
373         UI  857.33  932.04 1064.81 1131.31 1183.05 1211.21 1262.21 1262.21 1262.21 1218.54
374         UI 1189.1 1123.19 1016.15  925.91  854.62  766.36  699.93  639.84  585.79  530.33
375         UI  484.44   441.0  403.56  360.63  330.99  294.11  269.84   248.3  236.22  201.95
376         UI  201.95  172.61   139.6   139.6   139.6  118.12   90.16   90.16   90.16   90.16
377         UI   90.16   79.42   32.06   32.06   32.06   32.06   32.06   32.06   32.06   32.06
378         UI   32.06   32.06   32.06   32.06   32.06   32.06   32.06   32.06   32.06     0.0
```

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379          KK    K3RB   CNAME   J2-K3
380          KO       0       0     0.0       0      22
381          HC       2

382          KK   J2-K3   CNAME    K3RB
383          KO       0       0     0.0       0      22
384          RS       4    FLOW     0.0     0.0
385          RC    0.05   0.048    0.05 4071.93  0.0059     0.0
             * J2-K3
386          RX     0.0   390.0   490.0   502.0   520.0   532.0   632.0  1022.0
387          RY    20.0    14.5    11.5    10.0    10.0    11.5    14.5    20.0

388          KK      K3
389          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
390          KM   L=4.92     Lca=2.65     S=44.16     Kn=0.050     LAG=93.6
391          KM   S-GRAPH TYPE=DES RNGLND
392          KO       0       0     0.0       1      22
393          BA   1.636
394          LG    0.35    0.35   3.421   0.582     0.0
             * K3
395          UI     0.0    58.6    58.6    58.6    58.6  132.87  178.79  231.72  287.22  333.42
396          UI  374.63  416.06  465.04   498.4  523.32  535.26  561.57  561.57  561.57  546.52
397          UI  528.98  508.31  466.83  418.22  391.32  351.35  318.32  291.61  266.72  243.82
398          UI   222.2   205.3   179.7  166.92  157.94  130.85  127.83  110.47  110.47   92.85
399          UI   89.85   88.89   62.11   62.11   62.11   62.11    41.1   40.11   40.11   40.11
400          UI   40.11   40.11   23.61   14.26   14.26   14.26   14.26   14.26   14.26   14.26
401          UI   14.26   14.26   14.26   14.26   14.26   14.26   14.26   14.26   14.26   14.26
```

0

HEC-1 INPUT PAGE 10

```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

402          KK      E5
403          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
404          KM   L=3.01     Lca=1.41     S=28.56     Kn=0.050     LAG=65.8
405          KM   S-GRAPH TYPE=DES RNGLND
406          KO       0       0     0.0       1      22
407          BA   1.308
408          LG   0.347   0.344    3.94   0.429   0.968
             * E5
409          UI     0.0   66.73   66.73   66.73  187.33  261.54  342.37  416.83  480.54  556.36
410          UI  598.07  622.96  639.46  636.14  605.78  574.36  496.51  443.91  383.22  336.88
411          UI  298.49  258.94  227.11  198.14  176.39   149.0   129.8   120.7  102.31   94.82
412          UI   70.72   70.72   61.39   45.68   45.68   45.68   45.68   18.08   16.24   16.24
413          UI   16.24   16.24   16.24   16.24   16.24   16.24   16.24   16.24   16.24     0.0

414          KK     E6R   CNAME   E5-E6
415          KO       0       0     0.0       0      22
416          HC       5

417          KK   E5-E6   CNAME     E6R
418          KO       0       0     0.0       0      22
419          RS       6    FLOW     0.0     0.0
420          RC   0.063   0.051   0.063  5105.8  0.0037     0.0
             * E5-E6
421          RX     0.0   850.0   980.0   990.0  1030.0  1040.0  1230.0  2020.0
422          RY    25.0    13.0    13.0    10.0    10.0    12.0    12.0    25.0

423          KK      E6
424          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
425          KM   L=3.04     Lca=1.06     S=34.17     Kn=0.050     LAG=57.1
426          KM   S-GRAPH TYPE=DES RNGLND
427          KO       0       0     0.0       1      22
428          BA   2.038
429          LG   0.343   0.336   4.356   0.367   0.711
             * E6
430          UI     0.0  120.38  120.38   205.7  403.51   574.9  733.36  874.59  1019.0 1083.61
431          UI  1153.6 1153.67  1100.2 1038.99  882.77  767.24  653.83  562.64  487.32  412.46
432          UI  353.67  303.21  257.92  226.95  190.12   175.5  127.59  127.59   96.61    82.4
433          UI    82.4    82.4   36.99    29.3    29.3    29.3    29.3    29.3    29.3    29.3
434          UI    29.3    29.3     0.0

435          KK       E   CNAME      2R
436          KO       0       0     0.0       0      22
437          HC       2

438          KK      2R   CNAME       E
439          KO       0       0     0.0       0      22
440          RN      2R

441          KK      G1
442          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
443          KM   L=2.38     Lca=1.08     S=33.76     Kn=0.045     LAG=47.1
444          KM   S-GRAPH TYPE=DES RNGLND
445          KO       0       0     0.0       1      22
446          BA   1.119
```

0

HEC-1 INPUT PAGE 11

```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

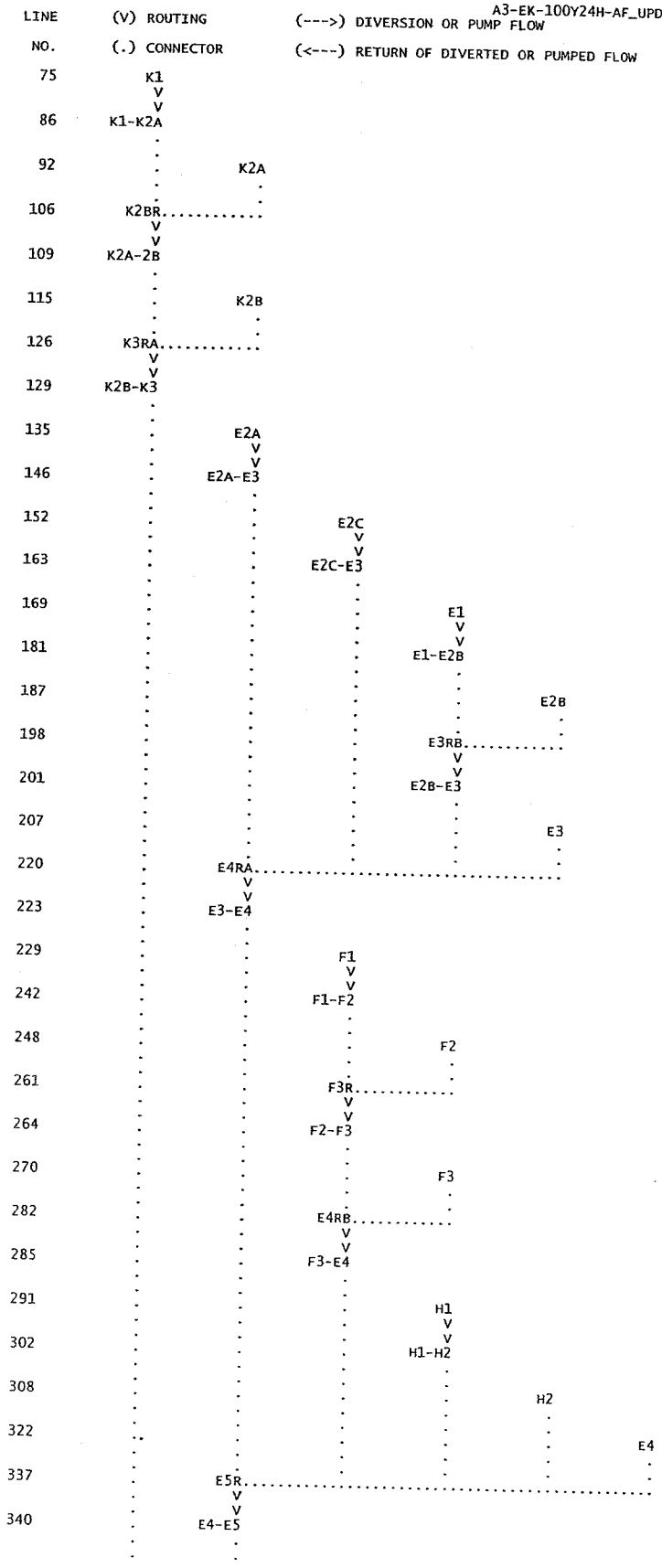
447          LG    0.35    0.35    4.68   0.299     0.0
             * G1
448          UI     0.0   80.16   80.16  213.17  354.95   484.3  602.66  698.84  750.22  768.22
449          UI  735.63  666.98  553.71  458.04  381.89  318.75  263.34   222.2  176.93  151.12
450          UI  124.96  103.28   84.96   70.59   54.87   54.87   43.58   19.51   19.51   19.51
451          UI   19.51   19.51   19.51   19.51   19.51     0.0

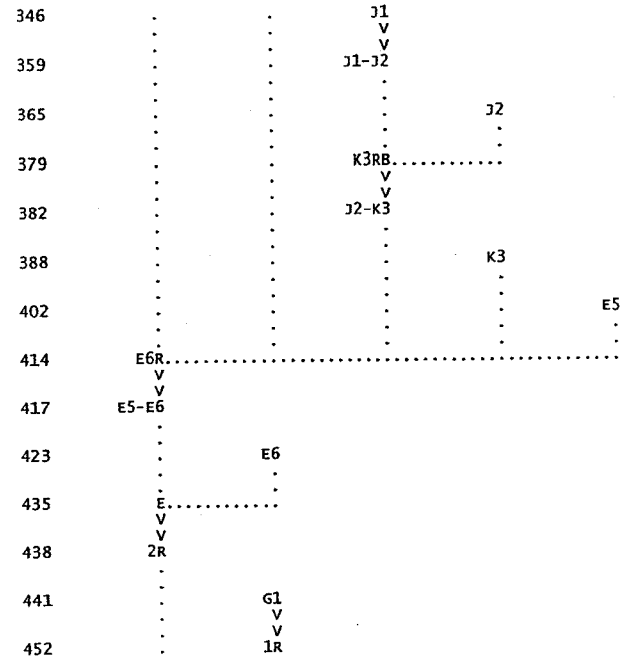
452          KK      1R   CNAME       G
453          KO       0       0     0.0       0      22
454          RN      1R
455          ZZ
```

0

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT


LINE
NO.
(V) ROUTING
(.) CONNECTOR
(---->) DIVERSION OR PUMP FLOW
(<----) RETURN OF DIVERTED OR PUMPED FLOW
75
K1
86
K1-K2A
92
K2A
106
K2BR
109
K2A-2B
115
K2B
126
K3RA
129
K2B-K3
135
E2A
146
E2A-E3
152
E2C
163
E2C-E3
169
E1
181
E1-E2B
187
E2B
198
E3RB
201
E2B-E3
207
E3
220
E4RA
223
E3-E4
229
F1
242
F1-F2
248
F2
261
F3R
264
F2-F3
270
F3
282
E4RB
285
F3-E4
291
H1
302
H1-H2
308
H2
322
E4
337
E5R
340
E4-E5



(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY  1991                 *
*          VERSION 4.0.1E               *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

Buckeye/Sun Valley ADMS - May 2005
Michael Baker Jr., Inc. - Modeler: Jacob Lesue
basins E-K with Aluvial Fan updates
100-year 24-hour
Existing Conditions
Area 3 - Sub-basins E-K (Aluvial Fan updates)
Rainfall Loss Method - Green & Ampt
Unit Hydrograph Method - FCDMC S-Graph
Channel Routing Method - Normal Depth
Land Use - FCDMC GIS Data: mag_landuse (2000)
Soil Data - USDA SCS Soil Survey (1972 & 1981)
Units - L(mi) Lca(mi) S(ft/mi) LAG(min)

```
 14 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

 15 IN          TIME DATA FOR INPUT TIME SERIES
                    JXMIN         15  TIME INTERVAL IN MINUTES
                   JXDATE      1JAN94  STARTING DATE
                   JXTIME          0  STARTING TIME

 27 IN          TIME DATA FOR INPUT TIME SERIES
                    JXMIN         15  TIME INTERVAL IN MINUTES
                   JXDATE      1JAN94  STARTING DATE
                   JXTIME          0  STARTING TIME

 39 IN          TIME DATA FOR INPUT TIME SERIES
                    JXMIN         15  TIME INTERVAL IN MINUTES
                   JXDATE      1JAN94  STARTING DATE
                   JXTIME          0  STARTING TIME

 51 IN          TIME DATA FOR INPUT TIME SERIES
                    JXMIN         15  TIME INTERVAL IN MINUTES
                   JXDATE      1JAN94  STARTING DATE
                   JXTIME          0  STARTING TIME

 63 IN          TIME DATA FOR INPUT TIME SERIES
                    JXMIN         15  TIME INTERVAL IN MINUTES
                   JXDATE      1JAN94  STARTING DATE
                   JXTIME          0  STARTING TIME

    IT          HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1JAN94  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ,       2000  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      7JAN94  ENDING DATE
                   NDTIME        2235  ENDING TIME
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ICENT 19 CENTURY MARK

COMPUTATION INTERVAL 0.08 HOURS
TOTAL TIME BASE 166.58 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

16 JD INDEX STORM NO. 1
STRM 4.16 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

17 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
0.03	0.09	0.09	0.09	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

28 JD INDEX STORM NO. 2
STRM 3.95 PRECIPITATION DEPTH
TRDA 10.00 TRANSPOSITION DRAINAGE AREA

29 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
0.03	0.09	0.09	0.09	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

40 JD INDEX STORM NO. 3
STRM 3.82 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

41 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
0.03	0.09	0.09	0.09	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

52 JD INDEX STORM NO. 4
STRM 3.69 PRECIPITATION DEPTH
TRDA 40.00 TRANSPOSITION DRAINAGE AREA

53 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
0.03	0.09	0.09	0.09	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

64 JD INDEX STORM NO. 5
STRM 3.57 PRECIPITATION DEPTH
TRDA 80.00 TRANSPOSITION DRAINAGE AREA

65 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
0.03	0.09	0.09	0.09	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

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          **************
          *            *
75 KK     *     K1     *
          *            *
          **************
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THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
L=3.23 Lca=1.84 S=681.00 Kn=0.050 LAG=40.4
S-GRAPH TYPE=PHX MNT

79 KO OUTPUT CONTROL VARIABLES

IPRNT	3	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE
IPNCH	1	PUNCH COMPUTED HYDROGRAPH
IOUT	22	SAVE HYDROGRAPH ON THIS UNIT
ISAV1	1	FIRST ORDINATE PUNCHED OR SAVED
ISAV2	2000	LAST ORDINATE PUNCHED OR SAVED
TIMINT	0.083	TIME INTERVAL IN HOURS

(INCHES)	1.133	1.133	1.133	1.133
(AC-FT)	68.	68.	68.	68.

CU U ATI E A EA 1.12 S I

4 2 KK 1 CNA E

4 3 K

UTPUT C NT	A IA ES	
IP NT	3	P INT C NT
IP T	0	P T C NT
SCA	0.	HYD APH P T SCA E
IPNCH	0	PUNCH C PUTED HYD APH
I UT	22	SA E HYD APH N THIS UNIT
ISA 1	1	FI ST DINATE PUNCHED SA ED
ISA 2	2000	AST DINATE PUNCHED SA ED
TI INT	0.083	TI E INTE A IN H U S

HYD APH UTIN DATA

4 4 N N UTIN

HYD APH AT STATI N 1
T ANSP SITI N A EA 0.0 S I

PEAK F	TI E		A I U A E A E F			
		6-H	24-H	2-H	166. 8-H	
(CFS)	(H)	(CFS)				
86.	12. 8	14.	36.	12.		
		(INCHES) 1.203	1.203	1.203	1.203	
		(AC-FT) 2.	2.	2.	2.	

CU U ATI E A EA 1.12 S I

HYD APH AT STATI N 1
T ANSP SITI N A EA 10.0 S I

PEAK F	TI E		A I U A E A E F			
		6-H	24-H	2-H	166. 8-H	
(CFS)	(H)	(CFS)				
6.	12. 8	132.	33.	11.		
		(INCHES) 1.100	1.100	1.100	1.100	
		(AC-FT) 66.	66.	66.	66.	

CU U ATI E A EA 1.12 S I

HYD APH AT STATI N 1
T ANSP SITI N A EA 20.0 S I

PEAK F	TI E		A I U A E A E F			
		6-H	24-H	2-H	166. 8-H	
(CFS)	(H)	(CFS)				
3.	12. 8	12.	31.	10.	4.	
		(INCHES) 1.03	1.03	1.03	1.03	
		(AC-FT) 62.	62.	62.	62.	

CU U ATI E A EA 1.12 S I

HYD APH AT STATI N 1
T ANSP SITI N A EA 40.0 S I

PEAK F	TI E		A I U A E A E F			
		6-H	24-H	2-H	166. 8-H	
(CFS)	(H)	(CFS)				
12.	12. 8	118.	2.	10.	4.	
		(INCHES) 0.	0.	0.	0.	
		(AC-FT) 8.	8.	8.	8.	

CU U ATI E A EA 1.12 S I

HYD APH AT STATI N 1
T ANSP SITI N A EA 80.0 S I

PEAK F	TI E		A I U A E A E F			
		6-H	24-H	2-H	166. 8-H	
(CFS)	(H)					

+	671.	12.58	(CFS)	111.	28.	9.	4.
			(INCHES)	0.922	0.922	0.922	0.922
			(AC-FT)	55.	55.	55.	55.

CUMULATIVE AREA = 1.12 SQ MI

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INTERPOLATED HYDROGRAPH AT 1R

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR
+ (CFS)	(HR)	(CFS)				
+ 819.	12.58		136.	34.	11.	5.
		(INCHES)	1.133	1.133	1.133	1.133
		(AC-FT)	68.	68.	68.	68.

CUMULATIVE AREA = 1.12 SQ MI

0

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	K1	1433.	12.50	254.	74.	25.	1.54		
+	ROUTED TO	K1-K2A	1031.	13.25	254.	74.	25.	1.54		
+	HYDROGRAPH AT	K2A	827.	13.25	245.	62.	21.	1.95		
+	2 COMBINED AT	K2BR	1839.	13.25	495.	135.	45.	3.49		
+	ROUTED TO	K2A-2B	1701.	13.67	493.	135.	45.	3.49		
+	HYDROGRAPH AT	K2B	217.	12.58	32.	8.	3.	0.42		
+	2 COMBINED AT	K3RA	1718.	13.67	520.	142.	48.	3.91		
+	ROUTED TO	K2B-K3	1392.	15.17	514.	142.	48.	3.91		
+	HYDROGRAPH AT	E2A	572.	12.67	105.	26.	9.	0.80		
+	ROUTED TO	E2A-E3	461.	13.67	105.	26.	9.	0.80		
+	HYDROGRAPH AT	E2C	541.	12.58	88.	22.	7.	0.72		
+	ROUTED TO	E2C-E3	424.	13.58	88.	22.	7.	0.72		
+	HYDROGRAPH AT	E1	790.	12.50	125.	32.	11.	0.96		
+	ROUTED TO	E1-E2B	687.	12.83	125.	32.	11.	0.96		
+	HYDROGRAPH AT	E2B	352.	12.58	57.	14.	5.	0.47		
+	2 COMBINED AT	E3RB	958.	12.83	181.	45.	15.	1.42		
+	ROUTED TO	E2B-E3	751.	13.75	179.	45.	15.	1.42		
+	HYDROGRAPH AT	E3	1130.	13.00	289.	72.	24.	2.49		
+	4 COMBINED AT	E4RA	2205.	13.58	645.	163.	54.	5.42		
+	ROUTED TO	E3-E4	1911.	14.67	637.	163.	54.	5.42		
+	HYDROGRAPH AT	F1	1868.	12.83	433.	121.	40.	3.10		
+	ROUTED TO	F1-F2	1823.	12.83	432.	121.	40.	3.10		
+	HYDROGRAPH AT	F2	1333.	12.75	266.	69.	23.	2.21		
+	2 COMBINED AT	F3R	3030.	12.83	693.	188.	63.	5.31		
+	ROUTED TO	F2-F3	2783.	13.08	692.	188.	63.	5.31		

FAN 38

+	HYDROGRAPH AT	F3	375.	12.75	69.	17.	6.	0.74
+	2 COMBINED AT	E4RB	3032.	13.08	758.	205.	68.	6.05
+	ROUTED TO	F3-E4	2414.	14.58	752.	204.	68.	6.05
+	HYDROGRAPH AT	H1	472.	12.75	82.	20.	7.	1.07
+	ROUTED TO	H1-H2	314.	14.33	80.	20.	7.	1.07
+	HYDROGRAPH AT	H2	432.	13.25	128.	32.	11.	1.40
+	HYDROGRAPH AT	E4	966.	13.42	328.	83.	28.	3.04
+	5 COMBINED AT	E5R	4827.	14.58	1788.	475.	159.	16.98
+	ROUTED TO	E4-E5	4422.	15.67	1782.	475.	159.	16.98
+	HYDROGRAPH AT	J1	633.	13.08	160.	40.	13.	1.73
+	ROUTED TO	J1-J2	494.	15.33	158.	40.	13.	1.73
+	HYDROGRAPH AT	J2	1212.	13.33	379.	95.	32.	3.64
+	2 COMBINED AT	K3RB	1206.	13.33	529.	134.	45.	5.37
+	ROUTED TO	J2-K3	1184.	13.58	527.	134.	45.	5.37
+	HYDROGRAPH AT	K3	507.	13.33	160.	40.	13.	1.64
+	HYDROGRAPH AT	E5	645.	12.92	147.	37.	12.	1.31
+	5 COMBINED AT	E6R	5888.	15.58	2826.	770.	257.	29.20
+	ROUTED TO	E5-E6	5765.	16.00	2814.	770.	257.	29.20
+	HYDROGRAPH AT	E6	1194.	12.75	237.	60.	20.	2.04
+	2 COMBINED AT	E	5760.	16.00	2947.	822.	275.	31.24
+	ROUTED TO	2R	5727.	16.00	2931.	818.	273.	31.24
+	HYDROGRAPH AT	G1	819.	12.58	136.	34.	11.	1.12
+	ROUTED TO	1R	819.	12.58	136.	34.	11.	1.12

*** NORMAL END OF HEC-1 ***

Buckeye/Sun Valley Area Drainage Master Study
Sub-basins L-R
HEC-1 Model
100 year, 6 hour

Buckeye SunValley ADMS 4/27/05

UPDATED HEC-1 BOUNDARIES

Buckeye/Sun Valley Area Drainage Master Study
Sub-basins L-R
HEC-1 Model
100 year, 24 hour

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1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY  1991                 *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*        DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748              *
*                                       *
*****************************************
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x     x  xxxxxxx   xxxxx          x
x     x  x        x     x       xx
x     x  x        x             x
xxxxxxx  xxxx     x       xxxxx x
x     x  x        x             x
x     x  x        x     x       x
x     x  xxxxxxx  xxxxx         xxx
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT

PAGE 1

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LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
   1          ID  Buckeye/Sun Valley ADMS - May 2005
   2          ID  Michael Baker Jr., Inc. - Modeler: Jacob Lesue
   3          ID  100-year 6-hour
   4          ID  Existing Conditions
   5          ID  Area 3 - Sub-basins L-R (Aluvial Fan updates)
   6          ID  Rainfall Loss Method - Green & Ampt
   7          ID  Unit Hydrograph Method - FCDMC S-Graph
   8          ID  Channel Routing Method - Normal Depth
   9          ID  Land Use - FCDMC GIS Data: mag_landuse (2000)
  10          ID  Soil Data - USDA SCS Soil Survey (1972 & 1981)
  11          ID  Units - L(mi)   Lca(mi)   S(ft/mi)   LAG(min)
              *DIAGRAM
  12          IT       5 01JAN94        0    2000
  13          IO       3
  14          IN      15 01JAN94        0
  15          JD    3.23     0.01
              * 6-hour distribution, pattern 1.0
  16          PC     0.0    0.008    0.016    0.025    0.033    0.041     0.05    0.058    0.066    0.074
  17          PC   0.087    0.099    0.118    0.138    0.216    0.377    0.834    0.911    0.931     0.95
  18          PC   0.962    0.972    0.983    0.991      1.0
  19          IN      15 01JAN94        0
  20          JD   3.211      0.5
              * 6-hour distribution, pattern 1.0
  21          PC     0.0    0.008    0.016    0.025    0.033    0.041     0.05    0.058    0.066    0.074
  22          PC   0.087    0.099    0.118    0.138    0.216    0.377    0.834    0.911    0.931     0.95
  23          PC   0.962    0.972    0.983    0.991      1.0
  24          IN      15 01JAN94        0
  25          JD   3.188      1.0
              * 6-hour distribution, pattern 1.4
  26          PC     0.0   0.0084    0.016    0.025   0.0334   0.0414   0.0504   0.0584   0.0664   0.0748
  27          PC   0.087   0.0994   0.1188    0.148   0.2304   0.4067   0.7778   0.8813   0.9186   0.9452
  28          PC  0.9572   0.9684   0.9798   0.9898      1.0
  29          IN      15 01JAN94        0
  30          JD   3.101      5.0
              * 6-hour distribution, pattern 2.3
  31          PC     0.0    0.011   0.0173   0.0267   0.0387    0.049   0.0593   0.0693   0.0797   0.0903
  32          PC   0.103   0.1173   0.1383   0.1827   0.2693    0.458    0.686   0.8233   0.8893   0.9293
  33          PC  0.9487    0.962   0.9743   0.9877      1.0
  34          IN      15 01JAN94        0
  35          JD   3.036     10.0
              * 6-hour distribution, pattern 2.7
  36          PC     0.0   0.0134   0.0189   0.0287   0.0443   0.0574   0.0694   0.0818   0.0949   0.1076
  37          PC  0.1223   0.1382   0.1604   0.2063   0.2902   0.4664   0.6764   0.8069   0.8765   0.9189
  38          PC  0.9471   0.9608   0.9735   0.9873      1.0
  39          IN      15 01JAN94        0
  40          JD   2.939     20.0
              * 6-hour distribution, pattern 3.1
  41          PC     0.0   0.0158    0.022   0.0329   0.0511   0.0663   0.0799   0.0948   0.1102   0.1246
  42          PC   0.141   0.1587   0.1828     0.23   0.3122   0.4758   0.6684   0.7929   0.8643   0.9087
  43          PC  0.9434    0.958   0.9718   0.9863      1.0
  44          IN      15 01JAN94        0
  45          JD   2.875     30.0
              * 6-hour distribution, pattern 3.4
  46          PC     0.0   0.0172   0.0256   0.0378   0.0565   0.0719   0.0868    0.103   0.1191   0.1342
  47          PC  0.1513   0.1702   0.1961   0.2439   0.3263   0.4824   0.6655   0.7875    0.858   0.9031
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HEC-1 INPUT

PAGE 2

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LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
  48          PC   0.939   0.9544   0.9697   0.9851      1.0
  49          IN      15 01JAN94        0
  50          JD    2.81     40.0
              * 6-hour distribution, pattern 3.5
  51          PC     0.0   0.0182   0.0281   0.0413   0.0604   0.0759   0.0916   0.1088   0.1254    0.141
  52          PC  0.1586   0.1783   0.2056   0.2537   0.3362    0.487   0.6636   0.7836   0.8535   0.8991
  53          PC  0.9358   0.9519   0.9682   0.9843      1.0
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KK      R1
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=1.01      Lca=0.46      S=213.31      Kn=0.050      LAG=18.8
KM   S-GRAPH TYPE=PHX MNT
KO       0       0     0.0       1      22
BA    0.284
LG    0.35    0.35   4.358   0.374   8.387
* R1
UI     0.0   62.14  236.01  401.85  464.97  281.72   216.1  150.63  113.71   76.28
UI   57.55   39.69   27.53   24.54    9.63    9.63    9.63    9.63     0.0

KK     13R   CNAME       R
KO       0       0     0.0       0      22
RN     13R

KK      M1
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=5.19      Lca=2.41      S=230.06      Kn=0.050      LAG=66.8
KM   S-GRAPH TYPE=PHX MNT
KO       0       0     0.0       1      22
BA    5.686
LG    0.35    0.35   4.297    0.35  16.637
* M1
UI     0.0  285.74  285.74  285.74  777.57 1062.36 1436.64 1746.69  1963.2  2166.6
UI  2402.0 2950.38 3432.01 2399.97 1965.75 1755.17 1651.21 1526.96 1413.1 1330.61
UI  1198.5 1122.73 1012.84  904.53  777.77  717.96  682.12  653.26  597.45  521.66
UI  469.43  394.74  365.11  349.25  312.95  312.95  266.95  219.07  219.07  219.07
UI  181.82  139.83  139.83  139.83  139.83  139.83   125.2   54.77   54.77   54.77
UI   54.77   54.77   54.77   54.77   54.77   54.77   54.77   54.77   54.77   54.77
UI   54.77   54.77     0.0

KK   M1-M2   CNAME     M2R
KO       0       0     0.0       0      22
RS      24    FLOW     0.0     0.0
RC    0.04    0.04  0.04534769.89  0.0133     0.0
* M1-M2
RX     0.0   961.0  1028.0  1051.0  1136.0  1153.0  1193.0  1900.0
RY    15.5    12.0    11.8    10.3    10.0    11.0    11.2    15.5

KK      M2
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=6.59      Lca=3.00      S=71.62      Kn=0.050      LAG=100.2
KM   S-GRAPH TYPE=DES RNGLND
KO       0       0     0.0       1      22
BA    7.436
LG    0.35    0.35   3.959   0.445   0.291
* M2
```



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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

UI     0.0  250.38  250.38  250.38  250.38  438.17  719.85  924.82 1114.75 1312.86
UI  1497.2  1700.9 1779.05 2056.71 2161.12 2246.81 2290.07 2399.49 2399.49 2399.49
UI  2351.5 2259.21 2219.84 2074.04 1858.21 1745.08 1567.89 1438.64 1323.61 1214.96
UI  1118.4 1022.47  940.03  874.15  767.84  718.48  685.57  569.22   559.1  484.22
UI  472.03  435.02  383.92  383.92  334.13  265.38  265.38  265.38  257.86  171.39
UI  171.39  171.39  171.39  171.39  171.39  131.63   60.94   60.94   60.94   60.94
UI   60.94   60.94   60.94   60.94   60.94   60.94   60.94   60.94   60.94   60.94
UI   60.94   60.94   60.94   60.94     0.0

KK       M   CNAME      5R
KO       0       0     0.0       0      22
HC       2

KK      5R   CNAME       M
KO       0       0     0.0       0      22
RN      5R

KK      N1
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=2.79      Lca=1.44      S=340.38      Kn=0.050      LAG=39.7
KM   S-GRAPH TYPE=PHX MNT
KO       0       0     0.0       1      22
BA    1.524
LG    0.35    0.35   4.075   0.419   8.38
* N1
UI     0.0  128.28  166.77  436.68  697.63  885.37 1048.86 1439.85 1097.59  811.01
UI  717.89  633.24  554.41  482.34  398.71  327.22  300.33  268.08  210.75  167.66
UI  152.68   140.5  106.78   98.35   84.12   62.78   62.78   62.78   38.34   24.59
UI   24.59   24.59   24.59   24.59   24.59   24.59   24.59     0.0

KK   N1-N2   CNAME     N2R
KO       0       0     0.0       0      22
RS      21    FLOW     0.0     0.0
RC    0.05   0.047  0.0525647.52  0.0115     0.0
* N1-N2
RX     0.0   280.0   350.0   358.0   367.0   381.0   451.0   730.0
RY    17.0    13.0    11.5    10.0    10.0    11.5    13.0    17.0

KK      N2
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=5.64      Lca=3.27      S=170.14      Kn=0.055      LAG=90.7
KM   S-GRAPH TYPE=PHX MNT
KO       0       0     0.0       1      22
BA    3.325
LG    0.35    0.35   4.117   0.405    2.67
* N2
UI     0.0  123.04  123.04  123.04  123.04  310.82  395.95  496.74  616.35  730.85
UI  796.45  869.05  928.56  990.24 1125.95 1316.06 1517.94 1186.36  925.57  834.34
UI  764.31  726.51  694.11  654.42   619.9  586.86  557.14  517.77  491.74   466.8
UI  422.37  387.25   352.0  325.27  302.29  296.75  282.99  272.23  257.26  234.33
UI  202.13  202.13  163.14  157.22  157.22  143.92  134.76  134.76  134.76  103.63
UI   94.33   94.33   94.33   94.33   83.75   60.21   60.21   60.21   60.21   60.21
UI   60.21   60.21   60.21   32.52   23.58   23.58   23.58   23.58   23.58   23.58
UI   23.58   23.58   23.58   23.58   23.58   23.58   23.58   23.58   23.58   23.58
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139          UI   23.58   23.58   23.58   23.58   23.58
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HEC-1 INPUT


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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

140          KK       N   CNAME       8R
141          KO       0       0      0.0        0       22
142          HC       2

143          KK      8R   CNAME        N
144          KO       0       0      0.0        0       22
145          RN      8R

146          KK     P1A
147          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
148          KM    L=2.28      Lca=1.41      S=461.40      Kn=0.055      LAG=37.8
149          KM    S-GRAPH TYPE=PHX MNT
150          KO       0       0      0.0        1       22
151          BA     0.5
152          LG    0.35    0.35    3.987    0.405   16.364
             * P1A
153          UI     0.0   44.27   65.19    161.0   254.76   318.08   389.84   500.04   319.07   264.12
154          UI  232.17  203.71  176.98   147.14   118.21   105.19    95.13    74.96    59.42    52.89
155          UI   48.49   35.98   33.94    26.82    21.67    21.67    21.56     8.49     8.49     8.49
156          UI    8.49    8.49    8.49     8.49     8.49     8.49

157          KK  P1A-1B   CNAME     P1BR
158          KO       0       0      0.0        0       22
159          RS      18    FLOW      0.0      0.0
160          RC    0.05   0.047   0.0520102.87   0.0111      0.0
             * P1A-P1B
161          RX     0.0   280.0   350.0    358.0    367.0    381.0    451.0    730.0
162          RY    17.0    13.0    11.5     10.0     10.0     11.5     13.0     17.0

163          KK     P1B
164          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
165          KM    L=4.39      Lca=2.32      S=70.84      Kn=0.055      LAG=85.3
166          KM    S-GRAPH TYPE=PHX MNT
167          KO       0       0      0.0        1       22
168          BA   1.937
169          LG    0.35    0.35    4.23    0.393    4.667
             * P1B
170          UI     0.0   76.72   76.72    76.72    89.67   220.58   274.25   335.86   432.98   478.15
171          UI  527.91  570.85  609.55   688.62   814.07    942.3   716.43    568.2   506.83   467.32
172          UI   446.8  421.86  394.79   374.39   356.44   329.11   309.33   293.98   263.37   241.82
173          UI  216.83  200.89  187.72   181.75   176.46   163.15   160.42   127.42   126.04    109.8
174          UI   98.03   98.03   90.75    84.03    84.03    84.03    60.08    58.82    58.82    58.82
175          UI   58.82   40.74   37.54    37.54    37.54    37.54    37.54    37.54    37.54     17.9
176          UI   14.71   14.71   14.71    14.71    14.71    14.71    14.71    14.71    14.71    14.71
177          UI   14.71   14.71   14.71    14.71    14.71    14.71    14.71    14.71    14.71      0.0

178          KK       P   CNAME      12R
179          KO       0       0      0.0        0       22
180          HC       2
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HEC-1 INPUT


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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

181          KK     12R   CNAME        P
182          KO       0       0      0.0        0       22
183          RN     12R

184          KK      O1
185          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
186          KM    L=5.20      Lca=2.79      S=64.07      Kn=0.055      LAG=99.9
187          KM    S-GRAPH TYPE=PHX MNT
188          KO       0       0      0.0        1       22
189          BA   3.088
190          LG    0.35    0.35    4.191    0.393    2.105
             * O1
191          UI     0.0  103.98  103.98   103.98   103.98   181.97   298.95   378.66   446.43   550.06
192          UI  624.46  676.83  731.54   781.25   824.52   905.38  1042.04  1204.77   1242.7   887.05
193          UI   765.3   690.9  643.35   614.88   590.49   558.55   530.78   506.48   485.09   454.93
194          UI  429.36  410.34   388.6   356.95   326.56    302.9   274.89   260.97   254.42   242.21
195          UI  239.16  221.76  217.42   189.46   170.83   170.83   140.46   132.86   132.86   129.07
196          UI  113.88  113.88  113.88   113.88    79.72    79.72    79.72    79.72    79.72    79.72
197          UI   50.88   50.88   50.88    50.88    50.88    50.88    50.88    50.88    50.88    32.31
198          UI   19.93   19.93   19.93    19.93    19.93    19.93    19.93    19.93    19.93    19.93
199          UI   19.93   19.93   19.93    19.93    19.93    19.93    19.93    19.93    19.93    19.93
200          UI   19.93   19.93   19.93      0.0

201          KK      7R   CNAME        O
202          KO       0       0      0.0        0       22
203          RN      7R

204          KK     Q1A
205          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
206          KM    L=3.13      Lca=1.52      S=256.86      Kn=0.055      LAG=49.3
207          KM    S-GRAPH TYPE=PHX MNT
208          KO       0       0      0.0        1       22
209          BA   1.297
210          LG    0.35    0.35    4.127      0.4     11.2
             * Q1A
211          UI     0.0   89.12   89.12   213.78   363.94   517.41   613.88   697.52   873.62  1020.97
212          UI  663.18  556.48  506.64   454.84   413.29   367.46   326.01   281.03   232.04   214.37
213          UI  199.35   177.4  146.41   118.69   112.45    97.61    96.73    68.33    68.33     66.1
214          UI   43.61   43.61   43.61    43.61    30.77    17.08    17.08    17.08    17.08    17.08
215          UI   17.08   17.08   17.08    17.08    17.08    17.08      0.0

216          KK  Q1A-1B   CNAME     Q1BR
217          KO       0       0      0.0        0       22
218          RS       8    FLOW      0.0      0.0
```

```
219          RC    0.05    0.047    0.05 9170.53  0.0117     0.0
             * Q1A-Q1B
220          RX     0.0    280.0    350.0    358.0    367.0    381.0    451.0    730.0
221          RY    17.0     13.0     11.5     10.0     10.0     11.5     13.0     17.0
```



```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

222          KK     Q1B
223          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
224          KM   L=2.35     Lca=1.14     S=141.40     Kn=0.055     LAG=44.3
225          KM   S-GRAPH TYPE=PHX MNT
226          KO       0        0      0.0        1       22
227          BA    0.937
228          LG    0.35     0.35     4.32    0.373   14.815
             * Q1B
229          UI     0.0    71.67    71.67   221.51   340.68   455.79    538.5   651.95   833.61   538.15
230          UI  443.72   398.92   355.79   316.26   280.46   235.89   196.37   173.35   160.17   138.81
231          UI  114.82    91.58    84.67     78.5    62.48    54.95    54.15    35.07    35.07    35.07
232          UI   35.07    15.79    13.74    13.74    13.74    13.74    13.74    13.74    13.74    13.74
233          UI   13.74      0.0

234          KK       Q    CNAME      14R
235          KO       0        0      0.0        0       22
236          HC       2

237          KK     14R    CNAME        Q
238          KO       0        0      0.0        0       22
239          RN     14R

240          KK      L1
241          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
242          KM   L=4.93     Lca=2.29     S=308.27     Kn=0.050     LAG=60.6
243          KM   S-GRAPH TYPE=PHX MNT
244          KO       0        0      0.0        1       22
245          BA    3.546
246          LG   0.271    0.318    4.363    0.351   16.279
             * L1
247          UI     0.0   195.74   195.74   266.93   603.63   823.25  1120.55  1287.08  1452.32  1611.07
248          UI  1991.3  2326.76  1575.06  1312.31  1173.43  1097.39  1002.28   929.54    850.5   775.66
249          UI  701.22   620.51   525.99   484.91   458.87   430.63   397.34   321.57   290.98   250.11
250          UI  241.82   214.38   214.38   171.29   150.06   150.06   149.52    95.79    95.79    95.79
251          UI   95.79    95.79     79.7    37.52    37.52    37.52    37.52    37.52    37.52    37.52
252          UI   37.52    37.52    37.52    37.52    37.52    37.52    37.52      0.0

253          KK  L1-L2A    CNAME     L2AR
254          KO       0        0      0.0        0       22
255          RS       3     FLOW      0.0      0.0
256          RC   0.046    0.045    0.046 7078.75   0.0174     0.0
             * L1-L2A
257          RX     0.0     80.0    165.0    200.0    215.0    255.0    340.0    420.0
258          RY    19.0     17.0     14.0     10.0     10.0     14.0     18.0     22.0

259          KK      L2A
260          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
261          KM   L=2.46     Lca=1.12     S=136.18     Kn=0.055     LAG=45.0
262          KM   S-GRAPH TYPE=DES RNGLND
263          KO       0        0      0.0        1       22
264          BA    0.693
265          LG    0.35    0.384    5.641    0.202      0.0
             * L2A
266          UI     0.0    51.83    51.83   153.34   242.24   330.72   404.46   460.56   494.88   492.21
```



```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

267          UI  461.36   394.37   327.78   266.87   221.69   182.72   150.08   121.91   100.64    84.23
268          UI   69.92    54.93    46.45    35.48    35.48    26.06    12.61    12.61    12.61    12.61
269          UI   12.61    12.61    12.61    12.61

270          KK    L2BR    CNAME   L2A-2B
271          KO       0        0      0.0        0       22
272          HC       2

273          KK  L2A-2B    CNAME     L2BR
274          KO       0        0      0.0        0       22
275          RS       7     FLOW      0.0      0.0
276          RC   0.046    0.045   0.04620743.37   0.0147     0.0
             * L2A-L2B
277          RX     0.0     80.0    165.0    200.0    215.0    255.0    340.0    420.0
278          RY    19.0     17.0     14.0     10.0     10.0     14.0     18.0     22.0

279          KK      L2B
280          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
281          KM   L=5.13     Lca=1.82     S=93.37     Kn=0.055     LAG=78.1
282          KM   S-GRAPH TYPE=DES RNGLND
283          KO       0        0      0.0        1       22
284          BA    4.077
285          LG    0.35     0.35    4.179    0.399      0.0
             * L2B
286          UI     0.0   175.97   175.97   175.97   311.91   535.45   724.28    902.8  1071.35  1224.63
287          UI  1376.8  1511.61  1580.95  1658.53  1686.39  1686.39  1632.48  1568.59  1460.56  1278.33
288          UI  1172.5  1030.99   927.32   829.82   742.49    663.7   594.61   529.93   481.83    405.6
289          UI   377.6   331.75   310.22   269.82   269.19   186.51   186.51   186.51    145.4   120.46
290          UI  120.46   120.46   120.46     90.9    42.83    42.83    42.83    42.83    42.83    42.83
291          UI   42.83    42.83    42.83    42.83    42.83    42.83    42.83    42.83      0.0

292          KK     L3R    CNAME   L2B-L3
293          KO       0        0      0.0        0       22
294          HC       2

295          KK  L2B-L3    CNAME      L3R
296          KO       0        0      0.0        0       22
```

```
297          RS      19    FLOW      0.0      0.0
298          RC    0.05    0.04    0.06 19942.62   0.0089      0.0
             * L2B-L3
299          RX     0.0  1093.0  1210.0  1215.0  1225.0  1232.0  1372.0  2000.0
300          RY    18.0    11.8    11.7    10.0    10.0    11.7    11.8    18.0

301          KK      L2C
302          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
303          KM    L=3.20      Lca=1.55      S=91.31      Kn=0.055      LAG=61.2
304          KM    S-GRAPH TYPE=DES RNGLND
305          KO        0         0     0.0         1        22
306          BA    1.328
307          LG     0.35     0.35   4.189   0.422     0.0
             * L2C
308          UI      0.0    73.31   73.31   99.98  227.13  318.43   414.0  500.47   577.1  643.23
309          UI   678.82   702.58  699.63  666.25  621.66  533.29  468.31  402.86  351.31  303.79
310          UI    266.7   226.83  200.74  164.03  144.98  131.86  112.41   97.97    77.7    77.7
311          UI    56.55    50.18   50.18   50.18   28.53   17.84   17.84   17.84   17.84   17.84
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

312          UI    17.84    17.84    17.84    17.84    17.84      0.0

313          KK   L2C-2D    CNAME     L2DR
314          KO        0        0      0.0        0       22
315          RS        6     FLOW      0.0      0.0
316          RC    0.046    0.045    0.046 9752.35   0.0122      0.0
             * L2C-L2D
317          RX      0.0     80.0    165.0    200.0    215.0    255.0    340.0    420.0
318          RY     19.0     17.0     14.0     10.0     10.0     14.0     18.0     22.0

319          KK      L2D
320          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
321          KM    L=2.77      Lca=1.24      S=74.13      Kn=0.055      LAG=55.4
322          KM    S-GRAPH TYPE=DES RNGLND
323          KO        0         0     0.0         1        22
324          BA    1.232
325          LG     0.35     0.35   3.578   0.544     0.0
             * L2D
326          UI      0.0    75.42   75.42  141.88  262.35  378.71  482.07  569.62  651.08   696.0
327          UI   722.74   714.79  677.77  607.49  518.22  439.07   376.3  322.28  277.17  232.67
328          UI   200.55    167.8  142.18   124.1  114.53   79.93   79.93    61.7   51.62   51.62
329          UI    51.62    20.09   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36
330          UI    18.36      0.0

331          KK    L3RB    CNAME   L2D-L3
332          KO       0        0      0.0        0       22
333          HC       2

334          KK   L2D-L3    CNAME     L3RB
335          KO        0        0      0.0        0       22
336          RS       40     FLOW      0.0      0.0
337          RC     0.05     0.04     0.06 27374.0   0.0077      0.0
             * L2D-L3
338          RX      0.0  1093.0  1210.0  1215.0  1225.0  1232.0  1372.0  2000.0
339          RY     18.0    11.8    11.7    10.0    10.0    11.7    11.8    18.0

340          KK      L3
341          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
342          KM    L=4.75      Lca=2.00      S=44.27      Kn=0.055      LAG=91.0
343          KM    S-GRAPH TYPE=DES RNGLND
344          KO        0         0     0.0         1        22
345          BA    5.852
346          LG    0.341    0.328    3.98   0.419     1.05
             * L3
347          UI      0.0   216.51   216.51   216.51   216.51   546.97    701.8  899.01 1098.32 1266.32
348          UI   1460.0   1557.8 1786.11 1888.64 1950.18 2034.93 2074.93 2074.93 2053.76  1965.5
349          UI   1920.6 1789.17 1583.49 1486.07 1313.64 1207.78 1091.43   994.63   909.22   825.03
350          UI    759.9   663.98   614.46   574.55   483.48   461.45   408.18   402.68   331.99   331.99
351          UI   296.91   229.48   229.48   229.48   197.56   148.21   148.21   148.21   148.21   148.21
352          UI   121.69     52.7     52.7     52.7     52.7     52.7     52.7     52.7     52.7     52.7
353          UI     52.7     52.7     52.7     52.7     52.7     52.7     52.7      0.0
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

354          KK       L    CNAME       1R
355          KO       0        0      0.0        0       22
356          HC       3

357          KK      1R    CNAME        L
358          KO       0        0      0.0        0       22
359          RN      1R

360          KK      Z1
361          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
362          KM    L=1.70      Lca=0.66      S=47.00      Kn=0.055      LAG=39.1
363          KM    S-GRAPH TYPE=DES RNGLND
364          KO        0         0     0.0         1        22
365          BA    0.664
366          LG    0.321    0.292    4.004    0.43    2.909
             * Z1
367          UI      0.0    57.36    79.52   205.33   321.78   424.03   504.07    545.2   540.96   493.73
368          UI   399.49   319.19   256.28    205.1   164.91   127.66   104.64    87.86     60.8     54.1
369          UI    39.27    39.27     21.8    13.96    13.96    13.96    13.96    13.96    13.96      0.0

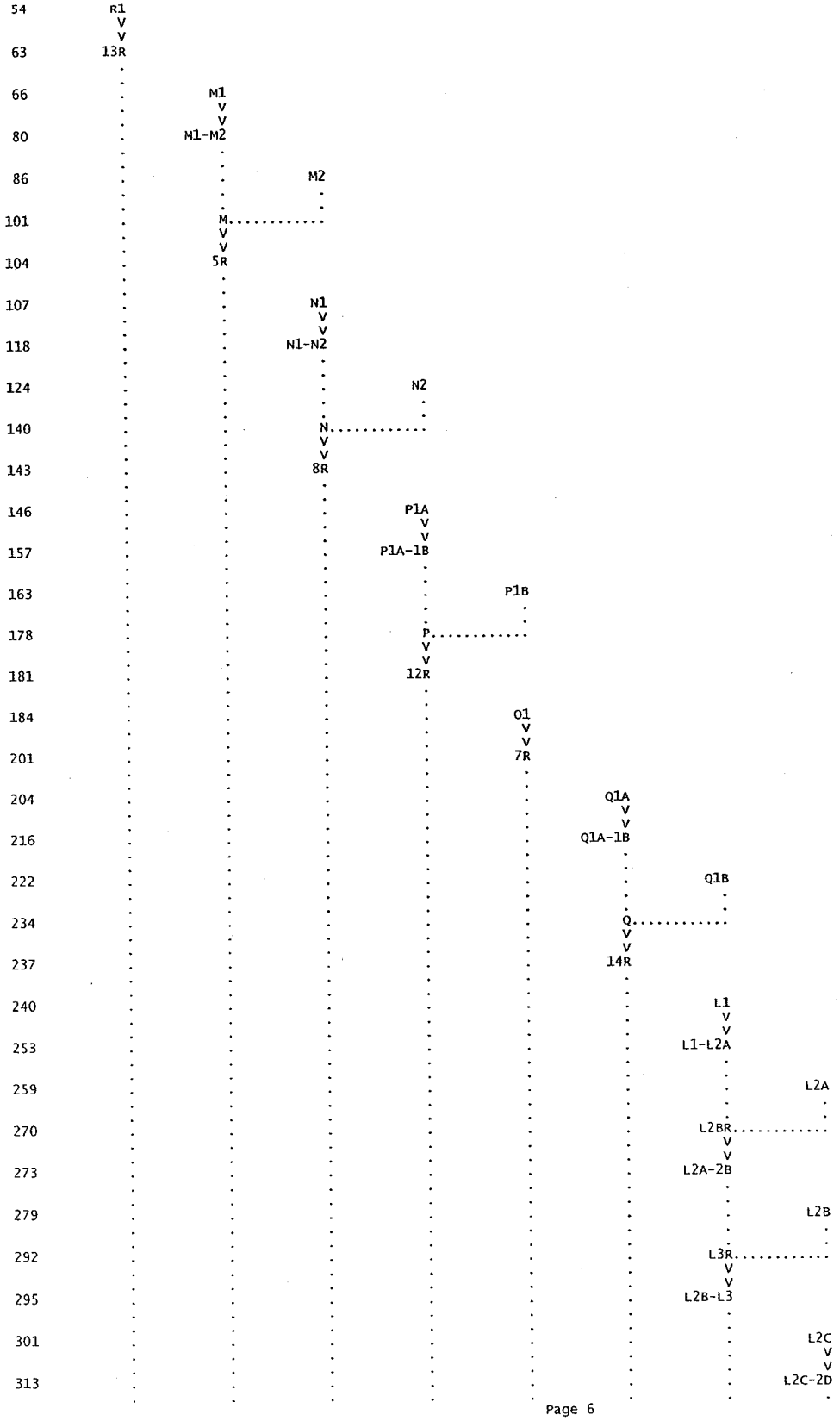
370          KK      4R    CNAME        Z
371          KO       0        0      0.0        0       22
372          RN      4R
373          ZZ
```

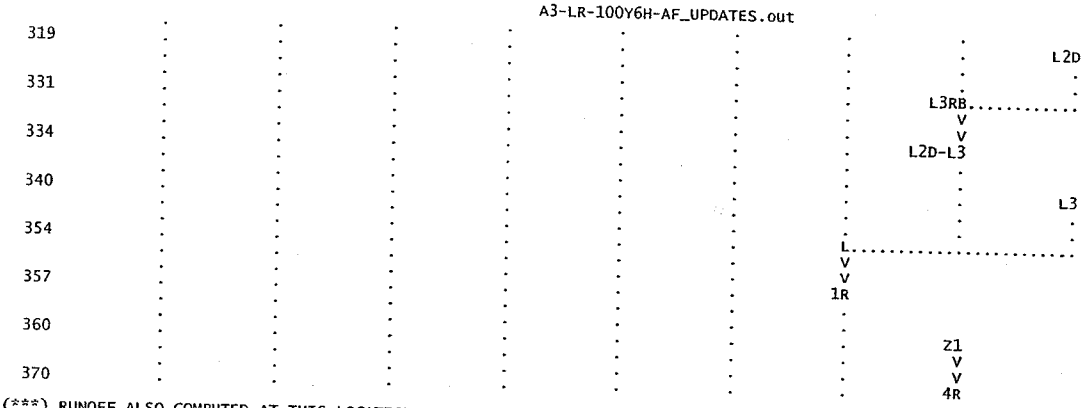
SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE NO.

(V) ROUTING
(.) CONNECTOR

(---->) DIVERSION OR PUMP FLOW
(<----) RETURN OF DIVERTED OR PUMPED FLOW





(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY  1991                 *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*            (916) 551-1748             *
*                                       *
*****************************************
```

Buckeye/Sun Valley ADMS - May 2005
Michael Baker Jr., Inc. - Modeler: Jacob Lesue
100-year 6-hour
Existing Conditions
Area 3 - Sub-basins L-R (Aluvial Fan updates)
Rainfall Loss Method - Green & Ampt
Unit Hydrograph Method - FCDMC S-Graph
Channel Routing Method - Normal Depth
Land Use - FCDMC GIS Data: mag_landuse (2000)
Soil Data - USDA SCS Soil Survey (1972 & 1981)
Units - L(mi) Lca(mi) S(ft/mi) LAG(min)

```
13 IO        OUTPUT CONTROL VARIABLES
                IPRNT        3  PRINT CONTROL
                IPLOT        0  PLOT CONTROL
                QSCAL       0.  HYDROGRAPH PLOT SCALE

14 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

19 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

24 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

29 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

34 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

39 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

44 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

49 IN        TIME DATA FOR INPUT TIME SERIES
                JXMIN       15  TIME INTERVAL IN MINUTES
               JXDATE   1JAN94  STARTING DATE
               JXTIME        0  STARTING TIME

   IT        HYDROGRAPH TIME DATA
                NMIN        5  MINUTES IN COMPUTATION INTERVAL
               IDATE   1JAN94  STARTING DATE
               ITIME     0000  STARTING TIME
                 NQ,     2000  NUMBER OF HYDROGRAPH ORDINATES
              NDDATE   7JAN94  ENDING DATE
              NDTIME     2235  ENDING TIME
              ICENT       19  CENTURY MARK

             COMPUTATION INTERVAL    0.08 HOURS
```

TOTAL TIME BASE 166.58 HOURS

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

15 JD INDEX STORM NO. 1
STRM 3.23 PRECIPITATION DEPTH
TRDA 0.01 TRANSPOSITION DRAINAGE AREA

16 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03
0.03	0.03	0.05	0.05	0.05	0.15	0.15	0.15	0.03	0.03
0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00								

20 JD INDEX STORM NO. 2
STRM 3.21 PRECIPITATION DEPTH
TRDA 0.50 TRANSPOSITION DRAINAGE AREA

21 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03
0.03	0.03	0.05	0.05	0.05	0.15	0.15	0.15	0.03	0.03
0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00								

25 JD INDEX STORM NO. 3
STRM 3.19 PRECIPITATION DEPTH
TRDA 1.00 TRANSPOSITION DRAINAGE AREA

26 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03
0.03	0.03	0.06	0.06	0.06	0.12	0.12	0.12	0.03	0.03
0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00								

30 JD INDEX STORM NO. 4
STRM 3.10 PRECIPITATION DEPTH
TRDA 5.00 TRANSPOSITION DRAINAGE AREA

31 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03
0.03	0.03	0.06	0.06	0.06	0.08	0.08	0.08	0.05	0.05
0.05	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00								

35 JD INDEX STORM NO. 5
STRM 3.04 PRECIPITATION DEPTH
TRDA 10.00 TRANSPOSITION DRAINAGE AREA

36 PI PRECIPITATION PATTERN

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
0.03	0.03	0.06	0.06	0.06	0.07	0.07	0.07	0.04	0.04
0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00								

40 JD INDEX STORM NO. 6
STRM 2.94 PRECIPITATION DEPTH
TRDA 20.00 TRANSPOSITION DRAINAGE AREA

41 PI PRECIPITATION PATTERN

0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06	0.04	0.04
0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00								

45 JD INDEX STORM NO. 7
STRM 2.88 PRECIPITATION DEPTH
TRDA 30.00 TRANSPOSITION DRAINAGE AREA

46 PI PRECIPITATION PATTERN

0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06	0.04	0.04
0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	734.	4.50	104.	26.	9.	4.	
			(INCHES) 1.459	1.460	1.460	1.460	
			(AC-FT) 52.	52.	52.	52.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 4R
TRANSPOSITION AREA 1.0 SQ MI

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	636.	4.50	95.	24.	8.	3.	
			(INCHES) 1.327	1.328	1.328	1.328	
			(AC-FT) 47.	47.	47.	47.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 4R
TRANSPOSITION AREA 5.0 SQ MI

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	442.	4.50	73.	18.	6.	3.	
			(INCHES) 1.027	1.028	1.028	1.028	
			(AC-FT) 36.	36.	36.	36.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 4R
TRANSPOSITION AREA 10.0 SQ MI

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	383.	4.50	65.	16.	5.	2.	
			(INCHES) 0.906	0.907	0.907	0.907	
			(AC-FT) 32.	32.	32.	32.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 4R
TRANSPOSITION AREA 20.0 SQ MI

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	319.	4.50	55.	14.	5.	2.	
			(INCHES) 0.765	0.766	0.766	0.766	
			(AC-FT) 27.	27.	27.	27.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 4R
TRANSPOSITION AREA 30.0 SQ MI

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	283.	4.50	49.	12.	4.	2.	
			(INCHES) 0.680	0.681	0.681	0.681	
			(AC-FT) 24.	24.	24.	24.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

HYDROGRAPH AT STATION 4R
TRANSPOSITION AREA 40.0 SQ MI

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	166.58-HR	
+	(CFS)	(HR)	(CFS)				
+	253.	4.58	43.	11.	4.	2.	
			(INCHES) 0.608	0.610	0.610	0.610	
			(AC-FT) 22.	22.	22.	22.	

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

INTERPOLATED HYDROGRAPH AT 4R

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
694.	4.50	(CFS)	100.	25.	8.	4.
		(INCHES)	1.405	1.406	1.406	1.406
		(AC-FT)	50.	50.	50.	50.

CUMULATIVE AREA = 0.66 SQ MI

0

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

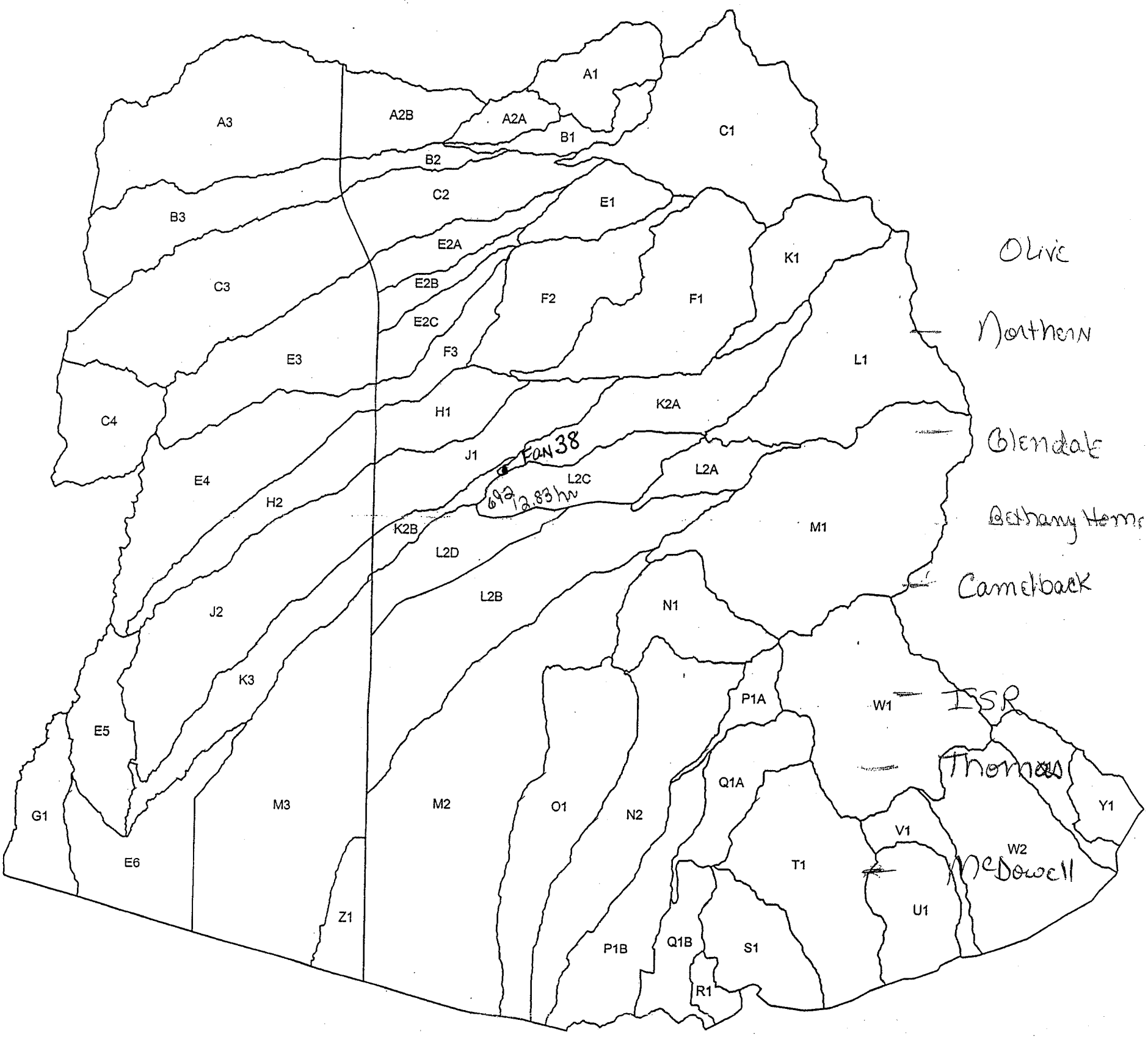
OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	R1	506.	4.25	47.	12.	4.	0.28		
ROUTED TO	13R	506.	4.25	47.	12.	4.	0.28		
HYDROGRAPH AT	M1	2809.	4.83	790.	203.	68.	5.69		
ROUTED TO	M1-M2	2265.	6.75	784.	203.	68.	5.69		
HYDROGRAPH AT	M2	1849.	5.42	633.	159.	53.	7.44		
2 COMBINED AT	M	2555.	6.58	1219.	318.	106.	13.12		
ROUTED TO	5R	2555.	6.58	1219.	318.	106.	13.12		
HYDROGRAPH AT	N1	1253.	4.50	210.	53.	18.	1.52		
ROUTED TO	N1-N2	840.	6.17	209.	53.	18.	1.52		
HYDROGRAPH AT	N2	1193.	5.17	366.	93.	31.	3.33		
2 COMBINED AT	N	1201.	6.00	515.	131.	44.	4.85		
ROUTED TO	8R	1201.	6.00	515.	131.	44.	4.85		
HYDROGRAPH AT	P1A	575.	4.42	89.	22.	7.	0.50		
ROUTED TO	P1A-1B	379.	5.83	88.	22.	7.	0.50		
HYDROGRAPH AT	P1B	852.	5.08	244.	62.	21.	1.94		
2 COMBINED AT	P	874.	5.17	309.	79.	26.	2.44		
ROUTED TO	12R	874.	5.17	309.	79.	26.	2.44		
HYDROGRAPH AT	O1	1057.	5.33	343.	88.	29.	3.09		
ROUTED TO	7R	1057.	5.33	343.	88.	29.	3.09		
HYDROGRAPH AT	Q1A	990.	4.58	193.	49.	16.	1.30		
ROUTED TO	Q1A-1B	843.	5.17	193.	49.	16.	1.30		
HYDROGRAPH AT	Q1B	851.	4.50	155.	39.	13.	0.94		
2 COMBINED AT	Q	1105.	5.08	318.	81.	27.	2.23		
ROUTED TO	14R	1105.	5.08	318.	81.	27.	2.23		
HYDROGRAPH AT	L1	2128.	4.75	543.	139.	46.	3.55		
ROUTED TO	L1-L2A	2066.	4.92	543.	139.	46.	3.55		
HYDROGRAPH AT	L2A	692.	4.58	113.	28.	9.	0.69		

+	2 COMBINED AT						
	L2BR	2391.	4.92	623.	159.	53.	4.24
+	ROUTED TO						
	L2A-2B	2167.	5.50	621.	159.	53.	4.24
+	HYDROGRAPH AT						
	L2B	1532.	5.08	418.	104.	35.	4.08
+	2 COMBINED AT						
	L3R	3064.	5.42	929.	236.	79.	8.32
+	ROUTED TO						
	L2B-L3	2551.	6.92	918.	236.	79.	8.32
+	HYDROGRAPH AT						
	L2C	754.	4.83	161.	40.	13.	1.33
+	ROUTED TO						
	L2C-2D	712.	5.25	161.	40.	13.	1.33
+	HYDROGRAPH AT						
	L2D	706.	4.75	136.	34.	11.	1.23
+	2 COMBINED AT						
	L3RB	1043.	5.00	260.	65.	22.	2.56
+	ROUTED TO						
	L2D-L3	653.	8.25	258.	65.	22.	2.56
+	HYDROGRAPH AT						
	L3	1832.	5.25	581.	146.	49.	5.85
+	3 COMBINED AT						
	L	2552.	6.92	1340.	361.	120.	16.73
+	ROUTED TO						
	1R	2552.	6.92	1340.	361.	120.	16.73
+	HYDROGRAPH AT						
	Z1	694.	4.50	100.	25.	8.	0.66
+	ROUTED TO						
	4R	694.	4.50	100.	25.	8.	0.66

*** NORMAL END OF HEC-1 ***

Buckeye SunValley ADMS 4/27/05

UPDATED HEC-1 BOUNDARIES



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1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY  1991                 *
*           VERSION 4.0.1E              *
*                                       *
*  RUN DATE          TIME               *
*                                       *
*****************************************
```


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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*          (916) 551-1748               *
*                                       *
*****************************************
```


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X     X XXXXXXX   XXXXX          X
X     X X        X     X        XX
X     X X              X       X
XXXXXXX XXXX           X       X
X     X X              X       X
X     X X              X       X
X     X XXXXXXX  XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT


```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
   1      ID  Buckeye/Sun Valley ADMS - May 2005
   2      ID  Michael Baker Jr., Inc. - Modeler: Jacob Lesue
   3      ID  100-year 24-hour)
   4      ID  Existing Conditions
   5      ID  Area 3 - Sub-basins L-R (Aluvial Fan updates)
   6      ID  Rainfall Loss Method - Green & Ampt
   7      ID  Unit Hydrograph Method - FCDMC S-Graph
   8      ID  Channel Routing Method - Normal Depth
   9      ID  Land Use - FCDMC GIS Data: mag_landuse (2000)
  10      ID  Soil Data - USDA SCS Soil Survey (1972 & 1981)
  11      ID  Units - L(mi)   Lca(mi)   S(ft/mi)   LAG(min)
          *DIAGRAM
  12      IT       5 01JAN94       0    2000
  13      IO       3
  14      IN      15 01JAN94       0
  15      JD    4.16    0.01
          * 24-hour distribution
  16      PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
  17      PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
  18      PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
  19      PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
  20      PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
  21      PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
  22      PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
  23      PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
  24      PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
  25      PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
  26      IN      15 01JAN94       0
  27      JD   3.952    10.0
          * 24-hour distribution
  28      PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
  29      PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
  30      PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
  31      PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
  32      PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
  33      PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
  34      PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
  35      PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
  36      PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
  37      PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
  38      IN      15 01JAN94       0
  39      JD   3.819    20.0
          * 24-hour distribution
  40      PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
  41      PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
  42      PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
  43      PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
  44      PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
  45      PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
  46      PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
  47      PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
  48      PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
  49      PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
  50      IN      15 01JAN94       0
  51      JD    3.69    40.0
          * 24-hour distribution
```

HEC-1 INPUT


```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
  52      PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
  53      PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
  54      PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
  55      PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
  56      PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
  57      PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
  58      PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
```

```
 59          PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
 60          PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
 61          PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
 62          IN      15 01JAN94       0
 63          JD   3.565    80.0
             * 24-hour distribution
 64          PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
 65          PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
 66          PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
 67          PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
 68          PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
 69          PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
 70          PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
 71          PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
 72          PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
 73          PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0
 74          IN      15 01JAN94       0
 75          JD   3.499   120.0
             * 24-hour distribution
 76          PC     0.0   0.002   0.005   0.008   0.011   0.014   0.017    0.02   0.023   0.026
 77          PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056    0.06
 78          PC   0.064   0.068   0.072   0.076    0.08   0.085    0.09   0.095     0.1   0.105
 79          PC    0.11   0.115    0.12   0.126   0.133    0.14   0.147   0.155   0.163   0.172
 80          PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
 81          PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
 82          PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
 83          PC   0.913   0.918   0.922   0.926    0.93   0.934   0.938   0.942   0.946    0.95
 84          PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977    0.98
 85          PC   0.983   0.986   0.989   0.992   0.995   0.998     1.0

 86          KK      R1
 87          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
 88          KM   L=1.01     Lca=0.46     S=213.31     Kn=0.050     LAG=18.8
 89          KM   S-GRAPH TYPE=PHX MNT
 90          KO       0       0     0.0       1      22
 91          BA   0.284
 92          LG    0.35    0.35   4.358   0.374   8.387
             * R1
 93          UI     0.0   62.14  236.01  401.85  464.97  281.72   216.1  150.63  113.71   76.28
 94          UI   57.55   39.69   27.53   24.54    9.63    9.63    9.63    9.63     0.0

 95          KK     13R   CNAME       R
 96          KO       0       0     0.0       0      22
 97          RN     13R
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 98          KK      M1
 99          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
100          KM   L=5.19     Lca=2.41     S=230.06     Kn=0.050     LAG=66.8
101          KM   S-GRAPH TYPE=PHX MNT
102          KO       0       0     0.0       1      22
103          BA   5.686
104          LG    0.35    0.35   4.297    0.35  16.637
             * M1
105          UI     0.0  285.74  285.74  285.74  777.57 1062.36 1436.64 1746.69  1963.2  2166.6
106          UI  2402.0 2950.38 3432.01 2399.97 1965.75 1755.17 1651.21 1526.96 1413.1 1330.61
107          UI  1198.5 1122.73 1012.84  904.53  777.77  717.96  682.12  653.26  597.45  521.66
108          UI  469.43  394.74  365.11  349.25  312.95  312.95  266.95  219.07  219.07  219.07
109          UI  181.82  139.83  139.83  139.83  139.83  139.83   125.2   54.77   54.77   54.77
110          UI   54.77   54.77   54.77   54.77   54.77   54.77   54.77   54.77   54.77   54.77
111          UI   54.77   54.77     0.0

112          KK   M1-M2   CNAME     M2R
113          KO       0       0     0.0       0      22
114          RS      23    FLOW     0.0     0.0
115          RC    0.04    0.04 0.04534769.89  0.0133     0.0
             * M1-M2
116          RX     0.0   961.0  1028.0  1051.0  1136.0  1153.0  1193.0  1900.0
117          RY    15.5    12.0    11.8    10.3    10.0    11.0    11.2    15.5

118          KK      M2
119          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
120          KM   L=6.59     Lca=3.00     S=71.62     Kn=0.050     LAG=100.2
121          KM   S-GRAPH TYPE=DES RNGLND
122          KO       0       0     0.0       1      22
123          BA   7.436
124          LG    0.35    0.35   3.959   0.445   0.291
             * M2
125          UI     0.0  250.38  250.38  250.38  250.38  438.17  719.85  924.82 1114.75 1312.86
126          UI  1497.2  1700.9 1779.05 2056.71 2161.12 2246.81 2290.07 2399.49 2399.49 2399.49
127          UI  2351.5 2259.21 2219.84 2074.04 1858.21 1745.08 1567.89 1438.64 1323.61 1214.96
128          UI  1118.4 1022.47  940.03  874.15  767.84  718.48  685.57  569.22   559.1  484.22
129          UI  472.03  435.02  383.92  383.92  334.13  265.38  265.38  265.38  257.86  171.39
130          UI  171.39  171.39  171.39  171.39  171.39  131.63   60.94   60.94   60.94   60.94
131          UI   60.94   60.94   60.94   60.94   60.94   60.94   60.94   60.94   60.94   60.94
132          UI   60.94   60.94   60.94   60.94     0.0

133          KK       M   CNAME      5R
134          KO       0       0     0.0       0      22
135          HC       2

136          KK      5R   CNAME       M
137          KO       0       0     0.0       0      22
138          RN      5R
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

139          KK      N1
140          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
```

```
KM   L=2.79      Lca=1.44      S=340.38      Kn=0.050      LAG=39.7
KM   S-GRAPH TYPE=PHX MNT
KO        0         0     0.0         1        22
BA    1.524
LG    0.35     0.35    4.075    0.419     8.38
* N1
UI     0.0   128.28   166.77   436.68   697.63   885.37  1048.86  1439.85  1097.59   811.01
UI  717.89   633.24   554.41   482.34   398.71   327.22   300.33   268.08   210.75   167.66
UI  152.68    140.5   106.78    98.35    84.12    62.78    62.78    62.78    38.34    24.59
UI   24.59    24.59    24.59    24.59    24.59    24.59    24.59      0.0

KK   N1-N2    CNAME      N2R
KO        0         0     0.0         0        22
RS       20      FLOW      0.0       0.0
RC     0.05    0.047   0.0525647.52   0.0115      0.0
* N1-N2
RX      0.0    280.0    350.0    358.0    367.0    381.0    451.0    730.0
RY     17.0     13.0     11.5     10.0     10.0     11.5     13.0     17.0

KK       N2
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=5.64      Lca=3.27      S=170.14      Kn=0.055      LAG=90.7
KM   S-GRAPH TYPE=PHX MNT
KO        0         0     0.0         1        22
BA    3.325
LG    0.35     0.35    4.117    0.405     2.67
* N2
UI     0.0   123.04   123.04   123.04   123.04   310.82   395.95   496.74   616.35   730.85
UI  796.45   869.05   928.56   990.24  1125.95  1316.06  1517.94  1186.36   925.57   834.34
UI  764.31   726.51   694.11   654.42    619.9   586.86   557.14   517.77   491.74    466.8
UI  422.37   387.25    352.0   325.27   302.29   296.75   282.99   272.23   257.26   234.33
UI  202.13   202.13   163.14   157.22   157.22   143.92   134.76   134.76   134.76   103.63
UI   94.33    94.33    94.33    94.33    83.75    60.21    60.21    60.21    60.21    60.21
UI   60.21    60.21    60.21    32.52    23.58    23.58    23.58    23.58    23.58    23.58
UI   23.58    23.58    23.58    23.58    23.58    23.58    23.58    23.58    23.58    23.58
UI   23.58    23.58    23.58    23.58    23.58

KK       N    CNAME       8R
KO        0         0     0.0         0        22
HC        2

KK      8R    CNAME        N
KO        0         0     0.0         0        22
RN       8R

KK     P1A
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=2.28      Lca=1.41      S=461.40      Kn=0.055      LAG=37.8
KM   S-GRAPH TYPE=PHX MNT
KO        0         0     0.0         1        22
BA      0.5
LG    0.35     0.35    3.987    0.405   16.364
* P1A
```



```
LINE  ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

UI     0.0    44.27    65.19    161.0   254.76   318.08   389.84   500.04   319.07   264.12
UI  232.17   203.71   176.98   147.14   118.21   105.19    95.13    74.96    59.42    52.89
UI   48.49    35.98    33.94    26.82    21.67    21.67    21.56     8.49     8.49     8.49
UI    8.49     8.49     8.49     8.49     8.49     8.49

KK  P1A-1B    CNAME     P1BR
KO        0         0     0.0         0        22
RS       19      FLOW      0.0       0.0
RC     0.05    0.047   0.0520102.87   0.0111      0.0
* P1A-P1B
RX      0.0    280.0    350.0    358.0    367.0    381.0    451.0    730.0
RY     17.0     13.0     11.5     10.0     10.0     11.5     13.0     17.0

KK     P1B
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=4.39      Lca=2.32      S=70.84      Kn=0.055      LAG=85.3
KM   S-GRAPH TYPE=PHX MNT
KO        0         0     0.0         1        22
BA    1.937
LG    0.35     0.35    4.23     0.393    4.667
* P1B
UI     0.0    76.72    76.72    76.72    89.67   220.58   274.25   335.86   432.98   478.15
UI  527.91   570.85   609.55   688.62   814.07    942.3   716.43    568.2   506.83   467.32
UI   446.8   421.86   394.79   374.39   356.44   329.11   309.33   293.98   263.37   241.82
UI  216.83   200.89   187.72   181.75   176.46   163.15   160.42   127.42   126.04    109.8
UI   98.03    98.03    90.75    84.03    84.03    84.03    60.08    58.82    58.82    58.82
UI   58.82    40.74    37.54    37.54    37.54    37.54    37.54    37.54    37.54     17.9
UI   14.71    14.71    14.71    14.71    14.71    14.71    14.71    14.71    14.71    14.71
UI   14.71    14.71    14.71    14.71    14.71    14.71    14.71    14.71    14.71      0.0

KK       P    CNAME      12R
KO        0         0     0.0         0        22
HC        2

KK     12R    CNAME        P
KO        0         0     0.0         0        22
RN      12R

KK      O1
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=5.20      Lca=2.79      S=64.07      Kn=0.055      LAG=99.9
KM   S-GRAPH TYPE=PHX MNT
KO        0         0     0.0         1        22
BA    3.088
LG    0.35     0.35    4.191    0.393    2.105
* O1
UI     0.0   103.98   103.98   103.98   103.98   181.97   298.95   378.66   446.43   550.06
UI  624.46   676.83   731.54   781.25   824.52   905.38  1042.04  1204.77   1242.7   887.05
```

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225          UI   765.3   690.9  643.35  614.88  590.49  558.55  530.78  506.48  485.09  454.93
226          UI  429.36  410.34   388.6  356.95  326.56   302.9  274.89  260.97  254.42  242.21
227          UI  239.16  221.76  217.42  189.46  170.83  170.83  140.46  132.86  132.86  129.07
228          UI  113.88  113.88  113.88  113.88   79.72   79.72   79.72   79.72   79.72   79.72
229          UI   50.88   50.88   50.88   50.88   50.88   50.88   50.88   50.88   50.88   32.31
230          UI   19.93   19.93   19.93   19.93   19.93   19.93   19.93   19.93   19.93   19.93
231          UI   19.93   19.93   19.93   19.93   19.93   19.93   19.93   19.93   19.93   19.93
```

HEC-1 INPUT PAGE 6

```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

232          UI   19.93   19.93   19.93     0.0

233          KK      7R   CNAME       0
234          KO       0       0     0.0       0      22
235          RN      7R

236          KK     Q1A
237          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
238          KM   L=3.13     Lca=1.52     S=256.86     Kn=0.055     LAG=49.3
239          KM   S-GRAPH TYPE=PHX MNT
240          KO       0       0     0.0       1      22
241          BA   1.297
242          LG    0.35    0.35   4.127     0.4    11.2
             * Q1A
243          UI     0.0   89.12   89.12  213.78  363.94  517.41  613.88  697.52  873.62 1020.97
244          UI  663.18  556.48  506.64  454.84  413.29  367.46  326.01  281.03  232.04  214.37
245          UI  199.35   177.4  146.41  118.69  112.45   97.61   96.73   68.33   68.33    66.1
246          UI   43.61   43.61   43.61   43.61   30.77   17.08   17.08   17.08   17.08   17.08
247          UI   17.08   17.08   17.08   17.08   17.08   17.08     0.0

248          KK  Q1A-1B   CNAME    Q1BR
249          KO       0       0     0.0       0      22
250          RS       8    FLOW     0.0     0.0
251          RC    0.05   0.047    0.05 9170.53  0.0117     0.0
             * Q1A-Q1B
252          RX     0.0   280.0   350.0   358.0   367.0   381.0   451.0   730.0
253          RY    17.0    13.0    11.5    10.0    10.0    11.5    13.0    17.0

254          KK     Q1B
255          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
256          KM   L=2.35     Lca=1.14     S=141.40     Kn=0.055     LAG=44.3
257          KM   S-GRAPH TYPE=PHX MNT
258          KO       0       0     0.0       1      22
259          BA   0.937
260          LG    0.35    0.35    4.32   0.373  14.815
             * Q1B
261          UI     0.0   71.67   71.67  221.51  340.68  455.79   538.5  651.95  833.61  538.15
262          UI  443.72  398.92  355.79  316.26  280.46  235.89  196.37  173.35  160.17  138.81
263          UI  114.82   91.58   84.67    78.5   62.48   54.95   54.15   35.07   35.07   35.07
264          UI   35.07   15.79   13.74   13.74   13.74   13.74   13.74   13.74   13.74   13.74
265          UI   13.74     0.0

266          KK       Q   CNAME     14R
267          KO       0       0     0.0       0      22
268          HC       2

269          KK     14R   CNAME       Q
270          KO       0       0     0.0       0      22
271          RN     14R
```

HEC-1 INPUT PAGE 7

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LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

272          KK      L1
273          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
274          KM   L=4.93     Lca=2.29     S=308.27     Kn=0.050     LAG=60.6
275          KM   S-GRAPH TYPE=PHX MNT
276          KO       0       0     0.0       1      22
277          BA   3.546
278          LG   0.271   0.318   4.363   0.351  16.279
             * L1
279          UI     0.0  195.74  195.74  266.93  603.63  823.25 1120.55 1287.08 1452.32 1611.07
280          UI  1991.3 2326.76 1575.06 1312.31 1173.43 1097.39 1002.28  929.54   850.5  775.66
281          UI  701.22  620.51  525.99  484.91  458.87  430.63  397.34  321.57  290.98  250.11
282          UI  241.82  214.38  214.38  171.29  150.06  150.06  149.52   95.79   95.79   95.79
283          UI   95.79   95.79    79.7   37.52   37.52   37.52   37.52   37.52   37.52   37.52
284          UI   37.52   37.52   37.52   37.52   37.52   37.52   37.52     0.0

285          KK  L1-L2A   CNAME    L2AR
286          KO       0       0     0.0       0      22
287          RS       3    FLOW     0.0     0.0
288          RC   0.046   0.045   0.046 7078.75  0.0174     0.0
             * L1-L2A
289          RX     0.0    80.0   165.0   200.0   215.0   255.0   340.0   420.0
290          RY    19.0    17.0    14.0    10.0    10.0    14.0    18.0    22.0

291          KK     L2A
292          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
293          KM   L=2.46     Lca=1.12     S=136.18     Kn=0.055     LAG=45.0
294          KM   S-GRAPH TYPE=DES RNGLND
295          KO       0       0     0.0       1      22
296          BA   0.693
297          LG    0.35   0.384   5.641   0.202     0.0
             * L2A
298          UI     0.0   51.83   51.83  153.34  242.24  330.72  404.46  460.56  494.88  492.21
299          UI  461.36  394.37  327.78  266.87  221.69  182.72  150.08  121.91  100.64   84.23
300          UI   69.92   54.93   46.45   35.48   35.48   26.06   12.61   12.61   12.61   12.61
301          UI   12.61   12.61   12.61   12.61

302          KK    L2BR   CNAME  L2A-2B
303          KO       0       0     0.0       0      22
304          HC       2
```

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KK  L2A-2B   CNAME    L2BR
KO        0       0     0.0       0      22
RS        7    FLOW     0.0     0.0
RC    0.046   0.045 0.04620743.37  0.0147     0.0
* L2A-L2B
RX      0.0    80.0   165.0   200.0   215.0   255.0   340.0   420.0
RY     19.0    17.0    14.0    10.0    10.0    14.0    18.0    22.0

KK     L2B
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=5.13      Lca=1.82      S=93.37      Kn=0.055      LAG=78.1
KO        0       0     0.0       1      22
BA    4.077
```

HEC-1 INPUT


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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10
LG     0.35    0.35   4.179   0.399     0.0
* L2B
UI      0.0  175.97  175.97  175.97  311.91  535.45  724.28   902.8 1071.35 1224.63
UI   1376.8 1511.61 1580.95 1658.53 1686.39 1686.39 1632.48 1568.59 1460.56 1278.33
UI   1172.5 1030.99  927.32  829.82  742.49   663.7  594.61  529.93  481.83   405.6
UI    377.6  331.75  310.22  269.82  269.19  186.51  186.51  186.51   145.4  120.46
UI   120.46  120.46  120.46    90.9   42.83   42.83   42.83   42.83   42.83   42.83
UI    42.83   42.83   42.83   42.83   42.83   42.83   42.83   42.83     0.0

KK     L3R   CNAME  L2B-L3
KO       0       0     0.0       0      22
HC       2

KK  L2B-L3   CNAME     L3R
KO        0       0     0.0       0      22
RS       18    FLOW     0.0     0.0
RC     0.05    0.04  0.0619942.62  0.0089     0.0
* L2B-L3
RX      0.0  1093.0  1210.0  1215.0  1225.0  1232.0  1372.0  2000.0
RY     18.0    11.8    11.7    10.0    10.0    11.7    11.8    18.0

KK     L2C
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=3.20      Lca=1.55      S=91.31      Kn=0.055      LAG=61.2
KO        0       0     0.0       1      22
BA    1.328
LG     0.35    0.35   4.189   0.422     0.0
* L2C
UI      0.0   73.31   73.31   99.98  227.13  318.43   414.0  500.47   577.1  643.23
UI   678.82  702.58  699.63  666.25  621.66  533.29  468.31  402.86  351.31  303.79
UI    266.7  226.83  200.74  164.03  144.98  131.86  112.41   97.97    77.7    77.7
UI    56.55   50.18   50.18   50.18   28.53   17.84   17.84   17.84   17.84   17.84
UI    17.84   17.84   17.84   17.84   17.84     0.0

KK  L2C-2D   CNAME    L2DR
KO        0       0     0.0       0      22
RS        6    FLOW     0.0     0.0
RC    0.046   0.045   0.046 9752.35  0.0122     0.0
* L2C-L2D
RX      0.0    80.0   165.0   200.0   215.0   255.0   340.0   420.0
RY     19.0    17.0    14.0    10.0    10.0    14.0    18.0    22.0

KK     L2D
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=2.77      Lca=1.24      S=74.13      Kn=0.055      LAG=55.4
KO        0       0     0.0       1      22
BA    1.232
LG     0.35    0.35   3.578   0.544     0.0
* L2D
UI      0.0   75.42   75.42  141.88  262.35  378.71  482.07  569.62  651.08   696.0
UI   722.74  714.79  677.77  607.49  518.22  439.07   376.3  322.28  277.17  232.67
UI   200.55   167.8  142.18   124.1  114.53   79.93   79.93    61.7   51.62   51.62
UI    51.62   20.09   18.36   18.36   18.36   18.36   18.36   18.36   18.36   18.36
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HEC-1 INPUT


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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10
UI    18.36     0.0

KK    L3RB   CNAME  L2D-L3
KO       0       0     0.0       0      22
HC       2

KK  L2D-L3   CNAME    L3RB
KO        0       0     0.0       0      22
RS       39    FLOW     0.0     0.0
RC     0.05    0.04    0.06 27374.0  0.0077     0.0
* L2D-L3
RX      0.0  1093.0  1210.0  1215.0  1225.0  1232.0  1372.0  2000.0
RY     18.0    11.8    11.7    10.0    10.0    11.7    11.8    18.0

KK     L3
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=4.75      Lca=2.00      S=44.27      Kn=0.055      LAG=91.0
KO        0       0     0.0       1      22
BA    5.852
LG    0.341   0.328    3.98   0.419    1.05
* L3
UI      0.0  216.51  216.51  216.51  216.51  546.97   701.8  899.01 1098.32 1266.32
UI   1460.0  1557.8 1786.11 1888.64 1950.18 2034.93 2074.93 2074.93 2053.76  1965.5
UI   1920.6 1789.17 1583.49 1486.07 1313.64 1207.78 1091.43  994.63  909.22  825.03
UI    759.9  663.98  614.46  574.55  483.48  461.45  408.18  402.68  331.99  331.99
```

```
383          UI  296.91  229.48  229.48  229.48  197.56  148.21  148.21  148.21  148.21  148.21
384          UI  121.69    52.7    52.7    52.7    52.7    52.7    52.7    52.7    52.7    52.7
385          UI    52.7    52.7    52.7    52.7    52.7    52.7    52.7     0.0

386          KK       L   CNAME      1R
387          KO       0       0     0.0       0      22
388          HC       3

389          KK      1R   CNAME       L
390          KO       0       0     0.0       0      22
391          RN      1R

392          KK      Z1
393          KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
394          KM   L=1.70     Lca=0.66     S=47.00     Kn=0.055     LAG=39.1
395          KM   S-GRAPH TYPE=DES RNGLND
396          KO       0       0     0.0       1      22
397          BA   0.664
398          LG   0.321   0.292   4.004    0.43   2.909
             * Z1
399          UI     0.0   57.36   79.52  205.33  321.78  424.03  504.07   545.2  540.96  493.73
400          UI  399.49  319.19  256.28   205.1  164.91  127.66  104.64   87.86    60.8    54.1
401          UI   39.27   39.27    21.8   13.96   13.96   13.96   13.96   13.96   13.96     0.0
```



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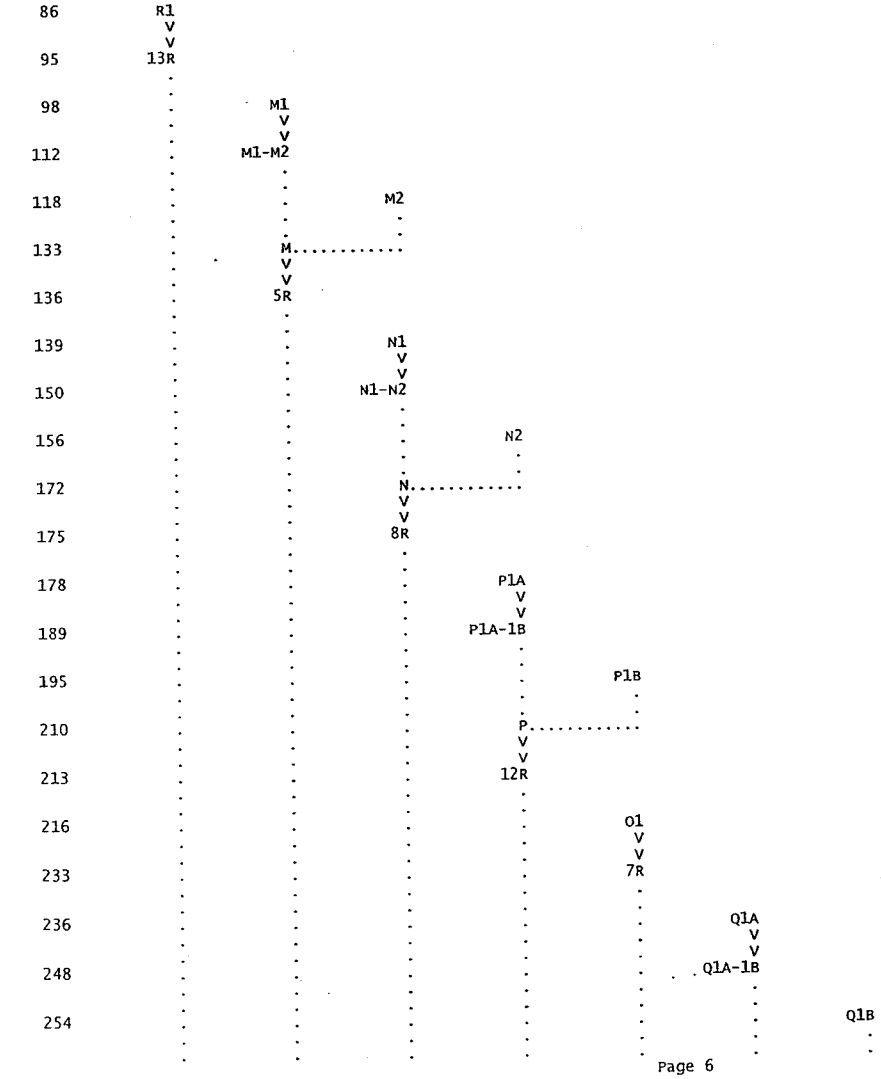
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

402          KK      4R   CNAME       Z
403          KO       0       0     0.0       0      22
404          RN      4R
405          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK



```
                *           *
402 KK          *     4R    *        CNAME       Z
                *           *
                ***************

403 KO          OUTPUT CONTROL VARIABLES
                     IPRNT         3  PRINT CONTROL
                     IPLOT         0  PLOT CONTROL
                     QSCAL        0.  HYDROGRAPH PLOT SCALE
                     IPNCH         0  PUNCH COMPUTED HYDROGRAPH
                      IOUT        22  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1         1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2      2000  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT     0.083  TIME INTERVAL IN HOURS


                HYDROGRAPH ROUTING DATA

404 RN          NO ROUTING

                                                                      ***
      ***             ***             ***             ***             ***

                  HYDROGRAPH AT STATION       4R
                TRANSPOSITION AREA      0.0 SQ MI

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR            24-HR           72-HR      166.58-HR
+    (CFS)        (HR)
                                   (CFS)
+     585.       12.50             84.             22.              7.              3.
                  (INCHES)        1.183           1.218           1.218           1.218
                  (AC-FT)           42.             43.             43.             43.

                  CUMULATIVE AREA =     0.66 SQ MI

      ***             ***             ***             ***             ***

                  HYDROGRAPH AT STATION       4R
                TRANSPOSITION AREA      10.0 SQ MI

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR            24-HR           72-HR      166.58-HR
+    (CFS)        (HR)
                                   (CFS)
+     540.       12.50             78.             20.              7.              3.
                  (INCHES)        1.090           1.123           1.124           1.124
                  (AC-FT)           39.             40.             40.             40.

                  CUMULATIVE AREA =     0.66 SQ MI

      ***             ***             ***             ***             ***

                  HYDROGRAPH AT STATION       4R
                TRANSPOSITION AREA      20.0 SQ MI

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR            24-HR           72-HR      166.58-HR
+    (CFS)        (HR)
                                   (CFS)
+     511.       12.50             74.             19.              6.              3.
                  (INCHES)        1.030           1.062           1.063           1.063
                  (AC-FT)           36.             38.             38.             38.

                  CUMULATIVE AREA =     0.66 SQ MI

      ***             ***             ***             ***             ***

                  HYDROGRAPH AT STATION       4R
                TRANSPOSITION AREA      40.0 SQ MI

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR            24-HR           72-HR      166.58-HR
+    (CFS)        (HR)
                                   (CFS)
+     483.       12.50             69.             18.              6.              3.
                  (INCHES)        0.972           1.003           1.003           1.003
                  (AC-FT)           34.             36.             36.             36.

                  CUMULATIVE AREA =     0.66 SQ MI

      ***             ***             ***             ***             ***

                  HYDROGRAPH AT STATION       4R
                TRANSPOSITION AREA      80.0 SQ MI

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR            24-HR           72-HR      166.58-HR
+    (CFS)        (HR)
                                   (CFS)
+     456.       12.50             65.             17.              6.              2.
                  (INCHES)        0.914           0.944           0.945           0.945
                  (AC-FT)           32.             33.             33.             33.

                  CUMULATIVE AREA =     0.66 SQ MI

      ***             ***             ***             ***             ***

                  HYDROGRAPH AT STATION       4R
                TRANSPOSITION AREA     120.0 SQ MI
```

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
		(CFS)				
441.	12.50		63.	16.	5.	2.
		(INCHES)	0.884	0.913	0.913	0.913
		(AC-FT)	31.	32.	32.	32.

CUMULATIVE AREA = 0.66 SQ MI

*** *** *** *** ***

INTERPOLATED HYDROGRAPH AT 4R

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	166.58-HR
		(CFS)				
558.	12.50		80.	21.	7.	3.
		(INCHES)	1.127	1.161	1.161	1.161
		(AC-FT)	40.	41.	41.	41.

CUMULATIVE AREA = 0.66 SQ MI

0

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	R1	387.	12.25	37.	10.	3.	0.28		
ROUTED TO	13R	387.	12.25	37.	10.	3.	0.28		
HYDROGRAPH AT	M1	3301.	12.83	825.	236.	79.	5.69		
ROUTED TO	M1-M2	2392.	14.67	820.	235.	79.	5.69		
HYDROGRAPH AT	M2	2347.	13.42	786.	198.	66.	7.44		
2 COMBINED AT	M	3187.	14.50	1544.	421.	141.	13.12		
ROUTED TO	5R	3187.	14.50	1544.	421.	141.	13.12		
HYDROGRAPH AT	N1	1211.	12.50	192.	52.	17.	1.52		
ROUTED TO	N1-N2	758.	14.08	192.	52.	17.	1.52		
HYDROGRAPH AT	N2	1331.	13.17	378.	99.	33.	3.33		
2 COMBINED AT	N	1385.	13.25	565.	149.	50.	4.85		
ROUTED TO	8R	1385.	13.25	565.	149.	50.	4.85		
HYDROGRAPH AT	P1A	441.	12.42	73.	21.	7.	0.50		
ROUTED TO	P1A-1B	296.	13.92	72.	21.	7.	0.50		
HYDROGRAPH AT	P1B	842.	13.08	231.	61.	20.	1.94		
2 COMBINED AT	P	891.	13.17	301.	81.	27.	2.44		
ROUTED TO	12R	891.	13.17	301.	81.	27.	2.44		
HYDROGRAPH AT	O1	1163.	13.33	349.	91.	30.	3.09		
ROUTED TO	7R	1163.	13.33	349.	91.	30.	3.09		
HYDROGRAPH AT	Q1A	915.	12.58	173.	48.	16.	1.30		
ROUTED TO	Q1A-1B	757.	13.17	173.	48.	16.	1.30		
HYDROGRAPH AT	Q1B	740.	12.50	134.	38.	13.	0.94		
2 COMBINED AT	Q	1059.	13.08	304.	85.	28.	2.23		
ROUTED TO									

+		14R	1059.	13.08	304.	85.	28.	2.23
+	HYDROGRAPH AT	L1	2267.	12.75	527.	150.	50.	3.55
+	ROUTED TO	L1-L2A	2154.	12.92	527.	150.	50.	3.55
+	HYDROGRAPH AT	L2A	570.	12.58	92.	23.	8.	0.69
+	2 COMBINED AT	L2BR	2519.	12.92	616.	172.	57.	4.24
+	ROUTED TO	L2A-2B	2228.	13.42	614.	172.	57.	4.24
+	HYDROGRAPH AT	L2B	1700.	13.08	449.	112.	37.	4.08
+	2 COMBINED AT	L3R	3676.	13.33	1051.	282.	94.	8.32
+	ROUTED TO	L2B-L3	3004.	14.75	1039.	282.	94.	8.32
+	HYDROGRAPH AT	L2C	692.	12.83	145.	36.	12.	1.33
+	ROUTED TO	L2C-2D	651.	13.25	145.	36.	12.	1.33
+	HYDROGRAPH AT	L2D	655.	12.75	124.	31.	10.	1.23
+	2 COMBINED AT	L3RB	1104.	13.00	266.	66.	22.	2.56
+	ROUTED TO	L2D-L3	705.	16.17	263.	66.	22.	2.56
+	HYDROGRAPH AT	L3	2129.	13.25	658.	166.	56.	5.85
+	3 COMBINED AT	L	3437.	14.75	1778.	490.	164.	16.73
+	ROUTED TO	1R	3437.	14.75	1778.	490.	164.	16.73
+	HYDROGRAPH AT	Z1	558.	12.50	80.	21.	7.	0.66
+	ROUTED TO	4R	558.	12.50	80.	21.	7.	0.66

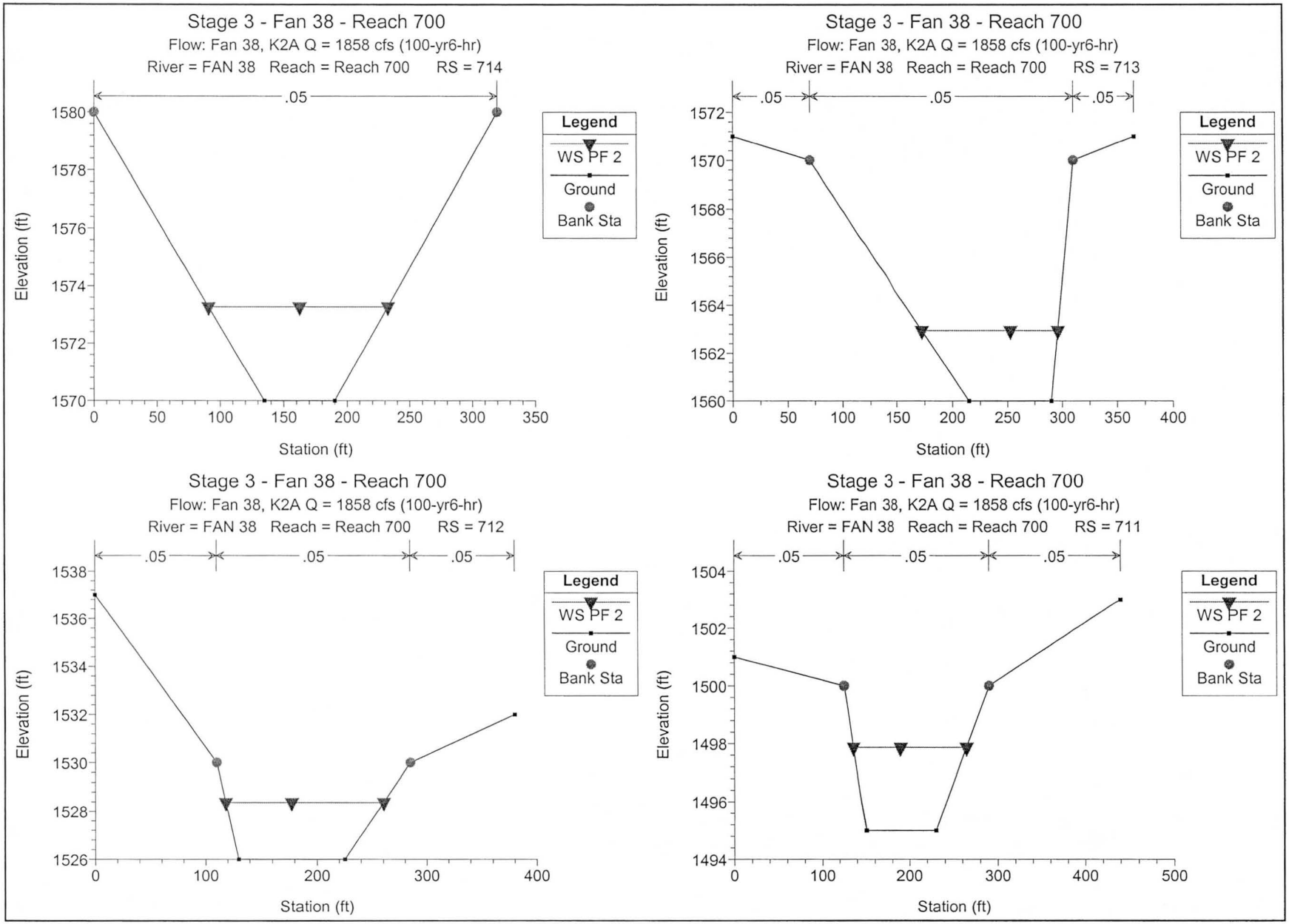
*** NORMAL END OF HEC-1 ***

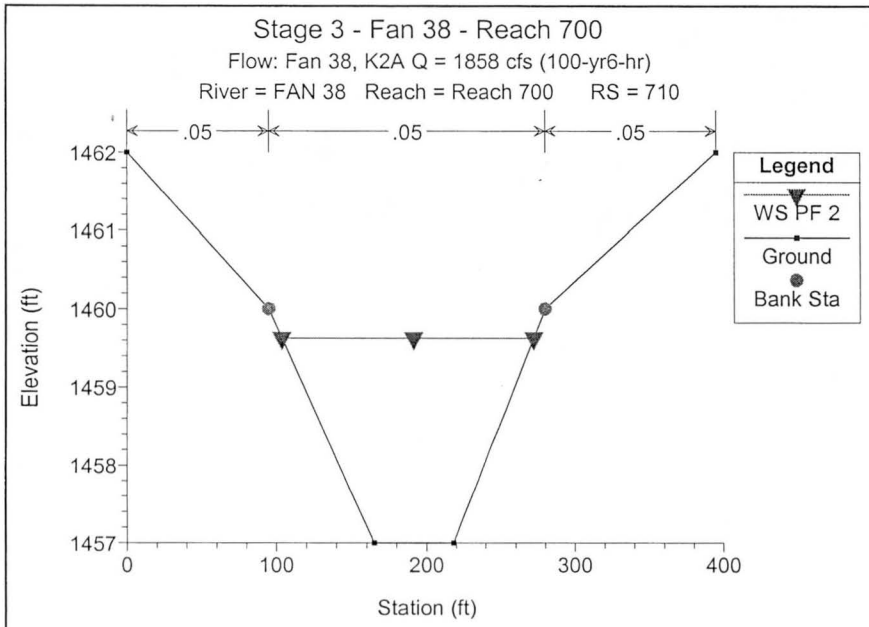
APPENDIX E
HYDRAULIC ANALYSIS SUPPORTING DOCUMENTATION

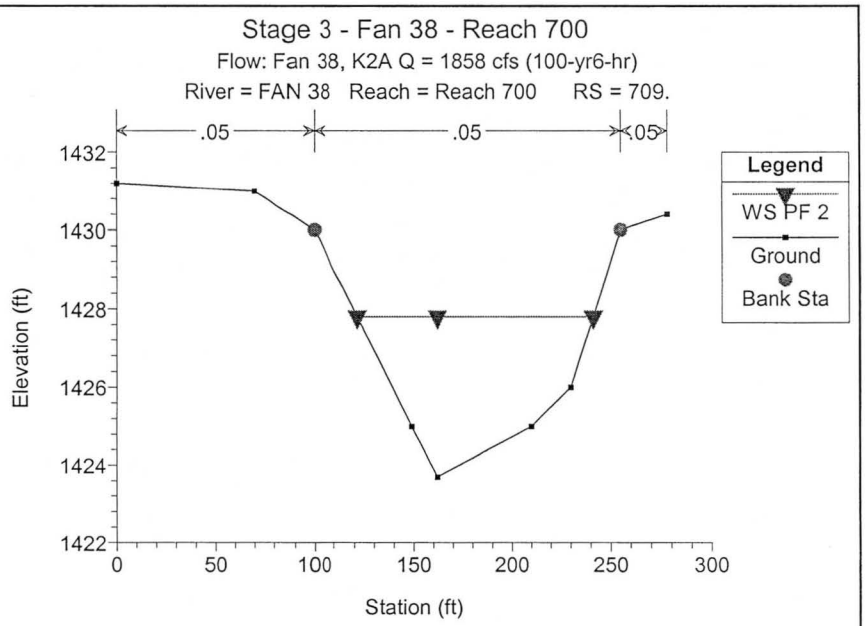
E.1 Hydraulic Calculations

HEC-RAS Plan: Plan 02 River: FAN 38 Reach: Reach 700 Profile: PF 2

Reach	River Sta	Profile	Q Total	W.S. Elev	Min Ch El	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Vel Total	Flow Area	Top Width	Froude # Chl	Sta W.S. Lft	Sta W.S. Rgt
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(sq ft)	(ft)		(ft)	(ft)
Reach 700	714	PF 2	1858.00	1573.3	1570.00	1572.63	1573.79	0.012696	5.78	5.78	321.60	141.67	0.68	90.85	232.52
Reach 700	713	PF 2	1858.00	1562.9	1560.00	1562.42	1563.57	0.014617	6.35	6.35	292.47	123.60	0.73	172.29	295.89
Reach 700	712	PF 2	1858.00	1528.4	1526.00	1528.11	1529.05	0.020031	6.61	6.61	281.09	142.37	0.83	118.16	260.53
Reach 700	711	PF 2	1858.00	1497.9	1495.00		1498.47	0.014226	6.21	6.21	299.31	128.75	0.72	135.66	264.41
Reach 700	710	PF 2	1858.00	1459.6	1457.00	1459.41	1460.26	0.022173	6.37	6.37	291.67	168.75	0.85	103.62	272.37
Reach 700	709.	PF 2	1858.00	1427.8	1423.70	1427.10	1428.38	0.012019	6.07	6.07	305.93	119.82	0.67	121.48	241.30


Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
River = FAN 38 Reach = Reach 700 RS = 714
.05
Elevation (ft)
Station (ft)
Legend
WS PF 2
Ground
Bank Sta
Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
River = FAN 38 Reach = Reach 700 RS = 713
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
WS PF 2
Ground
Bank Sta
Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
River = FAN 38 Reach = Reach 700 RS = 712
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
WS PF 2
Ground
Bank Sta
Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
River = FAN 38 Reach = Reach 700 RS = 711
.05
.05
.05
Elevation (ft)
Station (ft)
Legend
WS PF 2
Ground
Bank Sta


Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
River = FAN 38 Reach = Reach 700 RS = 710
.05
.05
.05
Legend
WS PF 2
Ground
Bank Sta
Elevation (ft)
1462
1461
1460
1459
1458
1457
0
100
200
300
400
Station (ft)


Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
River = FAN 38 Reach = Reach 700 RS = 709.
.05
.05
.05
Legend
WS PF 2
Ground
Bank Sta
Elevation (ft)
1432
1430
1428
1426
1424
1422
0
50
100
150
200
250
300
Station (ft)

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X     X
X     X  X        X            X   X    X    X    X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Stage 3 - Fan 38 - Reach 700
Project File : Stage3_Fan38_Reach700.prj
Run Date and Time: 4/13/2007 8:27:29 AM

Project in English units

Project Description:
& RSTAR0131 TJCL / MAFO

PLAN DATA

Plan Title: Plan 03
Plan File : p:\S\STAR00000131\0600INFO\EP\WR\605WR Hydraulic Calcs\HEC-RAS\4-13-2007\Stage3_Fan38_Reach700.p03

Geometry Title: Fan 38 - n = 0.050 Reach 700
Geometry File : p:\S\STAR00000131\0600INFO\EP\WR\605WR Hydraulic Calcs\HEC-RAS\4-13-2007\Stage3_Fan38_Reach700.g01

Flow Title : Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
Flow File : p:\S\STAR00000131\0600INFO\EP\WR\605WR Hydraulic Calcs\HEC-RAS\4-13-2007\Stage3_Fan38_Reach700.f02

Plan Summary Information:
Number of: Cross Sections = 6 Multiple Openings = 0
Culverts = 0 Inline Structures = 0
Bridges = 0 Lateral Structures = 0

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

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

Encroachment Data
Equal Conveyance = True
Left Offset = 0
Right Offset = 0

River = FAN 38 Reach = Reach 700

RS	Profile	Method	Value1	Value2
699	PF 2	1	0	284

River = FAN 38 Reach = Reach 1100

RS	Profile	Method	Value1	Value2
1099	PF 2	1	0	350
1098	PF 2	1	0	400

FLOW DATA

Flow Title: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
Flow File : p:\S\STAR00000131\0600INFO\EP\WR\605WR Hydraulic Calcs\HEC-RAS\4-13-2007\Stage3_Fan38_Reach700.f02

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2
FAN 38	Reach 700	714	1858	1858
FAN 38	Reach 700	709.	1858	1858

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
FAN 38	Reach 700	PF 1		Normal S = 0.012

GEOMETRY DATA

Geometry Title: Fan 38 - n = 0.050 Reach 700
Geometry File : p:\S\STAR00000131\0600INFO\EP\WR\605WR Hydraulic Calcs\HEC-RAS\4-13-2007\Stage3_Fan38_Reach700.g01

CROSS SECTION

RIVER: FAN 38
REACH: Reach 700 RS: 714

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1580	135	1570	190	1570	320	1580

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	0	.05	320	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
0	320	750	750	.1	.3

CROSS SECTION

RIVER: FAN 38
REACH: Reach 700 RS: 713

INPUT
Description:
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1571	70	1570	215	1560	290	1560	310	1570
365	1571								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	70	.05	310	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
70	310	2030	2030	.1	.3

CROSS SECTION

RIVER: FAN 38
REACH: Reach 700 RS: 712

INPUT
Description:
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1537	110	1530	130	1526	225	1526	285	1530
380	1532								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	110	.05	285	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
110	285	1823	1823	.1	.3

CROSS SECTION

RIVER: FAN 38
REACH: Reach 700 RS: 711

INPUT
Description:
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1501	125	1500	150	1495	230	1495	290	1500
440	1503								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	125	.05	290	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
125	290	2177	2177	.1	.3

CROSS SECTION

RIVER: FAN 38
REACH: Reach 700 RS: 710

INPUT
Description:
Station Elevation Data num= 6

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1462	95	1460	165	1457	218	1457	280	1460
395	1462								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	95	.05	280	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
95	280	1998	1998	.1	.3

CROSS SECTION

RIVER: FAN 38
REACH: Reach 700 RS: 709.

INPUT
Description:
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1431.2	70	1431	100	1430	149	1425	162	1423.7
210	1425	230	1426	255	1430	278	1430.4		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.05	100	.05	255	.05

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
100	255	2279.45	2279.45 2279.45	.1	.3

SUMMARY OF MANNING'S N VALUES

River:FAN 38

Reach	River Sta.	n1	n2	n3
Reach 700	714	.05	.05	.05
Reach 700	713	.05	.05	.05
Reach 700	712	.05	.05	.05
Reach 700	711	.05	.05	.05
Reach 700	710	.05	.05	.05
Reach 700	709.	.05	.05	.05

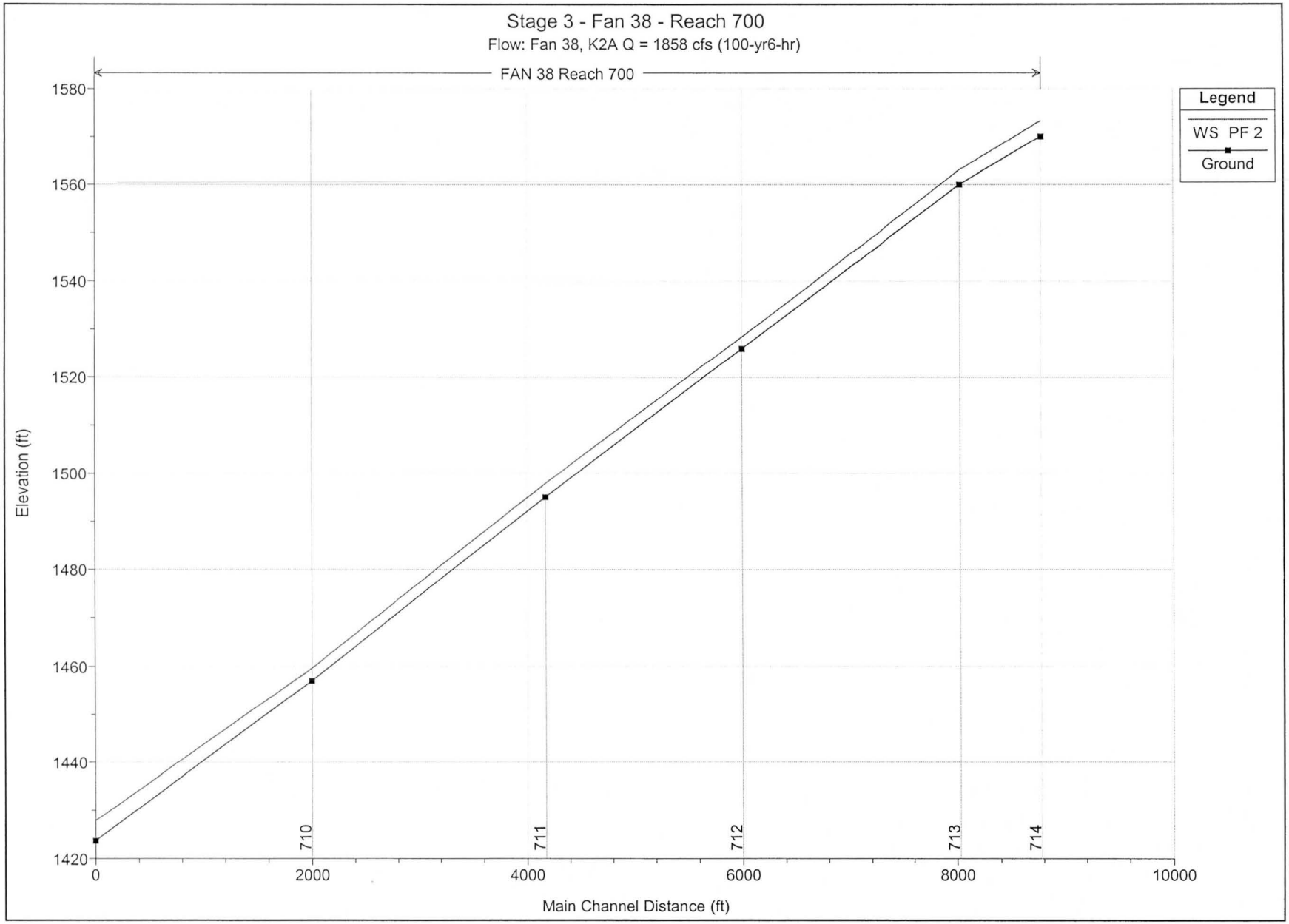
SUMMARY OF REACH LENGTHS

River: FAN 38

Reach	River Sta.	Left	Channel	Right
Reach 700	714	750	750	750
Reach 700	713	2030	2030	2030
Reach 700	712	1823	1823	1823
Reach 700	711	2177	2177	2177
Reach 700	710	1998	1998	1998
Reach 700	709.	2279.45	2279.45	2279.45

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: FAN 38

Reach	River Sta.	Contr.	Expan.
Reach 700	714	.1	.3
Reach 700	713	.1	.3
Reach 700	712	.1	.3
Reach 700	711	.1	.3
Reach 700	710	.1	.3
Reach 700	709.	.1	.3


Stage 3 - Fan 38 - Reach 700
Flow: Fan 38, K2A Q = 1858 cfs (100-yr6-hr)
FAN 38 Reach 700
Legend
WS PF 2
Ground
Elevation (ft)
1580
1560
1540
1520
1500
1480
1460
1440
1420
710
711
712
713
714
0
2000
4000
6000
8000
10000
Main Channel Distance (ft)

APPENDIX F
EROSION/SEDIMENT TRANSPORT

F.1 Ayres Associates Sediment Transport Studies - Final

Pertinent excerpts of the *Buckeye/Sun Valley Area Drainage Master Study Technical Data Notebook Volume VI: Sediment Transport Studies Final* Contract FCD 2002C027 December 2004

JULY 2005

BUCKEYE/SUN VALLEY AREA DRAINAGE MASTER STUDY
TECHNICAL DATA NOTEBOOK CONTRACT FCD 2002C027

VOLUME VI: SEDIMENT TRANSPORT STUDIES
FINAL

PREPARED FOR

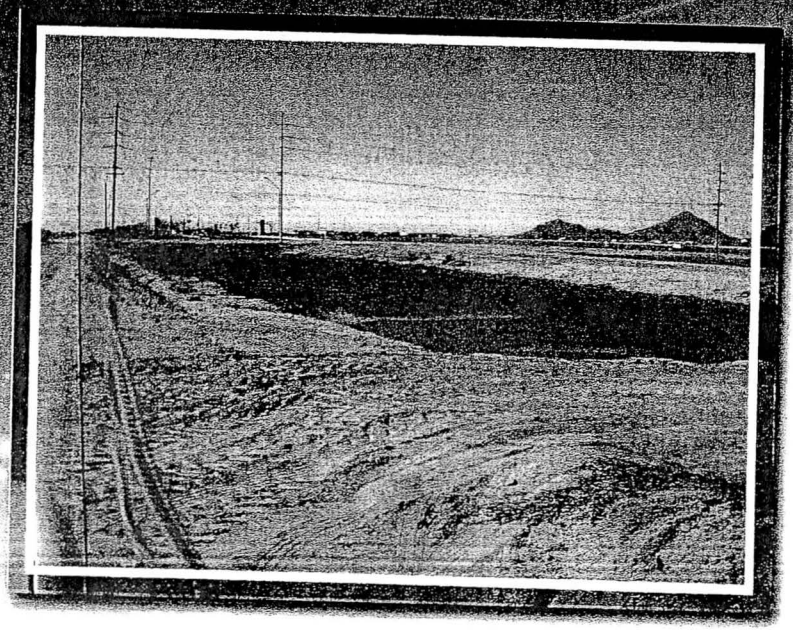
Flood Control District of Maricopa County

2801 W. DURANGO STREET
PHOENIX, ARIZONA 85009-6399

PREPARED BY

7310 N. 16TH STREET, SUITE 310
PHOENIX, ARIZONA 85020-5250
PHONE: (602) 943-1003 FAX: (602) 943-1303

IN ASSOCIATION WITH



DRAFT TECHNICAL MEMORANDUM T2.6.7

Sediment Yield Analysis (Subtask 2.6.7)
Buckeye/Sun Valley Area Drainage Master Study

Contract No. FCD 2002C027

Prepared for:

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

Prepared by:

AYRES ASSOCIATES
Ayres Associates Inc
3665 JFK Parkway
Building 2, Suite 200
Fort Collins, Colorado 80525

REGISTERED GEOLOGIST
CERTIFICATE NO.
39950
WILLIAM J.
SPITZ
Date Signed 12-14-04
ARIZONA, U.S.A.

December 2004

AYRES ASSOCIATES

TECHNICAL MEMORANDUM T2.6.7

To: Kathryn Gross, Valerie Swick – Flood Control District of Maricopa County, AZ

From: William J. Spitz, R.G., Anthony Alvarado, and Jim Schall, Ph.D.

Date: May 20, 2005

Re: **Technical Memorandum T2.6.7 (Contract No. FCD 2002C027)**
Buckeye/Sun Valley ADMS Sediment Yield Analysis (Subtask 2.6.7)

This Technical Memorandum (TM) is submitted by Ayres Associates in support of Subtask 2.6.7 of the Buckeye/Sun Valley Area Drainage Master Study (ADMS) Scope of Work (Contract FCD 2002C027).

The Buckeye/Sun Valley Area Drainage Master Study (ADMS) is being performed for the Flood Control District of Maricopa County (District) and the Town of Buckeye under Contract FCD. The purpose of the Buckeye/Sun Valley ADMS is to quantify the extent of drainage, flooding, and erosion problems, sources, and hazards in the Buckeye/Sun Valley area, and develop preliminary solutions to mitigate the identified concerns. Arizona Revised Statutes Title 48, Chapter 21, requires the Board of Directors to identify flood control problems and prepare plans that, when implemented, will eliminate or minimize flooding problems.

Task 2.6 represents the Geomorphic Evaluation and Landform Stability Assessment portion of the Scope of Work (SOW). The purpose of Task 2.6 is to provide a qualitative assessment of potential erosion and sedimentation hazards of primary washes, lateral and vertical stream instability, piedmont landform stability within the drainage networks of Area 3 (Buckeye Structures) and Area 4 (North Sun Valley) of the Buckeye/Sun Valley ADMS watershed, evaluate the 100-year storm event sediment yield for each of the three Buckeye Flood Retarding Structures (FRS), and delineate erosion hazard zones for watercourses within Areas 2 and 3 that have existing FEMA Flood Insurance Study (FIS) floodplain delineations.

1. OBJECTIVE

This TM documents the methodology and results of the sediment yield analysis performed under Subtask 2.6.7 by Ayres Associates. The objective of Subtask 2.6.7 was to evaluate the 100-year storm event sediment yield for each of the three Buckeye Flood Retarding Structures (FRS) and compare the results with the original sediment yield analysis performed for the design of the structures. Included in this TM is supporting documentation for the analysis with examples of the various calculations used.

2. METHODS

2.1 Field Data Collection

Field reconnaissance was performed to locate and measure areas of deposition along the FRSs. Sediment samples (**Figure 2.1**) were taken at various locations and the depths of the deposition were estimated. In some places, the outline of the deposition zone was determined; otherwise, the deposition area was measured using the 2003 MrSID aerial photography of the location.

Figure 2.1. Bulk sediment sample taken at the downstream end of White Tanks Wash.

All Terrain Vehicles (ATVs) with utility racks were the main mode of transportation used in the field reconnaissance (**Figure 2.2**). The Trimble GeoXT, which is shown mounted on the ATV in **Figure 2.3**, is part of the Trimble GeoExplorer CE Series, a handheld Windows CE device with an integrated Trimble GPS receiver. The GPS system uses the Wide Area Augmentation System (WAAS), which was created by the Federal Aviation Administration (FAA) as a free-to-air differential correction service. With Windows CE, the device is capable of incorporating mobile Geographic Information System (GIS) field software. The Trimble GeoXT provides sub-meter GPS accuracy with the portability of a fully editable mobile GIS database. For this project, the software used was ESRI's ArcPad 6.0, which is the mobile form of ArcGIS with GPSCorrect.

Figure 2.2. All Terrain Vehicle used for field data collection.

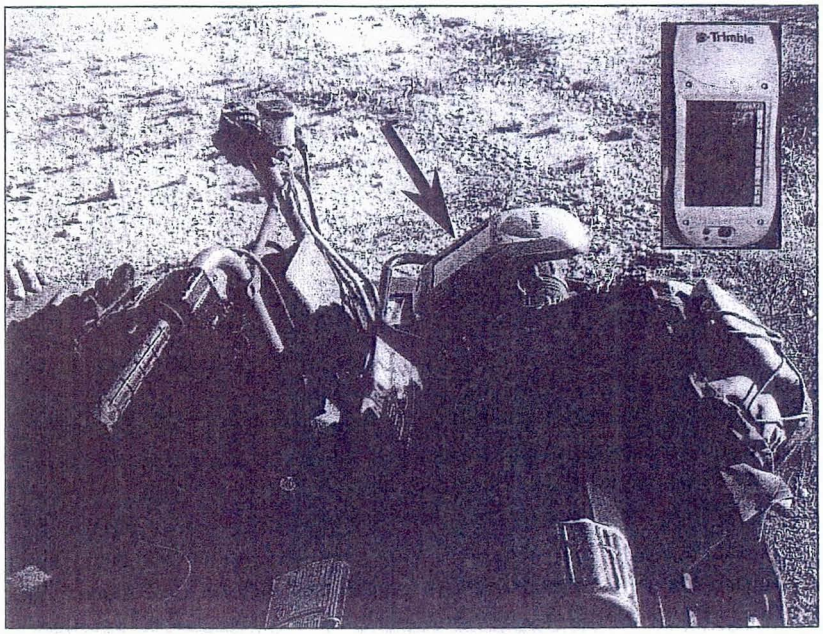


Figure 2.3. The Trimble GeoXT handheld GIS-based GPS unit (arrow) mounted on the ATV.

Using ArcPad with the georeferenced aerial orthophotography and the GPS Tracking Log, photos taken in the field were georeferenced and the sediment sample locations were accurately determined.

The portability of the Trimble GeoXT for use with the ATVs was accomplished using a GPS-mount placed on the front utility rack of the ATV. The mounted GPS was readily visible and allowed for easy tracking of the current location and navigation to a specific site.

2.2 Measurement of Sediment Deposition Volumes

The data collected in the field were used to estimate the volume of sediment deposition along each FRS. ArcGIS was the GIS software used for the sediment yield analysis. Ten-foot contour topography and 2003 MrSID orthophotography were obtained from the District and overlaid in ArcGIS. The topography and orthophotography were then utilized to guide the delineation and measurement of the actual deposition zones. The volume of sediment deposited along each FRS over the past 30 years was then calculated using the measured areas and field-estimated depths. **Table 2.1** presents the results as well as latitude and longitude locations of each major zone of deposition identified in the field or by using the orthophotography. If the average depth of deposition was unknown, a conservative estimated depth of 1 foot was used. **Figure 2.4** shows the FRS Area 3 drainage basins and sub-basins with the location of each deposition zone and the active alluvial fans in the area.

The largest volume of deposited sediment is found along FRS #1, which captures drainage from areas that include White Tank Wash and the major active alluvial fans at USGS Sites 36 through 39, as well as two lesser active fans identified in the field. The largest contribution of sediment (at Deposition Zone #1) is from the active fan area of USGS Site 36 (White Tank Fan).

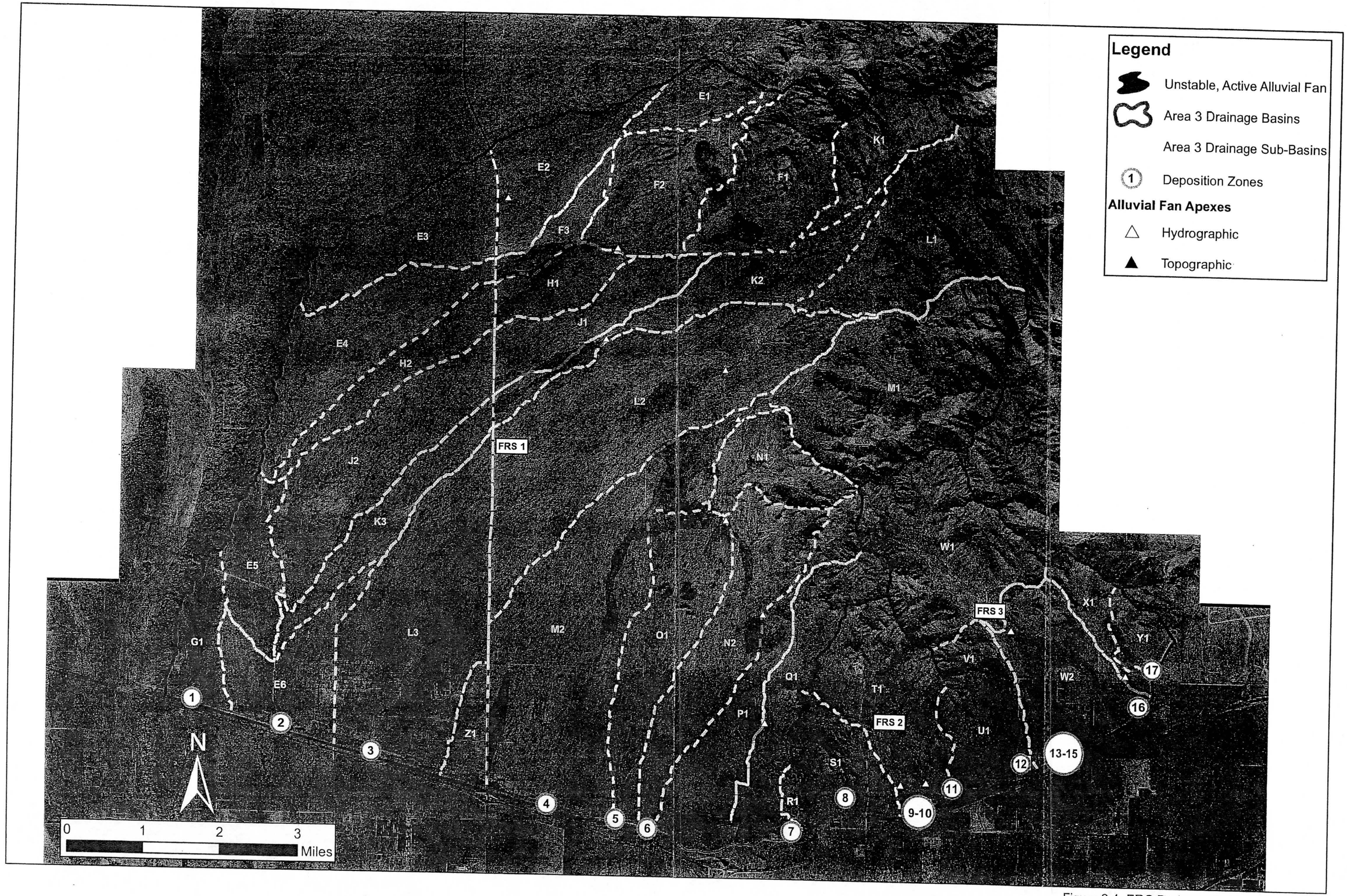


Figure 2.4. FRS Drainage Basins, Sub-basins, and Locations of Deposition Zones.

Table 2.1. Major Depositional Zones along the Buckeye Flood Retarding Structures.

#	Latitude	Longitude	FRS	Area (ft^2)	Average Depth (ft)	Volume (ac-ft)	Total FRS Volume
1	33° 27' 24.07"	112° 44' 38.90"	1	462,168	1.8	19.1	44.6
2	33° 27' 09.13"	112° 43' 27.61"	1	67,577	2.8	4.3	
3	33° 26' 52.34"	112° 42' 13.36"	1	123,181	1.0	2.8	
4	33° 26' 19.52"	112° 39' 48.39"	1	11,688	2.0	0.5	
5	33° 26' 08.85"	112° 38' 52.28"	1	72,852	2.5	4.2	
6	33° 26' 02.85"	112° 38' 24.23"	1	11,456	1.0	0.3	
7	33° 26' 03.45"	112° 36' 27.09"	1	584,376	1.0	13.4	
8	33° 26' 25.95"	112° 35' 43.98"	2	24,080	1.0	0.6	2.7
9	33° 26' 24.04"	112° 34' 37.43"	2	11,358	1.5	0.4	
10	33° 26' 33.42"	112° 34' 18.61"	2	6,276	2.0	0.3	
11	33° 26' 34.75"	112° 34' 17.19"	2	21,032	2.8	1.4	
12	33° 26' 55.39"	112° 33' 17.48"	3	29,545	1.0	0.7	3.0
13	33° 27' 03.79"	112° 32' 48.39"	3	6,879	2.5	0.4	
14	33° 27' 02.17"	112° 32' 39.78"	3	10,773	2.0	0.5	
15	33° 27' 03.08"	112° 32' 37.44"	3	11,930	2.0	0.5	
16	33° 27' 36.36"	112° 31' 41.74"	3	9,265	3.0	0.6	
17	33° 28' 01.80"	112° 31' 31.98"	3	23,291	0.5	0.3	

2.3. Initial Comparison With Original FRS Study

The only previous sediment yield study completed on the Buckeye FRSs was conducted on the area at the east edge of FRS #1 on sub-basin Q1 (**Figure 2.5**). This calculation was performed in 1974 by the Soil Conservation Service (SCS) using the Universal Soil Loss Equation (USLE) method. The study provides an estimated sediment yield of 0.015 ac-ft per square-mile per year and a volume of deposition over 25 years equal to 6 ac-ft (**Table 2.2**). This equals an average annual sediment storage in sub-basin Q1 of 0.09 ac-ft/mi^2/yr for the 25-year period.

Table 2.2. Comparison of 1974 and 2004 Estimated Volume Calculations at Sub-basin Q1.

Study	Deposition Area (ft^2)	Volume (ac-ft)	Sediment Storage (ac-ft/mi^2/yr)
2004 Measured (Zone #7)	314,353*	7.2 (30 yrs)	0.09
1974 USLE Analysis	440,000	6.0 (25 yrs)	0.09
*The western part of Deposition Zone #7 falls outside of the sub-basin Q1 and therefore was not included in the comparison.			

Deposition Zone #7, which was an area that was measured in the field in 2004, matches the outlet area for the SCS sub-basin Q1. Based on the field measurements of the area, the estimated deposition volume that occurred over the past 30 years is 7.2 ac-ft, which produces an average annual sediment storage of 0.09 ac-ft/mi^2/yr.

From the results of this comparison, it can be concluded that the 1974 analysis of this area was reasonable and that some of the same assumptions made in the SCS analysis can also be made in the current analysis.

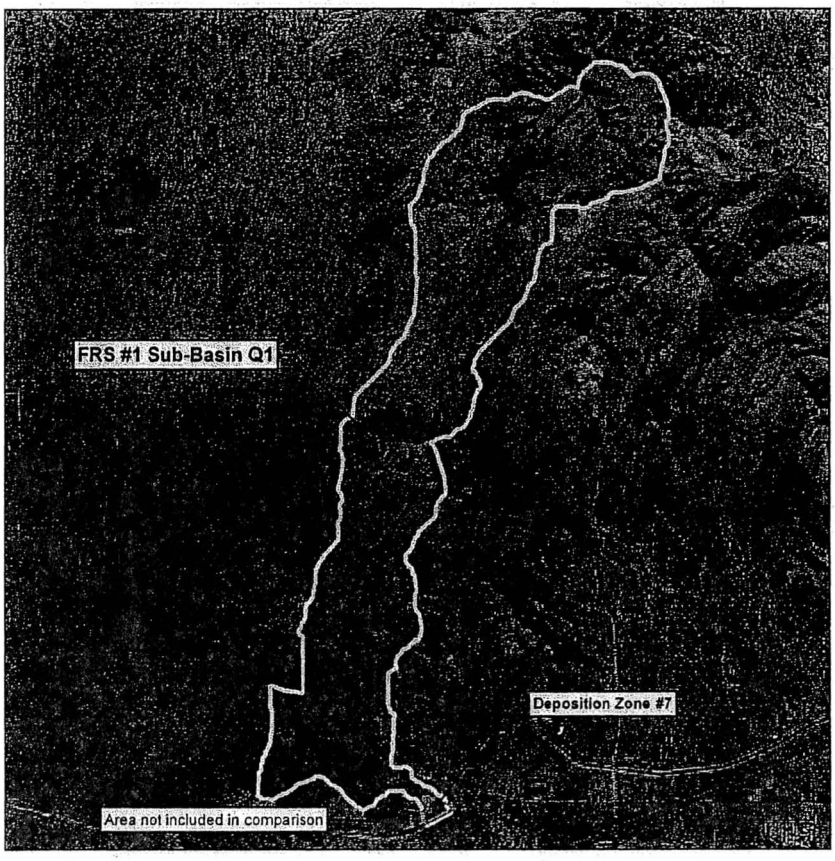


Figure 2.5. Deposition Zone #7 with sub-basin Q1 shown, as well as the portion of the area that was not included in the comparison.

2.4 Average Annual Sediment Yield Analysis Using RUSLE2

The current sediment yield calculations were conducted using the Revised Universal Soil Loss Equation (RUSLE). The computer program, RUSLE2, developed by the NRCS, was used to perform the analysis. RUSLE has the same form as the original USLE:

$$A = RKLSCP$$

where:

- A = Average annual soil loss (not the sediment yield)
- R = Rainfall erosivity
- K = Soil erodibility
- LS = Slope length and steepness
- C = Cover management factor
- P = Support conservation practices

Initially, RUSLE2 was used to calculate the average annual soil loss. However, RUSLE2 can be used to estimate storm event soil loss by adjusting the rainfall erosivity factor (Kelsey 2002). The rainfall erosivity value was adjusted to account for the 100-year, 24- and 6-hour events to provide an event-based soil loss (see Section 2.5).

2.4.1 Rainfall Erosivity

The R factor represents the rainfall erosivity of the climate at a particular location. The RUSLE2 climate database was utilized for the rainfall erosivity for the average annual analysis. In the USA climate database for Arizona, the erosivity for "Phoenix at point" was used. This rainfall erosivity value was 22.6.

2.4.2 Soil Erodibility

The K factor represents the base soil erodibility as determined using the soil erodibility nomograph. The K factor is an empirical measure of soil erodibility that is affected by intrinsic soil properties. Soils survey data of the area for RUSLE2 were acquired from the NRCS National RUSLE2 Database. The soil data for the drainage area of the three Buckeye FRSs is from two soil surveys: the southern part of the drainage area is from a soil survey of the central part of Maricopa County (Hartman 1977) and the northern part of the drainage area is from a soil survey of the Aguila-Carefree Area (Camp 1986). The soils mapping was also obtained in the form of a GIS shapefile, which provides the location and total area of each of the soil types. The GIS information was invaluable in determining the slope and the total area of each soil type.

The resulting soil types are shown in **Tables 2.3**, **2.4**, and **2.5**. For each soil description there were usually two or three soil types associated with it in the RUSLE2 database. For example, for the NRCS soil, Carrizo-Gunsight complex, 1 to 5 percent slopes, the user could select either "Carrizo gravelly sandy loam" or "Gunsight very gravelly sandy loam." For the purposes of this analysis, the soil type that gave the higher soil erodibility was used in the RUSLE2 calculation. In this example, "Gunsight very gravelly sandy loam" had a K value of 0.37 while "Carrizo gravelly sandy loam" has a K value of 0.32. Therefore, "Gunsight very gravelly sandy loam" was the soil type used to define K in calculating the soil loss for Carrizo-Gunsight complex.

2.4.3 Slope Length and Steepness

The LS factor jointly represents the effect of steepness, slope length, and shape (convex, concave, or uniform slopes) on sediment production. ArcGIS software was utilized to calculate the steepness or slope of each soil group using the NRCS soil survey GIS information. **Tables 2.6**, **2.7**, and **2.8** provide the calculated slopes. Slope length was estimated using the calculated slopes. If the slopes were 5 percent or less, the slope length input into RUSLE2 was 200 feet. If the slopes were between 5 and 15 percent, the slope length input into RUSLE2 was 100. If the slopes were greater than 15 percent, the slope length input into RUSLE2 was 30 feet (Tables 2.6, 2.7, and 2.8). These slope length estimates are based on the estimates made in the original 1974 sediment yield study. The shape was assumed to be a uniform up and down contouring over the course of the entire area. All three of these variables, the steepness or slope, the slope length, and the shape were input into RUSLE2 to calculate the LS factors shown in Tables 2.6, 2.7, and 2.8.

2.4.4. Cover Management Factor

The C factor, or cover management factor, is the ratio of soil loss from an area with specified vegetation and management to that from the fallow condition on which the factor K is evaluated. In the original 1974 study, a C factor of 0.3 for desert shrub was used. This was assumed to be reasonable and a C factor of 0.3 was used for the current analysis as well.

Table 2.3. Soil Groups and Erodibility Values for Buckeye FRS #1.

NRCS Soil Description	RUSLE2 Soil Type	Soil Erodibility K
Antho sandy loams	Antho sandy loam 25%	0.28
Carrizo very gravelly sand	Carrizo very gravelly sand 100%	0.06
Carrizo-Gunsight complex, 1 to 5 % slopes	Gunsight very gravelly sandy loam 30%	0.43
Cheriono-Rock outcrop complex	Cherioni extremely stony loam 60%	0.74
Chuckawalla-Gunsight complex, 1 to 8 % slopes	Gunsight very gravelly loam 35%	0.57
Cipriano very gravelly loam	Cipriano very gravelly loam 100%	0.74
Coolidge-Laveen association	Coolidge sandy loam 40%	0.28
Denure-Momoli-Carrizo complex	Momoli gravelly sandy loam 30%	0.43
Ebon-Gunsight-Cipriano association, 3 to 25 % slopes	Gunsight very gravelly sandy loam 20%	0.43
Ebon-Pinamt complex, 20 to 40 % slopes	Ebon very gravelly loam 45%	0.32
Gachado-Lomitas-Rock outcrop complex, 7 to 55 % slopes	Gachado very gravelly loam 45%	0.43
Gilman-Antho association	Gilman loam 50%	0.37
Gunsight-Cipriano complex, 1 to 7 % slopes	Gunsight very gravelly sandy loam 45%	0.43
Gunsight-Pinal complex, 1 to 10 % slopes	Pinal gravelly loam 30%	0.37
Gunsight-Rillito complex, 0 to 10 % slopes	Gunsight gravelly loam 40%	0.37
Gunsight-Rillito complex, 1 to 25 % slopes	Gunsight very gravelly loam 40%	0.57
Gunsight-Rillito complex, low precipitation, 1 to 40 % slopes	Gunsight very gravelly loam 40%	0.57
Harqua-Gunsight complex, 0 to 5 % slopes	Gunsight gravelly loam 35%	0.37
Perryville-Rillito complex, 0 to 3 % slopes	Perryville loam 35%	0.37
Pinal gravelly loam	Pinal gravelly loam 100%	0.37
Pinamt-Tremant complex, 1 to 10 % slopes	Tremant gravelly loam 35%	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	Quilotosa extremely gravelly sandy loam 50%	0.12
Rillito gravelly loam, 1 to 8 % slopes	Rillito gravelly loam 100%	0.37
Sal-Cipriano complex, 1 to 10 % slopes	Sal extremely gravelly loam 50%	0.37
Tremant gravelly loams, low precipitation	Tremant gravelly loam 35%	0.74

Table 2.4. Soil Groups and Erodibility Values for Buckeye FRS #2.

NRCS Soil Description	RUSLE2 Soil Type	Soil Erodibility K
Antho sandy loams	Antho gravelly sandy loam 30%	0.28
Cheriono-Rock outcrop complex	Cherioni extremely stony loam 60%	0.74
Gunsight-Pinal complex, 1 to 10 % slopes	Pinal gravelly loam 30%	0.37
Gunsight-Rillito complex, 0 to 10 % slopes	Gunsight gravelly loam 40%	0.37
Gunsight-Rillito complex, 1 to 25 % slopes	Gunsight very gravelly loam 40%	0.57
Pinamt-Tremant complex, 1 to 10 % slopes	Tremant gravelly loam 35%	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	Quilotosa extremely gravelly sandy loam 50%	0.12
Tremant-Rillito complex, 0 to 5 % slopes	Rillito gravelly loam 30%	0.37

Table 2.5. Soil Groups and Erodibility Values for Buckeye FRS #3.

NRCS Soil Description	RUSLE2 Soil Type	Soil Erodibility K
Antho-Carrizo-Maripo complex	Antho gravelly sandy loam 30%	0.28
Denure-Momoli-Carrizo complex	Momoli gravelly sandy loam 30%	0.43
Gunsight-Rillito complex, 0 to 10 % slopes	Gunsight gravelly loam 40%	0.37
Harqua-Gunsight complex, 0 to 5 % slopes	Gunsight gravelly loam 35%	0.37
Pinamt-Tremant complex, 1 to 10 % slopes	Tremant gravelly loam 35%	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	Quilotosa extremely gravelly sandy loam 50%	0.12
Rock outcrop-Cheriono complex	Cherioni extremely stony loam 60%	0.74

Table 2.6. Slope, Slope Length, and LS Factors for Buckeye FRS #1.

NRCS Soil Description	Slope	Slope Length (ft)	LS Factor
Antho sandy loams	1.7%	200	0.24
Carrizo very gravelly sand	1.9%	200	0.28
Carrizo-Gunsight complex, 1 to 5 % slopes	2.5%	200	0.36
Cheriono-Rock outcrop complex	21.6%	30	2.00
Chuckawalla-Gunsight complex, 1 to 8 % slopes	2.6%	200	0.37
Cipriano very gravelly loam	11.4%	100	1.60
Coolidge-Laveen association	1.4%	200	0.20
Denure-Momoli-Carrizo complex	2.2%	200	0.31
Ebon-Gunsight-Cipriano association, 3 to 25 % slopes	7.7%	100	0.96
Ebon-Pinamt complex, 20 to 40 % slopes	12.1%	100	1.70
Gachado-Lomitas-Rock outcrop complex, 7 to 55 % slopes	22.5%	30	2.10
Gilman-Antho association	1.2%	200	0.17
Gunsight-Cipriano complex, 1 to 7 % slopes	4.7%	200	0.70
Gunsight-Pinal complex, 1 to 10 % slopes	5.7%	100	0.70
Gunsight-Rillito complex, 0 to 10 % slopes	1.9%	200	0.27
Gunsight-Rillito complex, 1 to 25 % slopes	4.0%	200	0.57
Gunsight-Rillito complex, low precipitation, 1 to 40 % slopes	1.5%	200	0.21
Harqua-Gunsight complex, 0 to 5 % slopes	2.2%	200	0.31
Perryville-Rillito complex, 0 to 3 % slopes	1.5%	200	0.21
Pinal gravelly loam	6.3%	100	0.78
Pinamt-Tremant complex, 1 to 10 % slopes	5.8%	100	0.72
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	35.3%	30	3.20
Rillito gravelly loam, 1 to 8 % slopes	1.5%	200	0.22
Sal-Cipriano complex, 1 to 10 % slopes	3.4%	200	0.42
Tremant gravelly loams, low precipitation	1.4%	200	0.20

Table 2.7. Slope, Slope Length, and K Factors for Buckeye FRS #2.

NRCS Soil Description	Slope (%)	Slope Length (ft)	LS Factor
Antho sandy loams	2.3%	200	0.28
Cheriono-Rock outcrop complex	24.1%	30	0.74
Gunsight-Pinal complex, 1 to 10 % slopes	6.1%	100	0.37
Gunsight-Rillito complex, 0 to 10 % slopes	2.4%	200	0.37
Gunsight-Rillito complex, 1 to 25 % slopes	8.8%	100	0.57
Pinamt-Tremant complex, 1 to 10 % slopes	7.4%	100	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	36.2%	30	0.12
Tremant-Rillito complex, 0 to 5 % slopes	3.9%	200	0.37

Table 2.8. Slope, Slope Length, and K Factors for Buckeye FRS #3.

NRCS Soil Description	Slope (%)	Slope Length (ft)	LS Factor
Antho-Carrizo-Maripo complex	2.8%	200	0.28
Denure-Momoli-Carrizo complex	4.1%	200	0.43
Gunsight-Rillito complex, 0 to 10 % slopes	2.3%	200	0.37
Harqua-Gunsight complex, 0 to 5 % slopes	1.9%	200	0.37
Pinamt-Tremant complex, 1 to 10 % slopes	7.4%	100	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	37.3%	30	0.12
Rock outcrop-Cheriono complex	27.8%	30	0.74

2.4.5 Support Conservation Practices

Support conservation practices were not taken into account in this analysis; therefore, the P factor was assumed to be 1.0.

2.4.6 Average Annual Sediment Yield Results

The average annual sediment yield analysis was performed for each of the Buckeye FRSs (**Tables 2.9**, **2.10**, and **2.11**). An average annual soil loss was calculated in RUSLE2 for each soil group. Given these results and the GIS calculated total area of each soil group, an area weighted soil loss for each FRS drainage basin was computed. Channel erosion was taken into account as being 20 percent of the total soil loss as assumed in the original 1974 study. The sediment delivery, or how much of the sediment loss actually is transported to the FRS, was assumed to be 70 percent. The trap efficiency, or how much of the sediment is deposited in the FRS as opposed to flowing to the Hassayampa River, was assumed to be 65 percent. These same assumptions were made in the original 1974 sediment yield analysis. Accounting for these factors provided a final resultant sediment storage value or an estimate of how much sediment would be deposited at each FRS.

The results indicate that the calculated sediment storage is 0.20 ac-ft/mi^2/yr for FRS #1, 0.70 ac-ft/mi^2/yr for FRS #2, and 0.40 ac-ft/mi^2/yr for FRS #3. The calculated sediment storage of FRS #2 is higher than either of the calculated sediment storages for FRS #1 and #3 because of its high slope over a smaller area and also because it has a higher percentage of relict fan and mountain soil types. The calculated sediment storage of FRS #1 is lowest because of its lower average slope compared to the other two drainage areas.

These numbers appear reasonable when compared to other measured sediment yield data from the Southwest (**Table 2.12**). Table 2.12 presents actual data based on total sediment deposited over a certain period of time.

The numbers also appear reasonable when compared to computed average annual sediment yield estimates from previous Maricopa County studies as shown in **Table 2.13**. The previous studies conducted in the Maricopa County area have an arithmetic average of 0.65 ac-ft/mi^2/yr, which can be viewed as an upper limit of most of the estimates (JE Fuller 2003). The calculated sediment storage of FRS #2 is higher than the previous study average most likely because of higher average slope over a relatively small area.

3.5 Single Event Sediment Yield Analysis

A single event sediment yield analysis was performed on the 100-year, 6- and 24-hour events. Initially, the 100-year, 6- and 24-hour event-based sediment yield analyses were performed using the same parameter values as the average annual analysis in RUSLE2 with the exception of the R factor being adjusted to account for the events. However, this approach produced unreasonably low sediment loads so a different approach was taken. The second approach predicted a sediment load and deposition based on an assumption of the sediment concentration by volume given the flow characteristics that the flood would have. This approach led to a more reasonable prediction of the sediment deposition at the FRSs.

Table 2.9. FRS #1 Average Annual Sediment Yield RUSLE2 Results

					Annual R Factor	22.6				Sediment: tons/acre-ft	2156.22
Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Slope (%)	Slope Length (ft)	LS Factor	C Factor	K Factor	RUSLE2 Soil Loss (tons/ac/yr)	Weighted-Average Soil Loss (tons/ac/yr)
Antho sandy loams	Arizona\Phoenix at point	1 ANTHO SANDY LOAMS\ANTHO sandy loam 25%	6965.35	14.36%	1.7%	200	0.24	0.30	0.28	0.4	0.059
Carrizo very gravelly sand	Arizona\Phoenix at point	14 CARRIZO VERY GRAVELLY SAND\CARRIZO very gravelly sand 100%	2473.06	5.10%	1.9%	200	0.28	0.30	0.06	0.1	0.005
Carrizo-Gunsight complex, 1 to 5 percent slopes	Arizona\Phoenix at point	15 CARRIZO-GUNSIGHT COMPLEX, 1 TO 5 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 30%	3454.05	7.12%	2.5%	200	0.36	0.30	0.43	0.9	0.067
Cherlono-Rock outcrop complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	482.21	0.99%	21.6%	30	2.00	0.30	0.74	9.9	0.098
Chuckawalla-Gunsight complex, 1 to 8 percent slopes	Arizona\Phoenix at point	19 CHUCKAWALLA-GUNSIGHT COMPLEX, 1 TO 8 PERCENT SLOPES\GUNSIGHT very gravelly loam 35%	1454.62	3.00%	2.6%	200	0.37	0.30	0.57	1.3	0.039
Cipriano very gravelly loam	Arizona\Phoenix at point	21 CIPRIANO VERY GRAVELLY LOAM\CIPRIANO very gravelly loam 100%	260.70	0.54%	11.4%	100	1.60	0.30	0.74	7.5	0.040
Coolidge-Laveen association	Arizona\Phoenix at point	CV COOLIDGE-LAVEEN ASSOCIATION\COOLIDGE sandy loam 40%	721.22	1.49%	1.4%	200	0.20	0.30	0.28	0.3	0.005
Denure-Momoli-Carrizo complex	Arizona\Phoenix at point	29 DENURE-MOMOLI-CARRIZO COMPLEX\MOMOLI gravelly sandy loam 30%	2306.75	4.76%	2.2%	200	0.31	0.30	0.43	0.8	0.039
Ebon-Gunsight-Cipriano association, 3 to 25 percent slopes	Arizona\Phoenix at point	47 EBON-GUNSIGHT-CIPRIANO ASSOCIATION, 3 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 20%	704.65	1.45%	7.7%	100	0.96	0.30	0.43	2.5	0.036
Ebon-Pinamt complex, 20 to 40 percent slopes	Arizona\Phoenix at point	49 EBON-PINAMT COMPLEX, 20 TO 40 PERCENT SLOPES\EBON very gravelly loam 45%	446.62	0.92%	12.1%	100	1.70	0.30	0.32	3.6	0.033
Gachado-Lomitas-Rock outcrop complex, 7 to 55 percent slopes	Arizona\Phoenix at point	52 GACHADO-LOMITAS-ROCK OUTCROP COMPLEX, 7 TO 55 PERCENT SLOPES\GACHADO very gravelly loam 45%	535.04	1.10%	22.5%	30	2.10	0.30	0.43	6.0	0.066
Gilman-Antho association	Arizona\Phoenix at point	GM GILMAN-ANTHO ASSOCIATION\GILMAN loam 50%	456.13	0.94%	1.2%	200	0.17	0.30	0.37	0.4	0.004
Gunsight-Cipriano complex, 1 to 7 percent slopes	Arizona\Phoenix at point	68 GUNSIGHT-CIPRIANO COMPLEX, 1 TO 7 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 45%	94.77	0.20%	4.7%	200	0.70	0.30	0.43	1.8	0.004
Gunsight-Pinal complex, 1 to 10 percent slopes	Arizona\Phoenix at point	GWD GUNSIGHT-PINAL COMPLEX, 1 TO 10 PERCENT SLOPES\PINAL gravelly loam 30%	585.35	1.21%	5.7%	100	0.70	0.30	0.37	1.6	0.019
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	1332.15	2.75%	1.9%	200	0.27	0.30	0.37	0.6	0.016
Gunsight-Rillito complex, 1 to 25 percent slopes	Arizona\Phoenix at point	70 GUNSIGHT-RILLITO COMPLEX, 1 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	4194.56	8.65%	4.0%	200	0.57	0.30	0.57	2.0	0.173
Gunsight-Rillito complex, low precipitation, 1 to 40 percent slopes	Arizona\Phoenix at point	71 GUNSIGHT-RILLITO COMPLEX, LOW PRECIPITATION, 1 TO 40 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	378.99	0.78%	1.5%	200	0.21	0.30	0.57	0.7	0.006
Harqua-Gunsight complex, 0 to 5 percent slopes	Arizona\Phoenix at point	HLC HARQUA-GUNSIGHT COMPLEX, 0 TO 5 PERCENT SLOPES\GUNSIGHT gravelly loam 35%	61.37	0.13%	2.2%	200	0.31	0.30	0.37	0.7	0.001
Perryville-Rillito complex, 0 to 3 percent slopes	Arizona\Phoenix at point	PRB PERRYVILLE-RILLITO COMPLEX, 0 TO 3 PERCENT SLOPES\PERRYVILLE loam 35%	1038.32	2.14%	1.5%	200	0.21	0.30	0.37	0.5	0.010
Pinal gravelly loam	Arizona\Phoenix at point	PT PINAL GRAVELLY LOAM\PINAL gravelly loam 100%	38.09	0.08%	6.3%	100	0.78	0.30	0.37	1.8	0.001
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1952.98	4.03%	5.8%	100	0.72	0.30	0.74	3.2	0.129
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam	8411.65	17.35%	35.3%	30	3.20	0.30	0.12	2.4	0.416
Rillito gravelly loam, 1 to 8 percent slopes	Arizona\Phoenix at point	102 RILLITO GRAVELLY LOAM, 1 TO 8 PERCENT SLOPES\RILLITO gravelly loam 100%	7261.00	14.97%	1.5%	200	0.22	0.30	0.37	0.5	0.073
Sal-Cipriano complex, 1 to 10 percent slopes	Arizona\Phoenix at point	106 SAL-CIPRIANO COMPLEX, 1 TO 10 PERCENT SLOPES\SAL extremely gravelly loam 50%	1988.08	4.10%	3.4%	200	0.42	0.30	0.37	1.0	0.039
Tremant gravelly loams, low precipitation	Arizona\Phoenix at point	114 TREMANT GRAVELLY LOAMS, LOW PRECIPITATION\TREMANT gravelly loam 35%	129.93	0.27%	1.4%	200	0.20	0.30	0.74	0.9	0.014
		Total	48490.90	100.00%						Total Soil Loss (tons/ac/yr)	1.39
										Total Soil Loss(ac-ft/sq-mi/yr)	0.41
										Channel Erosion (20% of Total)	0.08
										Total Erosion	0.50
										Estimated 70% Delivery	0.35
										Estimated 65% Trap Efficiency	0.23
										Sediment Storage (ac-ft/sq-mi/yr)	**0.20**

Table 2.10. FRS #2 Average Annual Sediment Yield RUSLE2 Results

					Annual R Factor	22.6				Sediment: tons/acre-ft	2156.22
Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Slope (%)	Slope Length (ft)	LS Factor	C Factor	K Factor	RUSLE2 Soil Loss (Tons/Ac/Yr)	Weighted-Average Soil Loss (tons/ac/yr)
Antho association	Arizona\Phoenix at point	AL ANTHO ASSOCIATION\ANTHO gravelly sandy loam 30%	76.89	2.06%	2.3%	200	0.33	0.30	0.28	0.56	0.012
Cherlono-Rock outcrop complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	695.20	18.66%	24.1%	30	2.30	0.30	0.74	11	2.052
Gunsight-Pinal complex, 1 to 10 percent slopes	Arizona\Phoenix at point	GWD GUNSIGHT-PINAL COMPLEX, 1 TO 10 PERCENT SLOPES\PINAL gravelly loam 30%	524.60	14.08%	6.1%	100	0.75	0.30	0.37	1.7	0.239
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	96.47	2.59%	2.4%	200	0.34	0.30	0.37	0.76	0.020
Gunsight-Rillito complex, 1 to 25 percent slopes	Arizona\Phoenix at point	70 GUNSIGHT-RILLITO COMPLEX, 1 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	103.75	2.78%	8.8%	100	1.40	0.30	0.57	4.9	0.136
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1103.25	29.61%	7.4%	100	0.92	0.30	0.74	4.2	1.243
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam	494.30	13.26%	36.2%	30	3.30	0.30	0.12	2.5	0.332
Tremant-Rillito complex, 0 to 5 percent slopes	Arizona\Phoenix at point	TSC TREMANT-RILLITO COMPLEX, 0 TO 5 PERCENT SLOPES\RILLITO gravelly loam 30%	558.66	14.99%	3.9%	200	0.56	0.30	0.37	1.3	0.172
		Total	3726.48	100.00%						Total Soil Loss (tons/ac/yr)	4.21
										Total Soil Loss (ac-ft/sq-mi/yr)	1.25
										Channel Erosion (20% of Total)	0.25
										Total Erosion	1.50
										Estimated 70% Delivery	1.05
										Estimated 65% Trap Efficiency	0.68
										Sediment Storage (ac-ft/sq-mi/yr)	**0.70**

Table 2.11. FRS #3 Average Annual Sediment Yield RUSLE2 Results

					Annual R Factor	22.6				Sediment: tons/acre-ft	2156.22
Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Slope (%)	Slope Length (ft)	LS Factor	C Factor	K Factor	RUSLE2 Soil Loss (Tons/Ac/Yr)	Weighted-Average Soil Loss (tons/ac/yr)
Antho-Carrizo-Maripo complex	Arizona\Phoenix at point	3 ANTHO-CARRIZO-MARIPO COMPLEX\ANTHO sandy loam 35%	806.13	14.36%	2.8%	200	0.40	0.30	0.28	0.68	0.098
Denure-Momoli-Carrizo complex	Arizona\Phoenix at point	29 DENURE-MOMOLI-CARRIZO COMPLEX\MOMOLI gravelly sandy loam 30%	9.60	0.17%	4.1%	200	0.60	0.30	0.43	1.6	0.003
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	143.20	2.55%	2.3%	200	0.32	0.30	0.37	0.72	0.018
Harqua-Gunsight complex, 0 to 5 percent slopes	Arizona\Phoenix at point	HLC HARQUA-GUNSIGHT COMPLEX, 0 TO 5 PERCENT SLOPES\GUNSIGHT gravelly loam 35%	86.88	1.55%	1.9%	200	0.27	0.30	0.37	0.6	0.009
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1508.85	26.87%	7.4%	100	0.92	0.30	0.74	4.2	1.129
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam	2992.43	53.29%	37.3%	30	3.30	0.30	0.12	2.6	1.386
Rock outcrop-Cherioni complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	13.54	0.24%	27.8%	30	2.60	0.30	0.74	13	0.031
		Total	5615.45	100.00%						Total Soil Loss (tons/ac/yr)	2.67
										Total Soil Loss (ac-ft/sq-mi/yr)	0.79
										Channel Erosion (20% of Total)	0.16
										Total Erosion	0.95
										Estimated 70% Delivery	0.67
										Estimated 65% Trap Efficiency	0.43
										Sediment Storage (ac-ft/sq-mi/Yr)	**0.40**

Table 2.12. Comparison of Sediment Yield Data from the Southwest.

Watershed	Area (mi^2)	Period (years)	Sediment Yield (ac-ft/mi^2/yr)
Buckeye Flood Retarding Structures			
FRS #1	75.8	-	0.20
FRS #2	5.8	-	0.70
FRS #3	8.8	-	0.40
New Mexico (Curtis 1976)			
Santa Cruz	93.1	27.4	0.27
Santa Cruz R #6	3.12	6.7	3.30
Santa Cruz R #3	1.16	7.0	9.10
Zia Pueblo	2.40	7.0	5.84
Tortugas Arroyo	20.54	9.7	0.69
Upper Rio Hondo	93.9	12.9	0.54
Oak Creek	9.41	6.0	3.32
Upper Gila Valley Region	0.33	8.7	1.54
Southeastern Arizona – Walnut Gulch Experimental Watershed (Renard 1972)			
Basin 201	0.17	-	0.33
Basin 214	0.58	-	0.31
Basin 223	0.17	-	0.38
Glendora, California (PSIAC 1974)			
Bell Canyon #4	0.06	39	0.88
Eagle, Colorado (PSIAC 1974)			
Boca Mountain	< 0.01	7	0.65

Table 2.13. Comparison of Sediment Yield Analysis Results in Maricopa County.

Watershed	Area (mi^2)	Average Annual Sediment Yield (ac-ft/mi^2/yr)
Buckeye Flood Retarding Structures		
FRS #1	75.8	0.20
FRS #2	5.8	0.70
FRS #3	8.8	0.40
Maricopa County Previous Studies		
Casandro Wash[1]	1.2	0.31
Rawhide Wash[1]	13.6	0.39
Phoenix Mountain Preserve (Tatum Wash)[2]	1.9	1.9
Shea Boulevard (Tatum Wash)[2]	2.2	2.1
Western Tributary (Cherokee Wash)[3]	0.1	2.16
Desert Park Tributary (Cherokee Wash)[3]	0.3	1.98
Desert Greenbelt Project, AZ[4]	8.6	0.10
Cave Creek, AZ[4]	121.0	0.31
Spookhill Dam, AZ[4]	16.4	0.15
Saddleback Dam, AZ[4]	30.0	0.08
Davis Tank, AZ[5]	0.2	0.96
Kennedy Tank, AZ[5]	1.0	0.27
Juniper Wash, AZ[5]	2.0	0.29
Alhambra Tank, AZ[5]	6.6	0.03
Black Hills Tank, AZ[5]	1.1	0.68
Black Hills Tank, AZ[6]	1.6	0.58
Mesquite Tank, AZ[5]	9.0	0.03
Tank 76, AZ[5]	1.2	0.21
Spook Hill ADMP[7]	3.0 - 14.0	0.13
North Peoria ADMP[8]	0.1 - 32.9	0.31
	Average	**0.65**

1. CH2M-Hill 1994
2. JE Fuller 1997
3. WEST Consulting 1997
4. Hjalmarson 1996
5. Peterson 1962
6. Langbien, Hains and Culler 1951
7. JE Fuller 2000
8. JE Fuller 2002

2.5.1 Approach Using RUSLE2 and Erosion Works

For the 100-year event analysis, the software program Erosion Works (American Excelsior 2004) was chosen to calculate the rainfall erosivity. Erosion Works is a program that takes a given rainfall intensity hyetograph and provides the corresponding R value for an event-based soil loss analysis.

To determine the 100-year, 24- and 6-hour hyetographs for each of the structures, the procedures in Volume I of the Draft Drainage Design Manual for Maricopa County (Sabol et al. 2003) were followed. The 100-year, 24- and 6-hour area averaged point rainfall depths for each structure were obtained from the Buckeye/Sun Valley Area Drainage Master Study Hydrology Report (PBS&J 2004). **Table 2.14** shows the values that were used. The depth-area reduction factor (Table 3.13) was determined next using Figures 2.1 and 2.2 in Volume I of the Draft Drainage Design Manual (Sabol et al. 2003). The depth-area reduction factor was applied to the area-averaged point rainfall depths, which was then applied to the dimensionless distributions in Table 2.4 and 2.5 (after determining the appropriate pattern number for the 6-hour storm) of the Draft Drainage Design Manual. **Figures 2.6** and **2.7** show the final rainfall intensity hyetographs used in determining the rainfall erosivity for each FRS for the 100-year, 24- and 6-hour storms, respectively. With these hyetographs, the 100-year, 24- and 6-hour event rainfall erosivity values were calculated (**Table 2.15**).

Table 2.14. Basin 100-Year Rainfall Depths and Area Reduction Factors.

Drainage Basin	Rainfall Depth (ft) (6-hr)	Depth-Area Reduction Factor (6-hr)	Rainfall Depth (ft) (24-hr)	Depth-Area Reduction Factor (24-hr)
FRS #1	3.23	0.82	4.16	0.86
FRS #2	3.28	0.96	4.13	0.91
FRS #3	3.26	0.94	4.14	0.88

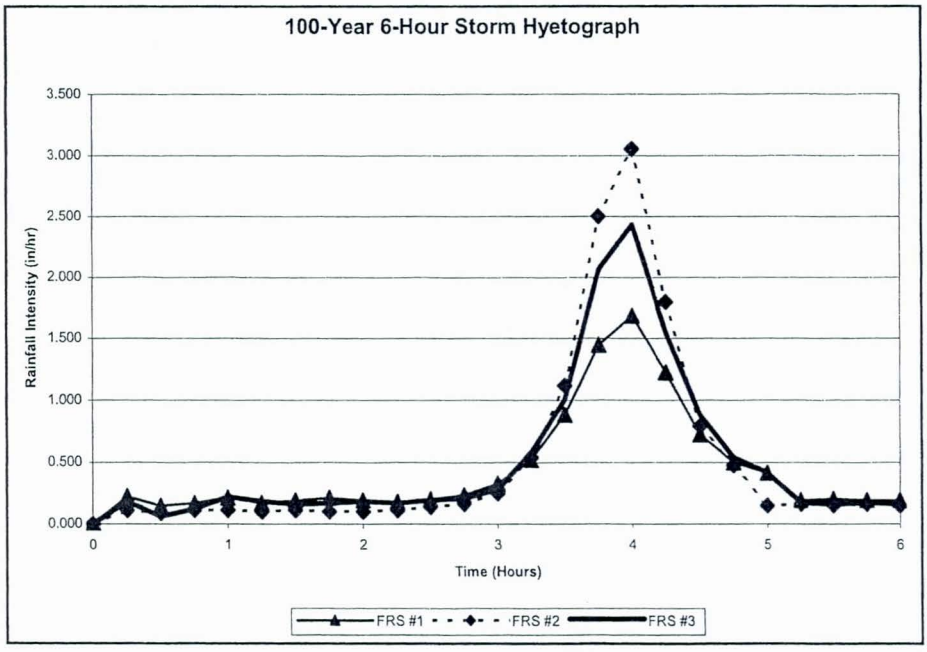


Figure 2.6. 100-Year 6-Hour Storm Hyetograph.

Table 2.16. FRS #1 100-Year 6-Hour Storm Sediment Yield RUSLE2 Results

Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Annual R Factor 22.6 Slope (%)	Slope Length (ft)	R (100yr 6hr) 31.72 Net LS Factor	Net C Factor	Net K Factor
Antho sandy loams	Arizona\Phoenix at point	1 ANTHO SANDY LOAMS\ANTHO sandy loam 25%	6965.35	14.36%	1.7%	200	0.24	0.30	0.28
Carrizo very gravelly sand	Arizona\Phoenix at point	14 CARRIZO VERY GRAVELLY SAND\CARRIZO very gravelly sand 100%	2473.06	5.10%	1.9%	200	0.28	0.30	0.06
Carrizo-Gunsight complex, 1 to 5 percent slopes	Arizona\Phoenix at point	15 CARRIZO-GUNSIGHT COMPLEX, 1 TO 5 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 30%	3454.05	7.12%	2.5%	200	0.36	0.30	0.43
Cheriono-Rock outcrop complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	482.21	0.99%	21.6%	30	2.00	0.30	0.74
Chuckawalla-Gunsight complex, 1 to 8 percent slopes	Arizona\Phoenix at point	19 CHUCKAWALLA-GUNSIGHT COMPLEX, 1 TO 8 PERCENT SLOPES\GUNSIGHT very gravelly loam 35%	1454.62	3.00%	2.6%	200	0.37	0.30	0.57
Cipriano very gravelly loam	Arizona\Phoenix at point	21 CIPRIANO VERY GRAVELLY LOAM\CIPRIANO very gravelly loam 100%	260.70	0.54%	11.4%	100	1.60	0.30	0.74
Coolidge-Laveen association	Arizona\Phoenix at point	CV COOLIDGE-LAVEEN ASSOCIATION\COOLIDGE sandy loam 40%	721.22	1.49%	1.4%	200	0.20	0.30	0.28
Denure-Momoli-Carrizo complex	Arizona\Phoenix at point	29 DENURE-MOMOLI-CARRIZO COMPLEX\MOMOLI gravelly sandy loam 30%	2306.75	4.76%	2.2%	200	0.31	0.30	0.43
Ebon-Gunsight-Cipriano association, 3 to 25 percent slopes	Arizona\Phoenix at point	47 EBON-GUNSIGHT-CIPRIANO ASSOCIATION, 3 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 20%	704.65	1.45%	7.7%	100	0.96	0.30	0.43
Ebon-Pinamt complex, 20 to 40 percent slopes	Arizona\Phoenix at point	49 EBON-PINAMT COMPLEX, 20 TO 40 PERCENT SLOPES\EBON very gravelly loam 45%	446.62	0.92%	12.1%	100	1.70	0.30	0.32
Gachado-Lomitas-Rock outcrop complex, 7 to 55 percent slopes	Arizona\Phoenix at point	52 GACHADO-LOMITAS-ROCK OUTCROP COMPLEX, 7 TO 55 PERCENT SLOPES\GACHADO very gravelly loam 45%	535.04	1.10%	22.5%	30	2.10	0.30	0.43
Gilman-Antho association	Arizona\Phoenix at point	GM GILMAN-ANTHO ASSOCIATION\GILMAN loam 50%	456.13	0.94%	1.2%	200	0.17	0.30	0.37
Gunsight-Cipriano complex, 1 to 7 percent slopes	Arizona\Phoenix at point	68 GUNSIGHT-CIPRIANO COMPLEX, 1 TO 7 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 45%	94.77	0.20%	4.7%	200	0.70	0.30	0.43
Gunsight-Pinal complex, 1 to 10 percent slopes	Arizona\Phoenix at point	GWD GUNSIGHT-PINAL COMPLEX, 1 TO 10 PERCENT SLOPES\PINAL gravelly loam 30%	585.35	1.21%	5.7%	100	0.70	0.30	0.37
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	1332.15	2.75%	1.9%	200	0.27	0.30	0.37
Gunsight-Rillito complex, 1 to 25 percent slopes	Arizona\Phoenix at point	70 GUNSIGHT-RILLITO COMPLEX, 1 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	4194.56	8.65%	4.0%	200	0.57	0.30	0.57
Gunsight-Rillito complex, low precipitation, 1 to 40 percent slopes	Arizona\Phoenix at point	71 GUNSIGHT-RILLITO COMPLEX, LOW PRECIPITATION, 1 TO 40 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	378.99	0.78%	1.5%	200	0.21	0.30	0.57
Harqua-Gunsight complex, 0 to 5 percent slopes	Arizona\Phoenix at point	HLC HARQUA-GUNSIGHT COMPLEX, 0 TO 5 PERCENT SLOPES\GUNSIGHT gravelly loam 35%	61.37	0.13%	2.2%	200	0.31	0.30	0.37
Perryville-Rillito complex, 0 to 3 percent slopes	Arizona\Phoenix at point	PRB PERRYVILLE-RILLITO COMPLEX, 0 TO 3 PERCENT SLOPES\PERRYVILLE loam 35%	1038.32	2.14%	1.5%	200	0.21	0.30	0.37
Pinal gravelly loam	Arizona\Phoenix at point	PT PINAL GRAVELLY LOAM\PINAL gravelly loam 100%	38.09	0.08%	6.3%	100	0.78	0.30	0.37
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1952.98	4.03%	5.8%	100	0.72	0.30	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam 5	8411.65	17.35%	35.3%	30	3.20	0.30	0.12
Rillito gravelly loam, 1 to 8 percent slopes	Arizona\Phoenix at point	102 RILLITO GRAVELLY LOAM, 1 TO 8 PERCENT SLOPES\RILLITO gravelly loam 100%	7261.00	14.97%	1.5%	200	0.22	0.30	0.37
Sal-Cipriano complex, 1 to 10 percent slopes	Arizona\Phoenix at point	106 SAL-CIPRIANO COMPLEX, 1 TO 10 PERCENT SLOPES\SAL extremely gravelly loam 50%	1988.08	4.10%	3.4%	200	0.42	0.30	0.37
Tremant gravelly loams, low precipitation	Arizona\Phoenix at point	114 TREMANT GRAVELLY LOAMS, LOW PRECIPITATION\TREMANT gravelly loam 35%	129.93	0.27%	1.4%	200	0.20	0.30	0.74
		Total	48490.90	100.00%					

RUSLE2 Avg Annual Soil Loss (tons/ac/yr)	100-Year 6-hr Weighted-Average Soil Loss (tons/ac/event)
0.4	0.083
0.1	0.007
0.9	0.094
9.9	0.138
1.3	0.055
7.5	0.057
0.3	0.007
0.8	0.055
2.5	0.051
3.6	0.047
6.0	0.093
0.4	0.005
1.8	0.005
1.6	0.027
0.6	0.023
2.0	0.243
0.7	0.008
0.7	0.001
0.5	0.014
1.8	0.002
3.2	0.181
2.4	0.584
0.5	0.103
1.0	0.055
0.9	0.003
Total Soil Loss (tons/acre)	1.94
Total Soil Loss (ac-ft/sq-mi)	0.58
Channel Erosion (20% of Total)	0.12
Total Erosion (ac-ft/sq-mi)	0.69
Estimated 70% Delivery	0.48
Estimated 65% Trap Efficiency	0.31
Sediment Storage (ac-ft/sq-mi)	**0.30**

Table 2.17. FRS #2 100-Year 6-Hour Storm Sediment Yield RUSLE2 Results

Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Annual R Factor 22.6 Slope (%)	Slope Length (ft)	R (100yr 6hr) 77.47 Net LS Factor	Net C Factor	Net K Factor
Antho association	Arizona\Phoenix at point	AL ANTHO ASSOCIATION\ANTHO gravelly sandy loam 30%	76.89	2.06%	2.3%	200	0.33	0.30	0.28
Cheriono-Rock outcrop complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	695.20	18.66%	24.1%	30	2.30	0.30	0.74
Gunsight-Pinal complex, 1 to 10 percent slopes	Arizona\Phoenix at point	GWD GUNSIGHT-PINAL COMPLEX, 1 TO 10 PERCENT SLOPES\PINAL gravelly loam 30%	524.60	14.08%	6.1%	100	0.75	0.30	0.37
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	96.47	2.59%	2.4%	200	0.34	0.30	0.37
Gunsight-Rillito complex, 1 to 25 percent slopes	Arizona\Phoenix at point	70 GUNSIGHT-RILLITO COMPLEX, 1 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	103.75	2.78%	8.8%	100	1.40	0.30	0.57
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1103.25	29.61%	7.4%	100	0.92	0.30	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam 5	494.30	13.26%	36.2%	30	3.30	0.30	0.12
Tremant-Rillito complex, 0 to 5 percent slopes	Arizona\Phoenix at point	TSC TREMANT-RILLITO COMPLEX, 0 TO 5 PERCENT SLOPES\RILLITO gravelly loam 30%	558.66	14.99%	3.9%	200	0.56	0.30	0.37
		Total	3726.48	100.00%					

RUSLE2 Avg Annual Soil Loss (tons/ac/yr)	100-Year 6-hr Weighted-Average Soil Loss (tons/ac/event)
0.56	0.040
11	7.034
1.7	0.820
0.76	0.067
4.9	0.468
4.2	4.262
2.5	1.137
1.3	0.668
Total Soil Loss (tons/acre)	14.50
Total Soil Loss (ac-ft/sq-mi)	4.30
Channel Erosion (20% of Total)	0.86
Total Erosion (ac-ft/sq-mi)	5.16
Estimated 70% Delivery	3.61
Estimated 65% Trap Efficiency	2.35
Sediment Storage (ac-ft/sq-mi)	**2.30**

Table 2.18. FRS #3 100-Year 6-Hour Storm Sediment Yield RUSLE2 Results

Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Annual R Factor 22.6 Slope (%)	Slope Length (ft)	R (100yr 6hr) 57.77 Net LS Factor	Net C Factor	Net K Factor
Antho-Carrizo-Maripo complex	Arizona\Phoenix at point	3 ANTHO-CARRIZO-MARIPO COMPLEX\ANTHO sandy loam 35%	806.13	14.36%	2.8%	200	0.40	0.30	0.28
Denure-Momoli-Carrizo complex	Arizona\Phoenix at point	29 DENURE-MOMOLI-CARRIZO COMPLEX\MOMOLI gravelly sandy loam 30%	9.60	0.17%	4.1%	200	0.60	0.30	0.43
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	143.20	2.55%	2.3%	200	0.32	0.30	0.37
Harqua-Gunsight complex, 0 to 5 percent slopes	Arizona\Phoenix at point	HLC HARQUA-GUNSIGHT COMPLEX, 0 TO 5 PERCENT SLOPES\GUNSIGHT gravelly loam 35%	86.88	1.55%	1.9%	200	0.27	0.30	0.37
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1508.85	26.87%	7.4%	100	0.92	0.30	0.74
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam 5	2992.43	53.29%	37.3%	30	3.30	0.30	0.12
Rock outcrop-Cherioni complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	13.54	0.24%	27.8%	30	2.60	0.30	0.74
		Total	5615.45	100.00%					

RUSLE2 Avg Annual Soil Loss (tons/ac/yr)	100-Year 6-hr Weighted-Average Soil Loss (tons/ac/event)
0.68	0.250
1.6	0.007
0.72	0.047
0.6	0.024
4.2	2.885
2.6	3.542
13	0.080
Total Soil Loss (tons/acre)	6.83
Total Soil Loss (ac-ft/sq-mi)	2.03
Channel Erosion (20% of Total)	0.41
Total Erosion (ac-ft/sq-mi)	2.43
Estimated 70% Delivery	1.70
Estimated 65% Trap Efficiency	1.11
Sediment Storage (ac-ft/sq-mi)	**1.10**

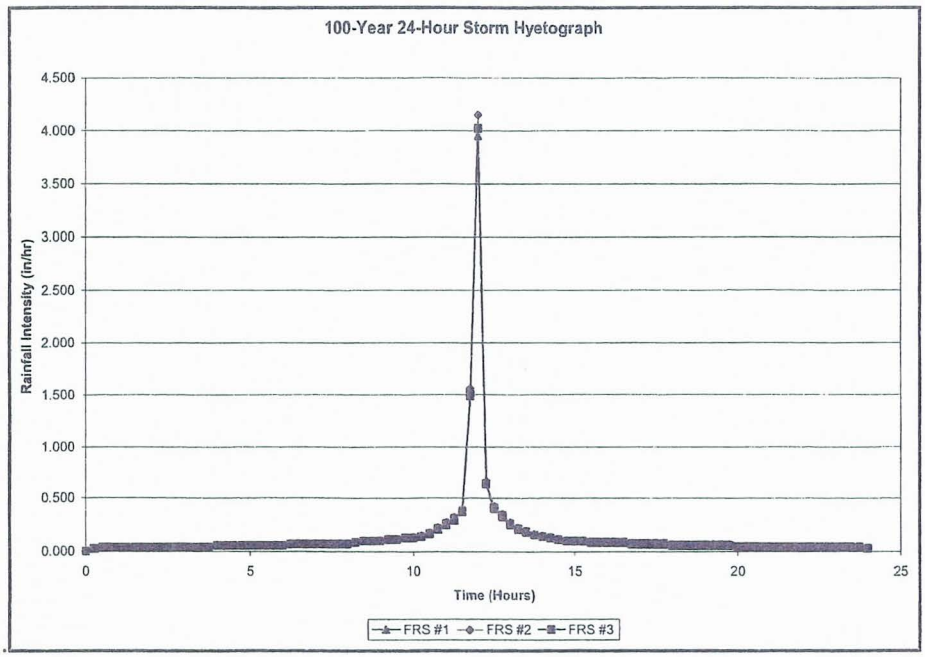


Figure 2.7. 100-Year 24-Hour Storm Hyetograph.

Table 2.15. Basin 100-Year Rainfall Erosivity Values.

Drainage Basin	Rainfall Erosivity R (6-hour)	Rainfall Erosivity R (24-hour)
FRS #1	31.72	66.96
FRS #2	77.47	74.38
FRS #3	57.77	69.62

2.5.2 Results of RUSLE2 and Erosion Works Approach

The results for the 100-year, 6-hour storm analysis are shown in **Tables 2.16**, **2.17**, and **2.18** with all RUSLE variables and values that were used. The calculated sediment storage for FRS #1 is 0.30 ac-ft/mi^2 per event, for FRS #2 was 2.30 ac-ft/mi^2 per event, for FRS #3 was 1.10 ac-ft/mi^2 per event. The final results for the 100-year, 24-hour storm analysis are shown in **Tables 2.19**, **2.20**, and **2.21**. The resulting sediment storage for FRS #1 was 0.70 ac-ft/mi^2 per event, for FRS #2 was 2.30 ac-ft/mi^2 per event, for FRS #3 was 1.30 ac-ft/mi^2 per event.

Compared to the average annual results, the results for the 100-yr event were not significantly greater. To better evaluate these results the sediment concentration by volume was computed (**Tables 2.22** and **2.23**). In an arid region the average sediment concentration throughout a large event, such as the 100-year flood, would be expected to be quite high. Concentrations of 5 percent (50,000 parts per million) or greater would not be unrealistic. However, many of the values in Tables 2.22 and 2.23 are considerably lower, suggesting that the single event application of the RUSLE may not be appropriate in an arid region. Therefore, an alternate approach to quantifying the single event sediment yield was adopted, as described in the following section.

Table 2.19. FRS #1 100-Year 24-Hour Storm Sediment Yield RUSLE2 Results

Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Annual R Factor	22.6	R (100yr 24hr)	66.96		RUSLE2	100-Year 24-hr
					Slope (%)	Slope Length (ft)	Net LS Factor	Net C Factor	Net K Factor	Avg Annual Soil Loss (tons/ac/yr)	Weighted-Average Soil Loss (tons/ac/event)
Antho sandy loams	Arizona\Phoenix at point	1 ANTHO SANDY LOAMS\ANTHO sandy loam 25%	6965.35	14.36%	1.7%	200	0.24	0.30	0.28	0.4	0.174
Carrizo very gravelly sand	Arizona\Phoenix at point	14 CARRIZO VERY GRAVELLY SAND\CARRIZO very gravelly sand 100%	2473.06	5.10%	1.9%	200	0.28	0.30	0.06	0.1	0.015
Carrizo-Gunsight complex, 1 to 5 percent slopes	Arizona\Phoenix at point	15 CARRIZO-GUNSIGHT COMPLEX, 1 TO 5 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 30%	3454.05	7.12%	2.5%	200	0.36	0.30	0.43	0.9	0.198
Cheriono-Rock outcrop complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	482.21	0.99%	21.6%	30	2.00	0.30	0.74	9.9	0.292
Chuckawalla-Gunsight complex, 1 to 8 percent slopes	Arizona\Phoenix at point	19 CHUCKAWALLA-GUNSIGHT COMPLEX, 1 TO 8 PERCENT SLOPES\GUNSIGHT very gravelly loam 35%	1454.62	3.00%	2.6%	200	0.37	0.30	0.57	1.3	0.116
Cipriano very gravelly loam	Arizona\Phoenix at point	21 CIPRIANO VERY GRAVELLY LOAM\CIPRIANO very gravelly loam 100%	260.70	0.54%	11.4%	100	1.60	0.30	0.74	7.5	0.119
Coolidge-Laveen association	Arizona\Phoenix at point	CV COOLIDGE-LAVEEN ASSOCIATION\COOLIDGE sandy loam 40%	721.22	1.49%	1.4%	200	0.20	0.30	0.28	0.3	0.015
Denure-Momoli-Carrizo complex	Arizona\Phoenix at point	29 DENURE-MOMOLI-CARRIZO COMPLEX\MOMOLI gravelly sandy loam 30%	2306.75	4.76%	2.2%	200	0.31	0.30	0.43	0.8	0.116
Ebon-Gunsight-Cipriano association, 3 to 25 percent slopes	Arizona\Phoenix at point	47 EBON-GUNSIGHT-CIPRIANO ASSOCIATION, 3 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 20%	704.65	1.45%	7.7%	100	0.96	0.30	0.43	2.5	0.108
Ebon-Pinamt complex, 20 to 40 percent slopes	Arizona\Phoenix at point	49 EBON-PINAMT COMPLEX, 20 TO 40 PERCENT SLOPES\EBON very gravelly loam 45%	446.62	0.92%	12.1%	100	1.70	0.30	0.32	3.6	0.098
Gachado-Lomitas-Rock outcrop complex, 7 to 55 percent slopes	Arizona\Phoenix at point	52 GACHADO-LOMITAS-ROCK OUTCROP COMPLEX, 7 TO 55 PERCENT SLOPES\GACHADO very gravelly loam 45%	535.04	1.10%	22.5%	30	2.10	0.30	0.43	6.0	0.196
Gilman-Antho association	Arizona\Phoenix at point	GM GILMAN-ANTHO ASSOCIATION\GILMAN loam 50%	456.13	0.94%	1.2%	200	0.17	0.30	0.37	0.4	0.011
Gunsight-Cipriano complex, 1 to 7 percent slopes	Arizona\Phoenix at point	68 GUNSIGHT-CIPRIANO COMPLEX, 1 TO 7 PERCENT SLOPES\GUNSIGHT very gravelly sandy loam 45%	94.77	0.20%	4.7%	200	0.70	0.30	0.43	1.8	0.010
Gunsight-Pinal complex, 1 to 10 percent slopes	Arizona\Phoenix at point	GWD GUNSIGHT-PINAL COMPLEX, 1 TO 10 PERCENT SLOPES\PINAL gravelly loam 30%	585.35	1.21%	5.7%	100	0.70	0.30	0.37	1.6	0.057
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	1332.15	2.75%	1.9%	200	0.27	0.30	0.37	0.6	0.049
Gunsight-Rillito complex, 1 to 25 percent slopes	Arizona\Phoenix at point	70 GUNSIGHT-RILLITO COMPLEX, 1 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	4194.56	8.65%	4.0%	200	0.57	0.30	0.57	2.0	0.513
Gunsight-Rillito complex, low precipitation, 1 to 40 percent slopes	Arizona\Phoenix at point	71 GUNSIGHT-RILLITO COMPLEX, LOW PRECIPITATION, 1 TO 40 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	378.99	0.78%	1.5%	200	0.21	0.30	0.57	0.7	0.017
Harqua-Gunsight complex, 0 to 5 percent slopes	Arizona\Phoenix at point	HLC HARQUA-GUNSIGHT COMPLEX, 0 TO 5 PERCENT SLOPES\GUNSIGHT gravelly loam 35%	61.37	0.13%	2.2%	200	0.31	0.30	0.37	0.7	0.003
Perryville-Rillito complex, 0 to 3 percent slopes	Arizona\Phoenix at point	PRB PERRYVILLE-RILLITO COMPLEX, 0 TO 3 PERCENT SLOPES\PERRYVILLE loam 35%	1038.32	2.14%	1.5%	200	0.21	0.30	0.37	0.5	0.030
Pinal gravelly loam	Arizona\Phoenix at point	PT PINAL GRAVELLY LOAM\PINAL gravelly loam 100%	38.09	0.08%	6.3%	100	0.78	0.30	0.37	1.8	0.004
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1952.98	4.03%	5.8%	100	0.72	0.30	0.74	3.2	0.382
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam 5	8411.65	17.35%	35.3%	30	3.20	0.30	0.12	2.4	1.234
Rillito gravelly loam, 1 to 8 percent slopes	Arizona\Phoenix at point	102 RILLITO GRAVELLY LOAM, 1 TO 8 PERCENT SLOPES\RILLITO gravelly loam 100%	7261.00	14.97%	1.5%	200	0.22	0.30	0.37	0.5	0.217
Sal-Cipriano complex, 1 to 10 percent slopes	Arizona\Phoenix at point	106 SAL-CIPRIANO COMPLEX, 1 TO 10 PERCENT SLOPES\SAL extremely gravelly loam 50%	1988.08	4.10%	3.4%	200	0.42	0.30	0.37	1.0	0.115
Tremant gravelly loams, low precipitation	Arizona\Phoenix at point	114 TREMANT GRAVELLY LOAMS, LOW PRECIPITATION\TREMANT gravelly loam 35%	129.93	0.27%	1.4%	200	0.20	0.30	0.74	0.9	0.007
		Total	48490.90	100.00%							

Total Soil Loss (tons/acre)	4.10
Total Soil Loss (ac-ft/sq-mi)	1.22
Channel Erosion (20% of Total)	0.24
Total Erosion (ac-ft/sq-mi)	1.46
Estimated 70% Delivery	1.02
Estimated 65% Trap Efficiency	0.66
Sediment Storage (ac-ft/sq-mi)	**0.70**

Table 2.20. FRS #2 100-Year 24-Hour Storm Sediment Yield RUSLE2 Results

Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Annual R Factor	22.6	R (100yr 24hr)	74.38		RUSLE2	100-Year 24-hr
					Slope (%)	Slope Length (ft)	Net LS Factor	Net C Factor	Net K Factor	Avg Annual Soil Loss (tons/ac/yr)	Weighted-Average Soil Loss (tons/ac/event)
Antho association	Arizona\Phoenix at point	AL ANTHO ASSOCIATION\ANTHO gravelly sandy loam 30%	76.89	2.06%	2.3%	200	0.33	0.30	0.28	0.56	0.038
Cheriono-Rock outcrop complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	695.20	18.66%	24.1%	30	2.30	0.30	0.74	11	6.754
Gunsight-Pinal complex, 1 to 10 percent slopes	Arizona\Phoenix at point	GWD GUNSIGHT-PINAL COMPLEX, 1 TO 10 PERCENT SLOPES\PINAL gravelly loam 30%	524.60	14.08%	6.1%	100	0.75	0.30	0.37	1.7	0.788
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	96.47	2.59%	2.4%	200	0.34	0.30	0.37	0.76	0.065
Gunsight-Rillito complex, 1 to 25 percent slopes	Arizona\Phoenix at point	70 GUNSIGHT-RILLITO COMPLEX, 1 TO 25 PERCENT SLOPES\GUNSIGHT very gravelly loam 40%	103.75	2.78%	8.8%	100	1.40	0.30	0.57	4.9	0.449
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1103.25	29.61%	7.4%	100	0.92	0.30	0.74	4.2	4.092
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam 5	494.30	13.26%	36.2%	30	3.30	0.30	0.12	2.5	1.091
Tremant-Rillito complex, 0 to 5 percent slopes	Arizona\Phoenix at point	TSC TREMANT-RILLITO COMPLEX, 0 TO 5 PERCENT SLOPES\RILLITO gravelly loam 30%	558.66	14.99%	3.9%	200	0.56	0.30	0.37	1.3	0.641
		Total	3726.48	100.00%							

Total Soil Loss (tons/acre)	13.92
Total Soil Loss (ac-ft/sq-mi)	4.13
Channel Erosion (20% of Total)	0.83
Total Erosion (ac-ft/sq-mi)	4.96
Estimated 70% Delivery	3.47
Estimated 65% Trap Efficiency	2.26
Sediment Storage (ac-ft/sq-mi)	**2.30**

Table 2.21. FRS #3 100-Year 24-Hour Storm Sediment Yield RUSLE2 Results

Soil Description	Climate	Soil Classification used in RUSLE2	Area (acre)	% of Total	Annual R Factor	22.6	R (100yr 24hr)	69.62		RUSLE2	100-Year 24-hr
					Slope (%)	Slope Length (ft)	Net LS Factor	Net C Factor	Net K Factor	Avg Annual Soil Loss (tons/ac/yr)	Weighted-Average Soil Loss (tons/ac/event)
Antho-Carrizo-Maripo complex	Arizona\Phoenix at point	3 ANTHO-CARRIZO-MARIPO COMPLEX\ANTHO sandy loam 35%	606.13	14.36%	2.8%	200	0.40	0.30	0.28	0.68	0.301
Denure-Momoli-Carrizo complex	Arizona\Phoenix at point	29 DENURE-MOMOLI-CARRIZO COMPLEX\MOMOLI gravelly sandy loam 30%	9.60	0.17%	4.1%	200	0.60	0.30	0.43	1.6	0.008
Gunsight-Rillito complex, 0 to 10 percent slopes	Arizona\Phoenix at point	GYD GUNSIGHT-RILLITO COMPLEX, 0 TO 10 PERCENT SLOPES\GUNSIGHT gravelly loam 40%	143.20	2.55%	2.3%	200	0.32	0.30	0.37	0.72	0.057
Harqua-Gunsight complex, 0 to 5 percent slopes	Arizona\Phoenix at point	HLC HARQUA-GUNSIGHT COMPLEX, 0 TO 5 PERCENT SLOPES\GUNSIGHT gravelly loam 35%	86.88	1.55%	1.9%	200	0.27	0.30	0.37	0.6	0.029
Pinamt-Tremant complex, 1 to 10 percent slopes	Arizona\Phoenix at point	98 PINAMT-TREMANT COMPLEX, 1 TO 10 PERCENT SLOPES\TREMANT gravelly loam 35%	1508.85	26.87%	7.4%	100	0.92	0.30	0.74	4.2	3.476
Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes	Arizona\Phoenix at point	100 QUILOTOSA-VAIVA-ROCK OUTCROP COMPLEX, 20 TO 65 PERCENT SLOPES\QUILOTOSA extremely gravelly sandy loam 5	2992.43	53.29%	37.3%	30	3.30	0.30	0.12	2.6	4.268
Rock outcrop-Cherioni complex	Arizona\Phoenix at point	18 CHERIONI-ROCK OUTCROP COMPLEX, 5 TO 60 PERCENT SLOPES\CHERIONI extremely stony loam 60%	13.54	0.24%	27.8%	30	2.60	0.30	0.74	13	0.097
		Total	5615.45	100.00%							

Total Soil Loss (tons/acre)	8.24
Total Soil Loss (ac-ft/sq-mi)	2.44
Channel Erosion (20% of Total)	0.49
Total Erosion (ac-ft/sq-mi)	2.93
Estimated 70% Delivery	2.05
Estimated 65% Trap Efficiency	1.33
Sediment Storage (ac-ft/sq-mi)	**1.30**

Table 2.22. Percentage by Volume of Sediment Loads for 100-year 6-hour Storm.

Area 3 Sub-Basin	RUSLE2 and Erosion Works Sediment Storage (ac-ft)	Runoff Volume (ac-ft)	Sediment by Volume (% Concentration)
G	0.33	79	0.42
E	3.54	1040	0.34
L	5.01	729	0.68
Z	0.21	50	0.42
M	3.93	632	0.62
N & O*	2.37	435	0.54
P	0.72	155	0.46
Q	0.66	159	0.41
R	0.09	23	0.39
S	3.22	104	3.00
T	6.90	231	2.90
U	3.22	111	2.82
V	0.77	56	1.36
W	4.29	400	1.06
X	3.08	64	4.59
Y	0.66	48	1.36

*Sub-Basins N & O were grouped because the main flow from Sub-Basin N is redirected into the same opening onto FRS #1.

Table 2.23. Percentage by Volume of Sediment Loads for 100-year 24-hour Storm.

Area 3 Sub-Basin	RUSLE2 and Erosion Works Sediment Storage (ac-ft)	Runoff Volume (ac-ft)	Sediment by Volume (% Concentration)
G	0.77	68	1.12
E	8.26	1637	0.50
L	11.69	976	1.18
Z	0.49	41	1.18
M	9.17	841	1.08
N & O*	5.53	477	1.15
P	1.68	160	1.04
Q	1.54	167	0.91
R	0.21	20	1.04
S	3.22	95	3.28
T	6.90	233	2.88
U	3.22	99	3.15
V	0.91	52	1.72
W	5.07	471	1.06
X	3.64	59	5.81
Y	0.78	42	1.82

*Sub-Basins N & O were grouped because the main flow from Sub-Basin N is redirected into the same opening onto FRS #1.

2.5.3 Approach Using Concentration By Volume

The sediment load was also estimated using a concentration by volume approach. Sediment concentrations by volume in arid regions can be very large, particularly during 100-year events. The Sediment and Erosion Design Guide (RCE 1994) recommends a range of 20 – 30 percent solids concentration by volume for a mud flood and up to a 50 percent solids concentration by volume for a mudflow. In a mudflood, the hydraulics of the flow are still basically governed by

conventional hydraulics, whereas in a mudflow the flows behave more as a slurry. In areas with active alluvial fans, mudfloods, basically water driven floods with high sediment loads, could easily occur. Mudflow events might also occur, but would be more limited in areal coverage.

The concentration by volume approach has been used in previous master drainage plans in the Maricopa County area. For the Adobe Dam/Desert Hills Area Drainage Master Plan, a concentration by volume of 5 percent was used (JE Fuller 2003). This value is considerably lower than that recommended in the Sediment and Erosion Design Guide; therefore sediment loads were calculated for concentrations of 5, 20, and 50 percent solids by volume. The results are presented in **Tables 2.24** and **2.25**.

3. CONCLUSIONS AND RECOMMENDATIONS

The objective of Subtask 2.6.7 was to evaluate sediment yield for each of the three Buckeye FRSs during a 100-year storm event. The analysis was accomplished using RUSLE2 and a concentration by volume approach. The concentration by volume approach gave the most reasonable results and the deposition trends for this approach were analyzed.

Deposition trends were examined for each of the sub-basins of the FRS drainage areas. Deposition was determined using the sediment loading for both the 100-year 24-hour storm and the 100-year 6-hour storm for each of the sub-basins given the calculated sediment load for each concentration level. The deposition area was obtained using the 100-year 24-hour and 100-year 6-hour storm floodplain provided by PBS&J. It was assumed that the ponded area of the 100-year flows would be a reasonable estimate of where the sediment load from the sub-basins would be deposited. The floodplain area for each sub-basin was calculated using ArcGIS software.

The results of this analysis are shown in **Table 3.1** and **Table 3.2**. These estimated depths should not be utilized to determine actual overtopping depths along each FRS, but instead only to reveal the depositional trends that might occur during the 100-year 6-hour storm and 100-year 24-hour storm events. As expected, the results show that the estimated depths for a 50 percent concentration are rather large, even given depths above thirty feet for sub-basins N and O, P and Q. The results for a 50 percent concentration are extremely conservative given that even in a mudflow event, concentrations this high would not be expected throughout the entire storm event. At the other extreme, a 5 percent concentration might be on the low side for a storm as large as the 100-year flood occurring in an arid region with active alluvial fans. Therefore, it is reasonable to conclude something between the 5 percent concentration and the 20 percent concentration.

There were four sub-basins that showed a higher depositional potential: N, O, P, and Q. This is consistent with the deposition depths seen in the field reconnaissance. Sub-basins N and O were grouped in the analysis because the main flow path for sub-basin N is redirected into sub-basin O. There will be some deposition still in sub-basin N, but some of that deposition from the flow will occur in sub-basin O. Therefore, the two sub-basins were grouped together for the purpose of this analysis. Deposition Zone 5 is within this area where an average of 2.5 feet of deposition was seen in the field. A view of Deposition Zone 5 is shown in **Figure 3.1**. In the photo it can be seen that this zone has been mechanically excavated. However, the area around the trees in the center of the picture gives an accurate depiction of the deposition in this zone.

Table 2.24. 100-Year 6-hour Sediment Load using Concentration by Volume.

Sub-Basin	Drainage Area (sq/mi)	Runoff Volume (ac-ft)	Sediment Load @ 5% Concentration (ac-ft)	Sediment Load @ 20% Concentration (ac-ft)	Sediment Load @ 50% Concentration (ac-ft)
G	1.1	79	4.16	19.75	79.00
E	11.8	1040	54.74	260.00	1040.00
L	16.7	729	38.37	182.25	729.00
Z	0.7	50	2.63	12.50	50.00
M	13.1	632	33.26	158.00	632.00
N & O*	7.9	435	22.89	108.75	435.00
P	2.4	155	8.16	38.75	155.00
Q	2.2	159	8.37	39.75	159.00
R	0.3	23	1.21	5.75	23.00
S	1.4	104	5.47	26.00	104.00
T	3	231	12.16	57.75	231.00
U	1.4	111	5.84	27.75	111.00
V	0.7	56	2.95	14.00	56.00
W	3.9	400	21.05	100.00	400.00
X	2.8	64	3.37	16.00	64.00
Y	0.6	48	2.53	12.00	48.00

*Sub-Basins N & O were grouped because the main flow from Sub-Basin N is redirected into the same opening onto FRS #1.

Table 2.25. 100-Year 24-hour Sediment Load using Concentration by Volume.

Sub-Basin	Drainage Area (sq/mi)	Runoff Volume (ac-ft)	Sediment Load @ 5% Concentration (ac-ft)	Sediment Load @ 20% Concentration (ac-ft)	Sediment Load @ 50% Concentration (ac-ft)
G	1.1	68	3.58	17.00	68.00
E	11.8	1637	86.16	409.25	1637.00
L	16.7	976	51.37	244.00	976.00
Z	0.7	41	2.16	10.25	41.00
M	13.1	841	44.26	210.25	841.00
N & O*	7.9	477	25.10	119.25	477.00
P	2.4	160	8.42	40.00	160.00
Q	2.2	167	8.79	41.75	167.00
R	0.3	20	1.05	5.00	20.00
S	1.4	95	5.00	23.75	95.00
T	3	233	12.26	58.25	233.00
U	1.4	99	5.21	24.75	99.00
V	0.7	52	2.74	13.00	52.00
W	3.9	471	24.79	117.75	471.00
X	2.8	59	3.11	14.75	59.00
Y	0.6	42	2.21	10.50	42.00

*Sub-Basins N & O were grouped because the main flow from Sub-Basin N is redirected into the same opening onto FRS #1.

Table 3.1. 100-year 6-hour Depths of Deposition by Sub-Basin.

Sub-Basin	Deposition Area (ac)	5% Concentration Deposition Depth (ft)	20% Concentration Deposition Depth (ft)	50% Concentration Deposition Depth (ft)
G	81.35	0.09	0.40	1.62
E	199.36	0.46	2.17	8.69
L	222.71	0.29	1.36	5.46
Z	70.89	0.06	0.29	1.18
M	134.34	0.41	1.96	7.84
N & O	15.93	2.40	11.38	45.52
P	6.86	1.98	9.41	37.63
Q	7.21	1.93	9.19	36.75
R	12.45	0.16	0.77	3.08
S	35.37	0.26	1.23	4.90
T	42.32	0.48	2.27	9.10
U	12.03	0.81	3.85	15.38
V	13.79	0.36	1.69	6.77
W	95.76	0.37	1.74	6.96
X	10.15	0.55	2.63	10.50
Y	15.21	0.28	1.32	5.26

*Sub-Basins N & O were grouped because the main flow from Sub-Basin N is redirected into the same opening onto FRS #1.

Table 3.2. 100-year 24-hour Depths of Deposition by Sub-Basin.

Sub-Basin	Deposition Area (ac)	5% Concentration Deposition Depth (ft)	20% Concentration Deposition Depth (ft)	50% Concentration Deposition Depth (ft)
G	81.35	0.09	0.40	1.62
E	199.36	0.46	2.17	8.69
L	222.71	0.29	1.36	5.46
Z	70.89	0.06	0.29	1.18
M	134.34	0.41	1.96	7.84
N & O	15.93	2.40	11.38	45.52
P	6.86	1.98	9.41	37.63
Q	7.21	1.93	9.19	36.75
R	12.45	0.16	0.77	3.08
S	35.37	0.26	1.23	4.90
T	42.32	0.48	2.27	9.10
U	12.03	0.81	3.85	15.38
V	13.79	0.36	1.69	6.77
W	95.76	0.37	1.74	6.96
X	10.15	0.55	2.63	10.50
Y	15.21	0.28	1.32	5.26

*Sub-Basins N & O were grouped because the main flow from Sub-Basin N is redirected into the same opening onto FRS #1.

Deposition Zone 6, as shown in **Figure 3.2** is located in sub-basin Q. Though the estimated deposition in this zone was only an average of 1 foot, there is the potential for significant sediment transport in the washes that are flowing into this zone as well as the potential from BSV Sites 7 and 8, which are not far upstream.

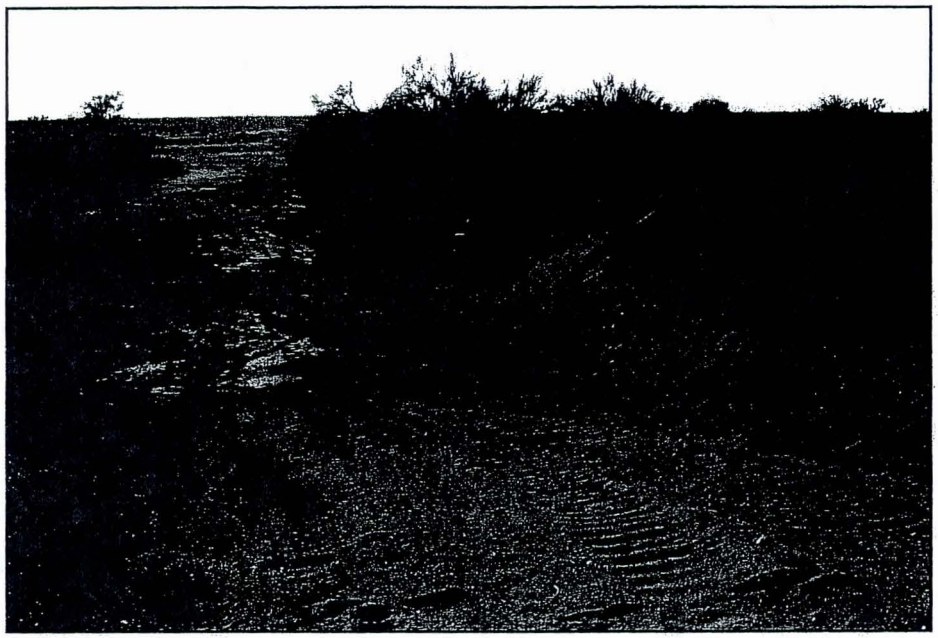


Figure 3.1. View looking downstream at Deposition Zone #5.

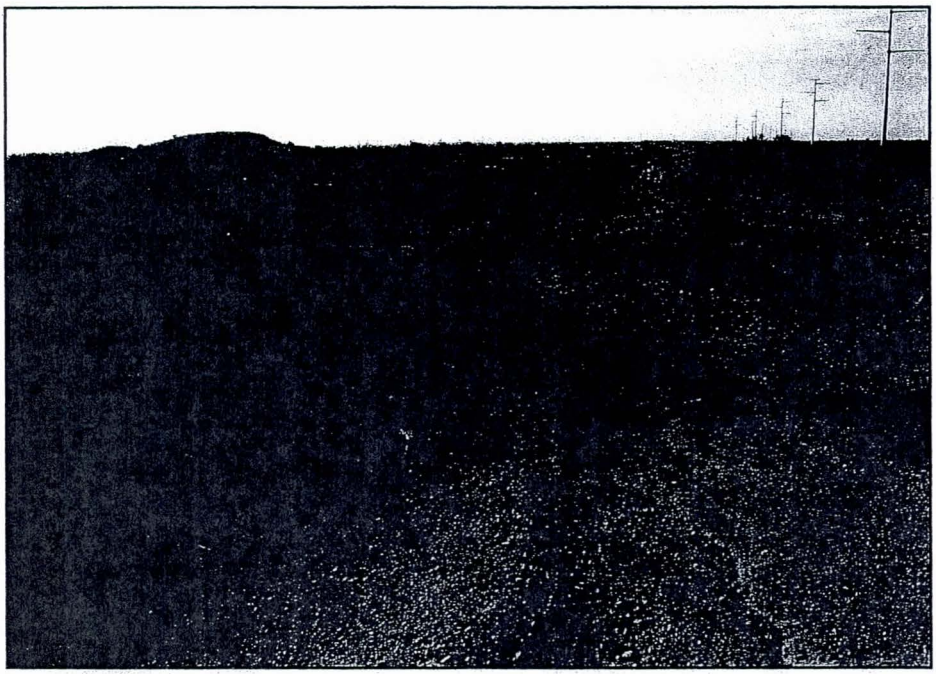


Figure 3.2. View looking across and downstream at Deposition Zone #6.

Within sub-basin Q is Deposition Zone 7 as shown in **Figure 3.3**. This zone is actually the BSV Site 9 active alluvial fan. While an average deposition of only 1 foot was measured here, it is an active alluvial fan located directly at FRS #1, with the potential for significant sediment deposition in a 100-year flood.

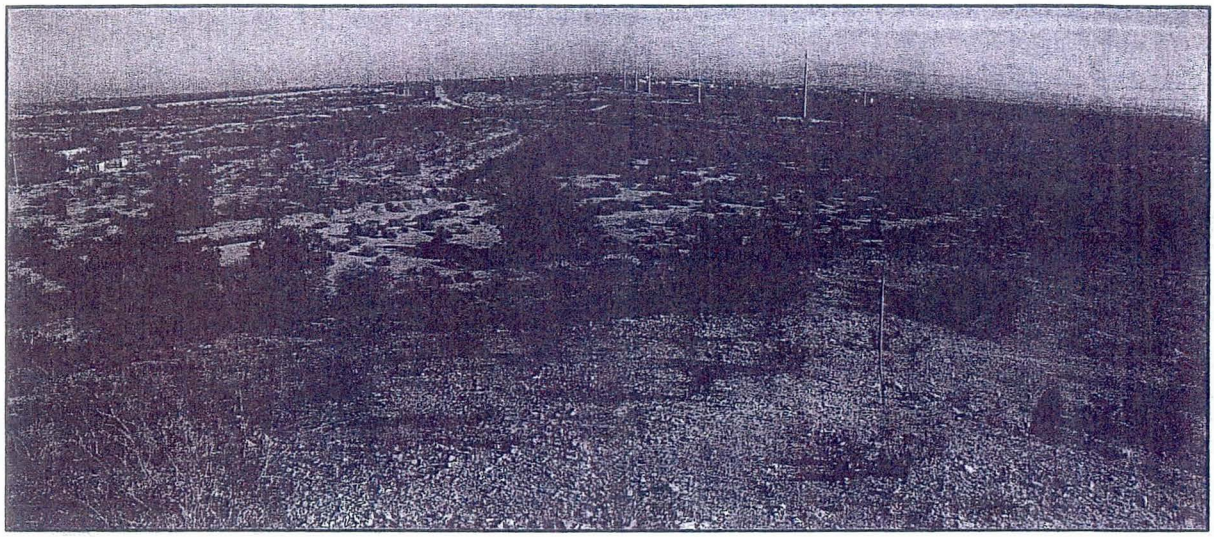


Figure 3.3. View southeast from a hill overlooking the fan at BSV Site 9 (Deposition Zone 7).

The USGS Site 36 active alluvial fan (White Tank Fan) is upstream of Zone 4 and within sub-basin M and would be a large source of sediment for this area. However, the area of deposition is large and, therefore, the potential deposition would be spread out. White Tanks Wash is within sub-basin E and is Deposition Zone 2. This area would also potentially have a large sediment load, but the deposition would be spread out as well.

In conclusion, it should be emphasized that the depths of deposition presented are estimated trends given the assumed floodplain deposition area and are not actual depths at the FRS.

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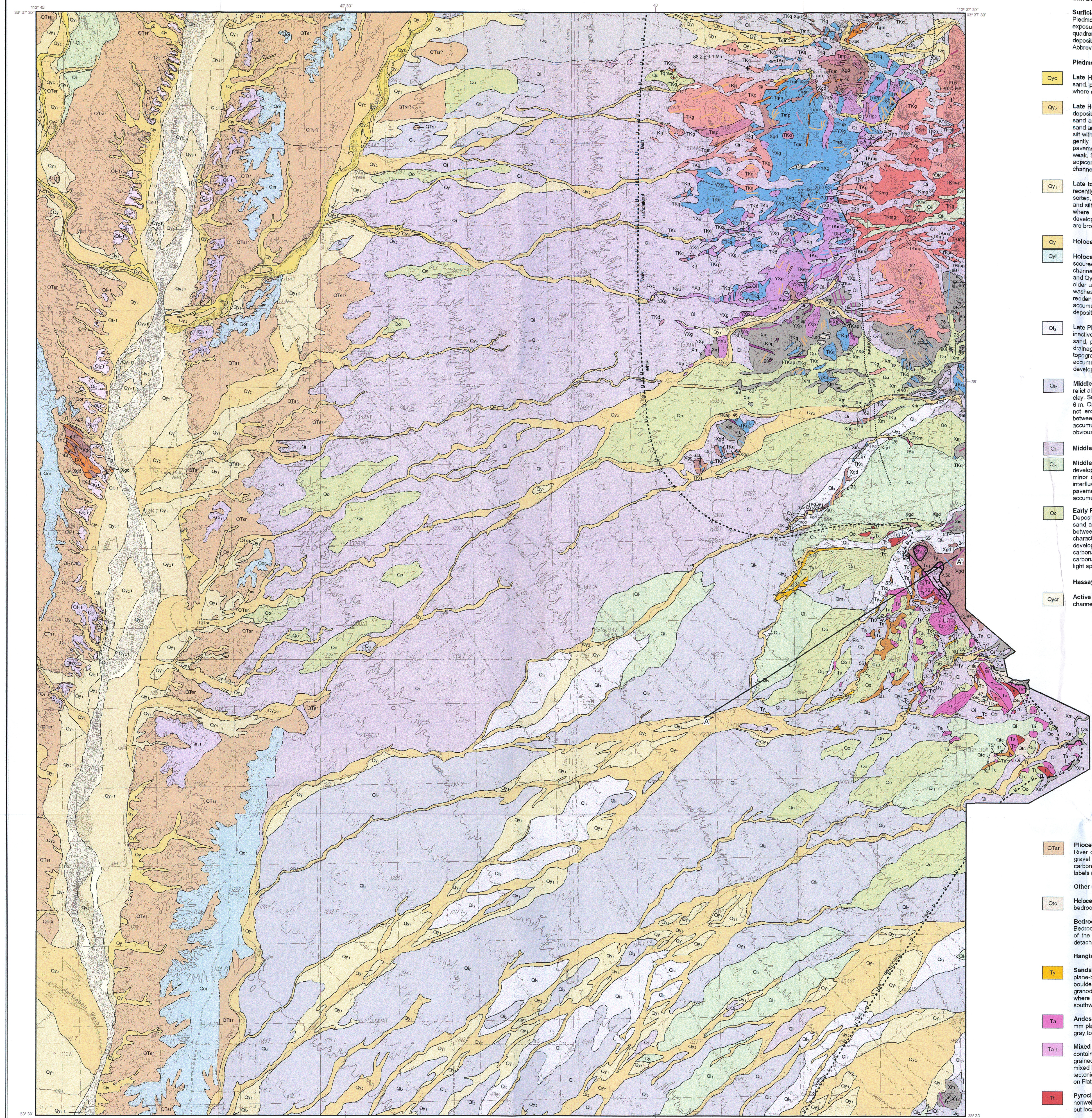
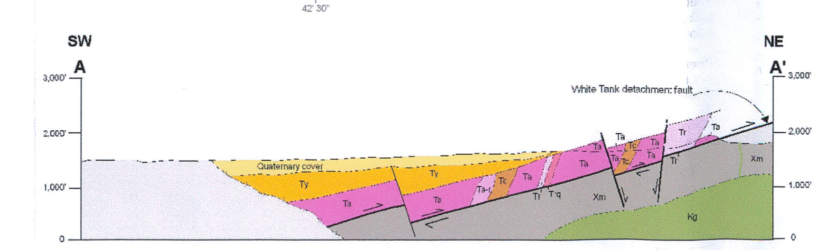
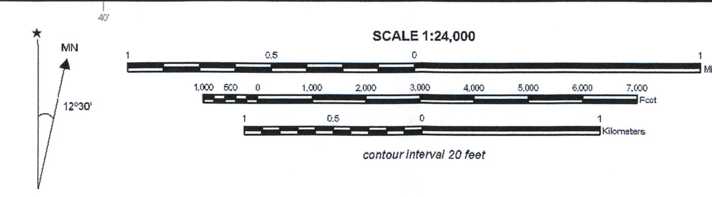


Topographic base from USGS Wagner Wash Well 7.5' quadrangle, compiled from aerial photographs taken 1951 and 1960; field checked in 1962. Transverse Mercator projection, NAD 27 datum, UTM zone 12 meters. Reprojected to NAD 83, stateplane feet. Magnetic declination 12.5° east of true north. Contour interval 20 feet.





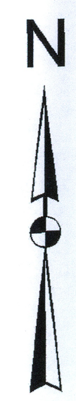
Map Legend

- Bedding, accurate
- Generic foliation
- Schistosity
- Inclined flow foliation
- Gneissic layering
- Vertical gneissic foliation
- Slickenside striae lineation
- Lineation in cumulate rocks
- Fault attitude

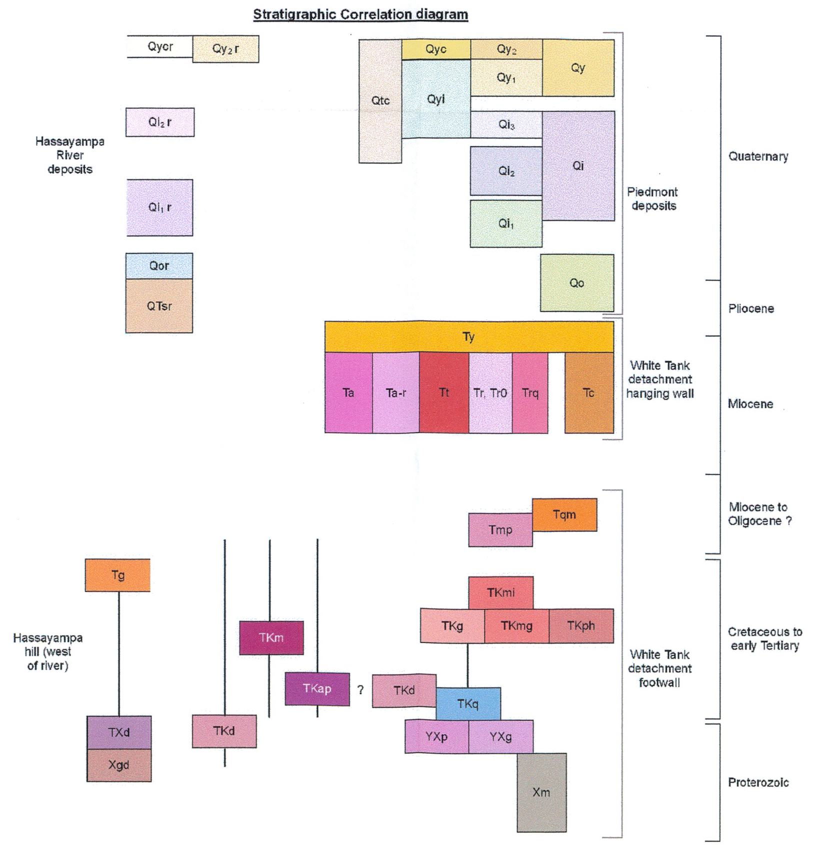
- Contact, accurate
- Contact, approximate
- Fault, accurate
- Fault, approximate
- Fault, concealed
- White Tank detachment fault, accurate (barbs on hanging wall)
- White Tank detachment fault, concealed (barbs on hanging wall)

Dikes

- Quartz monzonite porphyry dike (unit Tqm)
- Monzonite porphyry dike (unit Tmp)
- Basaltic dike (unit Tb)
- Mafic dike (unit TKm)
- Andesite porphyry dike (unit TKap)
- Fine-grained diorite stocks and dikes (unit TXd)
- Dacite porphyry dike (unit TKd)
- Rhyolite porphyry dike (unit TKq)



Stratigraphic Correlation diagram



Unit Descriptions

Surficial map units

Piedmont surficial deposits cover most of the Wagner Wash Well 7.5' quadrangle, with fairly extensive exposures of Quaternary to late Tertiary Hassayampa River deposits in the western part of the quadrangle. The lower margins of the piedmonts are defined by their intersection with relict river deposits. Approximate age estimates for the various units are given in parentheses after the unit name. Abbreviations are ka, thousands of years before present, and Ma, millions of years before present.

Piedmont Alluvium

Qyc — **Late Holocene active channel deposits of larger washes** – Poorly sorted to very poorly sorted sand, pebbles, and cobbles in channels of larger washes. Also includes minor bars and low terraces, where deposits are generally sand and silt with minor gravel.

Qy_2 — **Late Holocene deposits in active stream channels, low terraces, and alluvial fans** – Very young deposits associated with active or recently active fluvial systems. Channel deposits typically consist of sand and pebbles with some cobbles and small boulders in middle and upper piedmont areas, and sand and some pebbles lower on the piedmont. Terrace and fan deposits typically consist of sand and silt with some gravel lenses. Fan and terrace surfaces typically are planar where deposits are fine and gently undulating where deposits are coarser, with gravel bars and finer-grained swales. Desert pavement development is minimal and rock varnish is very light or nonexistent. Soil development is weak. Surface dissection is minimal and is associated with channels that are incised up to 1.5 m below adjacent fans or terraces. Channel patterns are variable, including anastamosing or distributary linked channels and separate small tributary channels feeding into larger channels.

Qy_1 — **Late to early Holocene deposits on alluvial fans and terraces** – Young deposits associated with recently active alluvial fans and terraces. In middle and upper piedmont areas, deposits are poorly sorted, consisting sand, silt, pebbles, and cobbles; in lower piedmont areas, deposits are typically sand and silt with minor gravel. Surface relief varies with particle size, with relict bar and swale topography where deposits are gravelly and relatively smooth surfaces where sand and silt predominate. Soil development is weak, with some soil structure and minor carbonate accumulation. Surfaces typically are brown to gray, with common gravel litter but minimal desert pavement or rock varnish.

Qy — **Holocene alluvial deposits, undifferentiated**

Qyi — **Holocene and late Pleistocene alluvial deposits** – Broadly rounded alluvial fans, and terraces and scoured benches along smaller tributary washes. Qyi surfaces are less than 1 m above active channels. They are primarily covered by a thin (< 1 m) veneer of Holocene fine-grained alluvium (Qy_2 and Qy_1) over reddened Pleistocene alluvium (Qi_2, Qi- or Qio) or eroded basin-fill deposits (QTs). The older units are exposed in scoured, eroded benches adjacent to active channels and in cut banks of washes. Holocene soils vary in development with color ranging from yellow brown (10YR) to slightly reddened (7.5YR) with no to weak subangular blocky structure and no to minor carbonate accumulation, although soils strongly effervesce due to source material. Coarse clasts within these deposits are typically reworked from older deposits and often exhibit carbonate coats or rinds.

Qi_3 — **Late Pleistocene alluvial fan and terrace deposits** – Younger intermediate deposits associated with inactive alluvial fans and terraces along washes. Deposits typically are poorly sorted mixtures of silt, sand, pebbles and cobbles with few small boulders. Surfaces are moderately dissected by tributary drainages that head on the surfaces and through-going distributary channels. Local surface topographic varies from about 1 to 2 m. Soil development is moderate, with minimal to some clay accumulation and soil reddening and weak to moderate calcic horizon development. Desert pavement development typically is moderate, and rock varnish varies from light to dark brown.

Qi_2 — **Middle Pleistocene alluvial fan deposits** – Older intermediate deposits associated with extensive relict alluvial fans. Deposits are poorly sorted, including sand, pebbles and cobbles, with minor silt and clay. Surfaces are moderately to deeply dissected, with local topographic relief varying from about 1 to 6 m. Original depositional topography typically is not preserved, and surfaces are quite smooth where not eroded. Qi_1 surfaces are drained by extensive tributary drainage networks. Interfluve areas between drainage vary from quite flat to broadly rounded. Soils have weak to moderate clay accumulation and slight reddening in the upper 30 cm beneath the surface, and calcic horizons show obvious visible carbonate accumulation.

Qi — **Middle and late Pleistocene alluvial fan and terrace deposits, undifferentiated**

Qi_1 — **Middle to early Pleistocene alluvial fan deposits** – Old relict alluvial fans with moderately strong soil development. Deposits are poorly sorted, including sand, pebbles, cobbles, and small boulders with minor silt and clay. Surfaces typically are moderately dissected with up to 6 m of local relief, but interfluve surfaces are quite smooth and have dark, strongly developed pebble-cobble desert pavements. Soils have moderate clay accumulation and obvious reddening and abundant carbonate accumulation resulting in weak cementation.

Qo — **Early Pleistocene to late Pliocene alluvial fan deposits** – High, very old relict alluvial fan deposits. Deposits typically are very poorly sorted, including angular to subangular cobbles and pebbles with sand and minor silt and clay. Surfaces are moderately to deeply dissected, with 2 to 10 m of relief between channels and ridgecrests. Original fan surfaces have been removed by erosion, so the characteristic topographic expression of these deposits are alternating ridges and valleys. Soil development is moderate to strong, depending on local preservation, but all soils are dominated by carbonate accumulation and clay-rich horizons were not observed. Surfaces typically are littered by carbonate fragments derived from eroded or perturbed petrocalcic horizons; this gives Qo surfaces a light appearance on aerial photographs.

Hassayampa River Alluvium

Qycr — **Active river channel deposits** – Moderately to poorly sorted sand, gravel and minor silt in active channels of the Hassayampa River. Gravel includes subangular to well-rounded clasts.

Qy_2r — **Late Holocene to modern floodplain deposits** – Sand, silt, and gravel deposits associated with slightly higher terraces along the Hassayampa River. Terrace surfaces are smooth and are less than 3 m above the active channel. Terrace surfaces are covered with fine-grained floodplain deposits, but relict gravel bars and lenses are common.

Qi_2r — **Middle to late Pleistocene river deposits** – Older terrace deposits of very limited extent found in a few places along the Hassayampa River. Deposits are gravelly with some sand, silt and clay. Soil development is moderate with some clay accumulation where terrace surfaces are well preserved. Terrace surfaces typically are less than 10 m above the active river channel.

Qi_1r — **Middle Pleistocene river deposits** – Deposits associated with a set of high terraces along the Hassayampa River. Terrace surfaces are of limited extent in this quadrangle. Terraces are fairly flat or slope gently toward the river, but terrace surfaces are dissected by tributary drainages. Deposits are quite gravelly at the surface but limited exposures indicate that they also contain sand and silt. Qi_1r terrace surfaces range from about 10 to 20 m above the active river channel.

Qor — **Early Pleistocene river deposits** – Deposits associated with the high terraces along the Hassayampa River that record the maximum aggradation of the river. Terrace surfaces are fairly flat or broadly rounded, but all terrace surfaces are moderately to deeply dissected by tributary drainages and the river and have been substantially modified by erosion. Exposures are poor, but well-rounded gravel is evident at the surface. Terrace surfaces are also covered with litter from underlying petrocalcic soil horizons. Qor terrace surfaces are more extensive than any of the younger Pleistocene terraces (Qi_2r). Terrace surfaces range from about 20 to 30 m above the active river channel, and rise to the north across the quadrangle.

QTsr — **Pliocene to early Pleistocene river deposits** – A moderately thick sequence of old Hassayampa River deposits that underlies the Qor terrace/fan deposits. These deposits consist of river sand, gravel and silt with a substantial component of tributary sand and gravel. Local zones of substantial carbonate accumulation may represent moderately to strongly developed buried soils. Queried unit labels (QTsr?) indicate areas where exposures are poor.

Other units

Qtc — Holocene and Pleistocene colluvium and talus – Very poorly sorted hillslope deposits mantling bedrock slopes.

Bedrock map units

Bedrock units are divided into three groups: 1) volcanic and sedimentary rocks in the hanging wall of the detachment fault, 2), plutonic and metamorphic rocks in the footwall of the White Tank detachment fault, and 3) plutonic rocks of the Belmont Mountains west of the Hassayampa River.

Hanging wall rock units, White Tank Mountains

Ty — **Sandstone and conglomerate (middle to late Tertiary)** – Thin- to medium-bedded, dominantly plane-bedded, gently dipping, pebbly sandstone, and rounded to sub-rounded, cobble-pebble, rare boulder, sandy conglomerate. In most areas, the unit is light-colored and clasts consist of >70% granodiorite, schist, and orthogneiss, and < 30% mafic volcanic rocks. Locally, mostly to the east, where volcanic clasts make up greater than 50%, the unit is reddish. Imbricated cobbles indicate southwest-directed paleocurrents.

Ta — **Andesite (middle Tertiary)** – Andesitic lava flows containing 1-25%, subhedral to euhedral, 0.5-4 mm plagioclase phenocrysts and minor <2 mm altered mafic phenocrysts. Matrix is typically dark gray to dark purple. Samples: CAF-2-7339, 7402, 7436, 7481, 7488.

Ta-r — **Mixed andesite and rhyolite (middle Tertiary)** – Rare flows of phenocryst-poor andesitic lava contain 5-50% irregular inclusions ranging in size from less than 1 m to greater than 50 m of fine-grained, phenocryst-poor rhyolite lava. The unit appears to be a distinctive flow characterized by mixed lava, but poor exposure makes it possible in some areas that the mixed nature of the unit is tectonic. The unit may correlate with a distinctive bimodal andesite-rhyolite mixed lava unit (Tax) on Flatiron Mountain in the southeastern Belmont Mountains.

Tt — **Pyroclastic rocks (middle Tertiary)** – Massive to thick-bedded, mostly matrix-supported, nonwelded felsic tuff with abundant lithic lapilli. Lithic clasts are dominantly andesite and rhyolite, but locally, granitic and metamorphic clasts are also abundant. Samples: CAF-27271, 7569.

Tr — **Phenocryst-poor rhyolite lava (middle Tertiary)** – Rhyolite lava containing 1-10% 1-3 mm feldspar phenocrysts. The lava is typically pink to lavender in color and preserves massive, flow-foliated and autobrecciated textures. Samples: CAF-2-7413, 7575

Trq — **Phenocryst-poor, quartz-phyric rhyolite lava (middle Tertiary)** – Rhyolite lava containing 1-10% 1-3 mm feldspar and quartz phenocrysts. The flows are typically pink to lavender in color and preserve massive flow-foliated and autobreccia textures. Samples: CAF-2-7476, 7564, 7565,

Tr0 — **Aphyric rhyolite lava (middle Tertiary)** – Rhyolite lava flows that are typically pink to lavendar in color and preserve massive flow-foliated and autobreccia textures.

Tc — **Conglomerate and breccia (middle Tertiary)** – A massive, rarely thick-bedded, dark reddish colored, clast-supported, sandy matrix, coarse-grained conglomerate and breccia unit dominated by granitic and metamorphic clasts, but also containing 0-30% andesite and rhyolite clasts. The clasts are typically cobble to boulder sized and sub-rounded to angular. The dominant clast types are (1) coarse-grained, potassium-feldspar porphyritic granite (similar to the YXg map unit of this map area), and (2) fine- to medium-grained biotite schist and amphibolite schist (similar to the Xp and Xa map units of the southerly adjacent Buckeye NW 7.5' quadrangle). The conglomerate and breccia unit is intimately interbedded (generally steeply-dipping) with the andesitic (Ta, Ta-r), and rhyolitic (Tr, Trq, Tr0) lava flows in the area. Sample CAF-2-7350.

Footwall rock units, White Tank Mountains

Age assignments for plutonic rocks in the northwestern White Tank Mountains are based primarily on their age relative to an early Tertiary to Late Cretaceous (56.2 ± 14 Ma) complex of medium-grained granite (TKg) and comagmatic heterogeneous mafic plutonic rocks (TKmg, TKmi, TKph). Hypabyssal rocks that are intruded by this complex are also assigned an early Tertiary to Late Cretaceous age (TKq, TKd), whereas those that intrude the complex are assigned a Tertiary age (Tqm, Tmp, Tb). Hypabyssal rocks with no known age relationship to the complex are assigned a Tertiary-Cretaceous age (TKap, TKm), and a mafic dike unit with a fine- to medium-grained phaneritic texture (TXd) is assigned a Tertiary-Early Proterozoic age. An undeformed coarse-grained granite (YXg), and associated pegmatite complex (YXp) is assigned a Middle to Early Proterozoic age, and tectonically foliated plutonic and metamorphic rocks are assigned to the Early Proteroic (Xgd, Xm).

Tqm — **Quartz monzonite porphyry (Tertiary)** – Fine-grained, typically dark greenish matrix porphyry containing 5-20% 0.5-30 mm subhedral to euhedral plagioclase, 1-10% 2-50 mm subhedral to euhedral potassium feldspar, and 1-10% 1-5 mm anhedral to subhedral, deeply embayed quartz phenocrysts, 1-5% 1-3 mm chloritic-altered biotite. The porphyry also contains sparse 0.2-1 mm clinopyroxene, and sparse opaque minerals. In some areas, the quartz monzonite porphyry has a light gray matrix and is very similar to the rhyolite porphyry (TKq). The quartz monzonite porphyry is distinguished from the rhyolite porphyry (TKq) and other quartz-phyric porphyry units based primarily on cross-cutting relationships. Along with the monzonite porphyry (Tmp), the quartz monzonite porphyry is one of the youngest intrusive units in the area. It consistently intrudes two important units; the medium-grained granite (TKg) and a swarm of basaltic dikes (Tb) that consistently intrude the rhyolite porphyry (TKq). The quartz monzonite porphyry correlates with Barrett's (1976) quartz monzonite porphyry. Samples: CAF-2-8222, 8228.

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GEOLOGIC MAP OF THE WAGNER WASH WELL 7.5' QUADRANGLE, MARICOPA COUNTY, ARIZONA

by Charles A. Ferguson, Jon E. Spencer, Philip A. Pearthree, Ann Youberg and John J. Field

Arizona Geological Survey Digital Geologic Map 38 (DGM-38), version 1.0

November, 2004

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Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award #03HQAG0114. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government.

Unit Descriptions continued...

Tmp — **Monzonite porphyry (Tertiary)** – Porphyritic dikes characterized by the absence of quartz phenocrysts visible in hand specimen. Phenocryst content varies from 10-50%. Subhedral to euhedral plagioclase (0.5-5 mm) is by far the most abundant phase. Potassium feldspar is virtually absent, but sparse, microscopic (<0.2 mm) subhedral to anhedral quartz is ubiquitous. Mafic phenocrysts are strongly chloritic-altered biotite (1-2% 0.4-1.5 mm), and 0.5-3% 0.5-1.5 mm glomeroporphyritic clinopyroxene. Traces of sphene (<0.3 mm) and opaques are associated with the biotite and clinopyroxene. Glomeroporphyritic clumps of clinopyroxene are commonly rimmed by euhedral plagioclase phenocrysts. The monzonite porphyry is generally coarser grained and has a more crystalline matrix than the andesite porphyry (TKap), but the two units which occur in different areas, the monzonite porphyry to the north and the andesite porphyry (TKap) to the south, may be correlative. The monzonite porphyry correlates with Barrett's (1976) monzonite porphyry and quartz latite porphyry units. Samples: CAF-2-8201, 8224, JES-12-9-03-2, 12-10-03-6.

Tb — **Basaltic dikes (Tertiary)** – Fine-grained, generally dark gray to purple, aphanitic-matrix basaltic dikes with sparse plagioclase (1-4 mm) and altered mafic (≤2 mm) phenocrysts. The basaltic dikes are similar to the generic mafic dikes (TKm) which tend to have fine-grained phaneritic matrix. The basaltic dikes represent a wide-ranging swarm of dikes that consistently intrude the medium-grained granite (TKg) and are mostly intruded by the quartz monzonite (Tqm) and monzonite porphyry (Tmp). In the north basaltic dikes are commonly intruded by parallel dikes of the quartz monzonite (Tqm) and monzonite porphyry (Tmp), and in some areas, overlapping relationships are present. The basaltic dikes correlate with Barrett's (1976) dacite porphyry dikes. Samples: JES-11-19-03-5, 12-10-03-2, 12-10-03-5.

TKm — **Mafic dikes (Tertiary – Cretaceous)** – Dark-colored, fine-grained to very fine-grained dioritic dikes with sparse 1-4 mm plagioclase and mafic phenocrysts. Samples: CAF-2-6959, 7077, JES-12-12-03-2, 12-12-03-3.

TKap — **Andesite porphyry (Tertiary – Cretaceous)** – Dark gray to purple matrix, andesite porphyry dikes with 10% 2-4 mm, euhedral plagioclase phenocrysts. The andesite porphyry appears to be restricted to the hanging wall of the Wagner fault. Samples: CAF-2-7124, 7137, 7323, 7324.

TXd — **Fine-grained diorite stocks and dikes (Tertiary – Early Proterozoic)** – Fine- to medium-grained, dark-green amphibolite to diorite, locally with felted mafic phenocrysts up to 10 mm. Samples: CAF-2-7978, 8135.

TKmg — **Heterogeneous mafic granitoid (early Tertiary – Late Cretaceous)** – A complex suite of granitoids ranging in composition from granodiorite to monzodiorite, quartz monzodiorite and diorite, and from very fine- to medium-grained (mixed together on scale of 10-100 cm), with highly variable mafic content (6-50% clinopyroxene, and hornblende, locally with some biotite), and up to 1% sphene. The granitioids form irregular stocks and dikes that both intrude and are intruded by the closely related TKg map unit. Some biotite granite in contact with dioritic granitoids is pegmatitic, with coarse interiors and vein-like form; in other places dioritic granitoids have chilled margins. The heterogeneous mafic granitoid unit correlates with Barrett's (1976) quartz diorite to the east of the Wagner fault, and possibly in part with the (TKgd) unit of Reynolds et al. (2002). Samples: CAF-2-6959, 7077, JES-11-17-03-2, 11-18-03-8, 12-11-03-3, 12-11-03-6.

TKmi — **Granitoids associated with heterogeneous mafic granitoids (early Tertiary – Late Cretaceous)** – Felsic to intermediate, sparsely quartz-phyric granitoids associated with mafic granitoids and probably comagmatic with them. This unit generally contains 3-8% mafic minerals (mostly pale green, alteration product or primary?, some vaguely micaceous) and 1-2% < 1mm sphene. Samples JES-11-18-03-1, 11-18-03-4, -11-18-03-7, 12-11-03-2, 12-11-03-5, 12-12-03-1.

TKph — **Pyroxene- and hornblende-rich mafic granitoids (early Tertiary – Late Cretaceous)** – An irregular shaped stock of very dark mafic granitoids. Sample JES-11-18-03-5 contains 25-35%, brownish green, 2-20 mm subhedral to euhedral hornblende phenocrysts within a fine- to medium-grained quartz monzonite matrix that contains 10-20% 0.5-1.0 mm, subhedral to euhedral clinopyroxene and 5% 0.5-3.5 mm, subhedral to euhedral hornblende. Sample JES-11-18-03-6 is a hornblendite containing ~35% 1-4 mm, subhedral to euhedral hornblende in a quartz monzodiorite matrix with up to 2% sphene. The rocks display faint layering defined by variations in the abundance and grain size of pyroxene and hornblende.

TKg — **Medium-grained granite (early Tertiary – Late Cretaceous)** – Medium-grained to locally coarse-grained, equigranular to potassium-feldspar porphyritic granite with 3-15%, ≤ 3 mm subhedral to euhedral biotite, up to 1% hornblende, and sparse opaques associated with the biotite and hornblende. The granite typically weathers into tors and rounded grus-covered hills, and is present on both sides of the Wagner fault. To the west, the granite is leucocratic (< 7% biotite), homogeneous, and porphyritic with up to 20% very fine-grained crystalline matrix. On the east side of Wagner fault, the granite ranges from medium-grained, equigranular granite, monzogranite, and granodiorite to sparsely and abundantly potassium-feldspar-porphyritic granite with potassium-feldspar phenocrysts up to 30 mm, and biotite content that ranges from 5-15%. The middle portion of the eastern pluton includes several irregular stocks of heterogeneous mafic granitoids (TKmg) that show abundant evidence of comagmatic emplacement with the granite. Contacts between the two units range from sharp to gradational with conflicting cross-cutting relationships. The mafic granitoids (TKmg) range from granodiorite and monzodiorite to diorite and pyroxenite (TKph), and in areas where contact relationships with the medium-grained granitoids are vague, a change from biotite-dominated to hornblende-dominated mafics is used as the criteria for unit assignment. To the west of the Wagner fault, where a K-Ar hornblende date of 88.2 ± 3.1 Ma (Armstrong, 1975 as reported in Reynolds et al., 1986) was obtained from this unit, the medium-grained granite correlates with Barrett's (1976) granite porphyry. To the east of the Wagner fault, where a K-Ar biotite cooling age of 19.6 ± 0.5 Ma (Shafiqullah et al., 1980) was obtained, this granite correlates with the granodiorite (TKgd) unit of Reynolds et al. (2002). Another sample of this unit, from the White Tank Mountains NE 7.5' quadrangle, yielded a U-Pb zircon date of 56.2 ± 14 Ma (Spencer et al., 2003). Our Late Cretaceous to early Tertiary age assignment for this unit is based on the interpretation that both the U-Pb and hornblende K-Ar dates reflect a Late Cretaceous to early Tertiary crystallization age, and the biotite K-Ar age is related to cooling during later extensional exhumation. Samples: CAF-2-6948, 7941, 8208, JES-11-18-03-2, 11-19-03-2, 12-10-03-11, 12-11-03-1, 12-11-03-4a, b. 11-18-03-2, 11-19-03-2, 12-10-03-11, 12-11-03-1, 12-11-03-4a, b.

TKd — **Dacite porphyry (early Tertiary – Late Cretaceous)** – Aphanitic-matrix feldspar porphyry containing 20-35% 2-15 mm plagioclase and lesser potassium feldspar, plus 1-5% biotite. The dacite porphyry is intimately related to the rhyolite porphyry (TKq) with conflicting intrusive relationships observed in several areas. The dacite porphyry probably represents the mafic end-member of a continuum of felsic porphyries dominated by the rhyolite porphyry (TKq). Samples: CAF-2-7087, 7089.

TKq — **Rhyolite porphyry (early Tertiary – Late Cretaceous)** – A composite unit of quartz-phyric rhyolite porphyry dikes and stocks with highly variable phenocryst content. The main outcrop area of this unit includes up to 30% country rock, which consists mostly of the coarse-grained granite (YXg) unit, but also includes significant areas of the granodiorite (Xgd) unit to the north. The rhyolite porphyry is characterized by light gray, commonly flow-foliated aphanitic matrix and contains between 0.5% and 40% 1-10 mm quartz, potassium feldspar, and plagioclase phenocrysts with sparse biotite, hornblende, and other mafics. More than 60% of the unit is represented by porphyry containing 10-15% 1-4 mm phenocrysts, and most of the rest consists of an aphyric to phenocryst-poor (≤5%) variety. Lesser amounts of coarse-grained (2-10 mm), phenocryst-rich (25-40%) porphyry is also present. In general, grain size and the abundance of accessory mafic minerals increases with phenocryst content. Contacts between the different varieties are sharp, and many of the dikes are occupied by more than one variety. The rhyolite porphyry, and its constituent phenocryst-poor to phenocryst-rich varieties, along with the dacite porphyry (TKd), represent a continuum of essentially contemporaneous felsic to intermediate hypabyssal rocks. The rhyolite porphyry is distinguished from the quartz monzonite porphyry (Tqm) by its lighter colored matrix and because it is older than the medium-grained granite (TKg). The bulk of the rhyolite porphyry correlates with the older rhyolite and aplite porphyries of Barrett (1976) and the intrusive rocks (Ti) unit of Reynolds et al. (2002). Samples: CAF-2-6950, 6954, 7005, 7133, 7246, 7247, 7261, 8203, JES-11-19-03-6, 11-19-03-8, 12-10-03-4, 12-10-03-7, 11-19-03-1, 11-19-03-4, 11-19-03-7, 12-9-03-1, 12-10-03-1, 12-10-03-3, 12-10-03-8, 12-12-03-4, 12-12-03-5, 12-12-03-6.

YXg — **Coarse-grained granite (Middle or Early Proterozoic)** – Coarse-grained, potassium-feldspar porphyritic granite with 7-10% biotite. The coarse-grained granite correlates with Barrett's (1976) granite unit. Sample 11-19-03.

YXp — **Pegmatite and leucogranite complex (Middle and Early Proterozoic)** – Medium- to coarse-grained pegmatite and heterogenous texture, banded, muscovite leucogranite. The pegmatite and leucogranite complex occurs in small stocks that intrude the granodiorite (Xgd) and metamorphic complex (Xm) along the southern margin of the coarse-grained granite (YXg) pluton.

Xm — **Metamorphic complex (Early Proterozoic)** – A metamorphic and plutonic complex consisting of four main rock types intimately mixed on a scale that precludes mapping separately, although each is recognized and locally mapped separately in this map area or in the southerly adjacent Buckeye NW 7.5' quadrangle. The oldest, making up between 0-70% of the unit, is a fine- to medium-grained, mafic-rich, variably quartz veined, banded orthogneiss and amphibolite schist (Xa). The metamorphic rocks are intruded by foliated, medium-grained granodiorite (Xgd), which makes up between 0-70% of the unit, and lesser amounts (0-10%) of weakly foliated, fine- to medium-grained, 10-20% biotite granite or quartz monzonite (Xg) that appears to be younger than the granodiorite (Xgd). The entire complex is intruded by pegmatite dikes (YXp) that make up between 0-5% of the unit. The metamorphic complex is distinguished from the heterogeneous mafic granitoid (TKm) unit by its pervasive tectonic foliation and by its ubiquitous pegmatite dikes and quartz veins. The metamorphic complex correlates with the undifferentiated metamorphic rocks (Xm) and granitic rocks and pegmatite (Xgr) units of Reynolds et al. (2002).

Xgd — **Granodiorite (Early Proterozoic)** – Medium-grained, weakly to strongly foliated granitoid ranging from monzogranite to granodiorite and quartz monzodiorite, and containing 15-40% mafics. Mafic minerals in sample CAF-2-8237 are hornblende (5-8% 1-3 mm) and clinopyroxene (2% <0.5 mm). The granodiorite is closely associated with the metamorphic complex (Xm), and may include up to 30% of its constituents in its outcrop area. The granodiorite correlates with the hornblende diorite, quartz diorite and diorite units of Barrett (1976) to the west of the Wagner fault in the northeast corner of the map area. In the south, the granodiorite correlates with the undifferentiated metamorphic rocks (Xm), granitic rocks and pegmatite (Xgr), and tonalite (Xt) units of Reynolds et al. (2002).

Belmont Mountains (west of the Hassayampa River)

Tb — **Basaltic dikes (Tertiary)** – Fine-grained, generally dark gray to purple, aphanitic-matrix basaltic dikes with sparse plagioclase (1-4 mm) and altered mafic phenocrysts (≤2 mm). These dikes may correlate with the basaltic dikes of the White Tank Mountains.

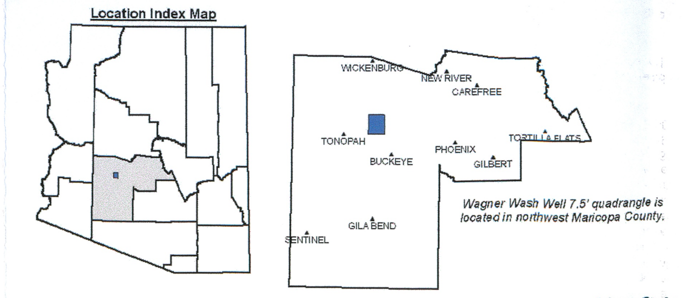
Tg — **Belmont Granite (Tertiary)** – Medium- to coarse-grained, 10% biotite, weakly potassium-feldspar porphyritic granite with ubiquitous 0.5-5.0 cm miarolitic cavities. The granite forms a series of southeast-striking, southwest-dipping dikes that intrude foliated granodiorite (Xgd) in a single hill along the west bank of the Hassayampa River. The margins of the dikes display contact zones up to 20 m wide that grade from flow-foliated, 5-10% 1-4 mm quartz-feldspar porphyry through 20-50% 2-4 mm, quartz-feldspar porphyry into the granitic interior of the dikes. These textural relationships, the host rock, and the orientation of the dikes are identical to what is observed in the southeast contact zone of the Belmont pluton in the southeast Belmont Mountains to the west. Samples from here and in the Belmont Mountains: CAF-2-7955, 7957, 7962, 7974, 7989, 8141.

TXd — **Fine-grained diorite stocks and dikes (Tertiary – Early Proterozoic)** – Fine- to medium-grained dark green amphibolite to diorite, locally with felted mafic phenocrysts up to 10 mm. Samples: CAF-2-7978, 8135.

Xgd — **Granodiorite (Early Proterozoic)** – Medium-grained, weakly to strongly foliated granodiorite to quartz monzodiorite containing between 15-40% mafics.

See accompanying 7-page text for more information.

Location Index Map



Wagner Wash Well 7.5' quadrangle is located in northwest Maricopa County.

APPENDIX G
PIEDMONT FLOOD HAZARD ASSESSMENT SUPPORTING DOCUMENTATION
(FOR REFERENCE ONLY)

G.1 AZGS Surficial Geology Mapping and associated report

Photocopies of *Surficial Geology Around the White Tank Mountain*, Central Arizona report and mapping

Surficial Geology Around the White Tank Mountains, Central Arizona

by

John J. Field and Philip A. Pearthree

Arizona Geological Survey
Open-File Report 91-8

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Arizona Geological Survey
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Prepared in cooperation with
the U.S. Geological Survey COGEOMAP Program,
the Flood Control District of Maricopa County,
and the Arizona Department of Water Resources

This report is preliminary and has not been edited
or reviewed for conformity with Arizona Geological Survey standards

Introduction

These nine maps depict the distribution and general ages of Quaternary geomorphic surfaces and associated alluvial deposits surrounding the White Tank Mountains, on the western margin of the Phoenix metropolitan area. The White Tank Mountains are one of many mountain ranges in the Basin and Range physiographic province of Arizona. The Basin and Range province in the vicinity of the study area is characterized by relatively small mountain ranges of modest topographic relief separated by wide, gently sloping piedmonts and basin bottom river drainages. The study area is drained by the Gila River. By indicating the age of alluvial surfaces and deposits, these maps provide a basis for evaluating the Quaternary geologic history of the area and assessing potential geologic hazards.

Alluvial surfaces and deposits differentiated for this map are assigned to Quaternary and Upper Tertiary geologic units primarily on the basis of the estimated timing of cessation of major deposition on each geomorphic surface. Relative topographic positions of each surface, surface characteristics, and degree of soil development in underlying deposits are the principal criteria used to assess surface age. The geomorphic surfaces and associated deposits were formed during discrete time intervals ranging from the Late Tertiary to the late Holocene. Six categories of alluvial surfaces are differentiated and mapped on the basis of surface age. Alluvial surfaces are further subdivided into piedmont and basin axis units. The characteristics of each map unit are described in detail below. The estimated ages of the units are inferred by correlation with similar surfaces and soils radiometrically dated elsewhere in the southwestern United States (Gile and others, 1981; Bull, 1991; Menges and McFadden, 1981).

The mapping is based primarily on interpretation of natural-color (1:24,000 scale) aerial photographs. Initial unit designations were later field checked throughout the map area. In extensive agricultural tracts where natural surface characteristics are altered, published soil surveys (Soil Conservation Service, 1977; 1986) were used to evaluate soil development and to delineate boundaries between surfaces of different ages. The nine 1:24,000 scale maps of this series represent a more detailed survey over a small portion of regions mapped on a reconnaissance basis (1:100,000 scale) by Demsey (1988, 1989).

This project was supported by the Arizona Geological Survey, U.S. Geological Survey Cooperative Geologic Mapping (COGEOMAP) Program, the Maricopa County Flood Control District, and the Arizona Department of Water Resources. Aerial photographs were provided by the U.S. Bureau of Land Management.

Description of Map Units

Piedmont Units

Y2 - Late Holocene alluvial fans, low terraces, and active stream channels, < 3 ka.

Alluvial fan deposits on the lower piedmont are fine silts and sands. Middle piedmont surfaces and active channels extending into the White Tank Mountains are very gravelly sands and

silts. Surfaces are typically undissected and display distributary drainage patterns, although 1.5 m arroyo cuts occur locally on the lower piedmont. Surfaces are typically smooth, but bar and swale topography is present on the middle piedmont. Desert pavement and desert varnish are absent. Minimal to no soil development has occurred. Soil great groups are Torrifluvents and Torriorthents. These areas are subject to occasional to frequent flooding.

Y1 - Late to early Holocene alluvial fans and terraces, 1 to 10 ka.

Deposits on the middle piedmont are a coarse poorly sorted, angular to subangular admixture of silt, sand, and gravel. On the lower piedmont, deposits are typically fine silt and sand. Surface relief is typically less than 0.5 m above active channels. Lower piedmont surfaces are smooth and flat with an incipient dendritic drainage pattern. Middle piedmont surfaces have well preserved bar and swale topography with very little tributary drainage development. A poorly developed pebble to granule desert pavement (cobble to granule on middle piedmont) exists over 50 to 85 percent of the surface. Surface cobbles, when present, are lightly and incompletely varnished along the base of the cobble to brownish black (10 YR 2/2). An orange (7.5 YR 7/6) to dull yellowish brown (10 YR 5/4) color is rarely observed on cobble undersides. Minimal soil development has occurred in the underlying deposits -- the most strongly developed profiles contain cambic horizons (hue 7.5 YR) above stage I to II calcic horizons. Soil great groups are Torrifluvents, Torriorthents, and Camborthids. Most Y1 areas are not subject to flooding at present. However, because typically there is little topographic relief between active channels and Y1 surfaces, they could potentially become subject to flooding through minor shifts in the present depositional patterns.

Y - Undifferentiated Holocene alluvial surfaces, 0 to 10 ka.

In some places this designation is used where the Y1 and Y2 surfaces are too intricately intermingled to map separately at this scale. In other areas on the lower piedmont the designation is used where surface characteristics are not distinctive of either Y1 or Y2 surfaces but are clearly of Holocene age. These areas may be subject to occasional to frequent flooding.

M2 - Latest to late Pleistocene alluvial fans, 10 to 150 ka.

Deposits are a poorly sorted, angular to subangular admixture of silt, sand, and gravel. The surfaces are moderately dissected with typically < 1 m to 3 m relief above active channels. Interfluve areas are broad and flat with original gravel bar and swale topography typically moderately to well preserved. A poorly to moderately developed cobble to granule desert pavement is found over 50 to 80 percent of the surface. Surface cobbles are incompletely varnished to very dark brown (7.5 YR 2/3) on top and reddish brown (2.5 YR 4/6) to more commonly dull orange (5 YR 6/4) on undersides. M2 surfaces are not widespread and are predominantly restricted to the middle piedmont. Underlying soils typically contain cambic horizons (hue 7.5 YR), above a stage I to II calcic horizon. Soil great groups are Camborthids and Haplargids. Most areas are free from flooding, although those areas of low relief could become susceptible to flooding with relatively minor shifts in depositional patterns.

M1b - Middle to late Pleistocene alluvial fans, 150 to 300 ka.

Deposits are a poorly sorted, angular to subangular admixture of silt, sand, and gravel. The surfaces are moderately dissected on the upper piedmont with 1-6 m of relief above active channels.

On the lower and middle piedmont relief may be less than 1 m. Interfluve areas are broad and flat with original gravel bar and swale topography poorly preserved. A moderately to well developed cobble to pebble desert pavement is found over 50 to 75 percent of the surface. Surface cobbles are incompletely varnished to black (5 YR 1.7/1) on top and reddish brown (2.5 YR 4/6) to less commonly dull orange (7.5 YR 7/4) on undersides. Underlying soils are characterized by weakly developed argillic horizons (hue 5 YR), typically above a stage II calcic horizon. Soil great groups are Haplargids and Calciorthids. Most areas are isolated from flooding except in entrenched channels, but areas of low relief on the middle and lower piedmont could become susceptible to flooding with relatively minor shifts in depositional patterns.

M12 - Middle or late Pleistocene distal alluvial fans, 10 to 300 ka.

Undifferentiated M1b and M2 surfaces. This designation is used mostly in agricultural areas where surface characteristics are destroyed and available soil descriptions do not enable differentiation of the two surfaces. This designation is locally used elsewhere in areas not field checked. Only areas of low relief may be susceptible to flooding.

M1a - Middle to early Pleistocene alluvial fans, 300 to 1,000 ka.

Deposits are a poorly sorted, angular to subangular admixture of silt, sand and gravel. The surfaces are moderately dissected with typically 1-6 m of relief above active channels but less than 0.5 m of relief above Unit M1b. Interfluve areas are broad, flat, and smooth; bar and swale topography is typically absent or poorly preserved. A well developed cobble to pebble desert pavement is found over the entire surface. Surface cobbles are completely varnished black (5 YR 1.7/1) on top and reddish brown (2.5 YR 4/8) on undersides. Surfaces are typically well preserved and are the darkest surfaces on the White Tank Mountains piedmont. Underlying soils are characterized by moderately to very strongly developed argillic horizons (hue 5 to 2.5 YR), commonly overlying a stage IV calcic horizon. (May locally be composed of river terraces west of the Hassayampa River). Soil great groups are Haplargids. These areas are isolated from active fluvial processes, and only entrenched channels are subject to flooding.

M1 - Middle Pleistocene alluvial fans, 150 to 1,000 ka.

Undifferentiated M1b and M1a surfaces. (May locally be composed of river terraces of the same age immediately north of and adjacent to Wagner Wash and Trilby Wash). On the middle piedmont this designation is used where the two surfaces are too intricately intermingled to map separately at this scale. In other areas this designation is used where surface characteristics are destroyed (agricultural areas) or where extensive field checking was not conducted (north of Wagner Wash and Trilby Wash). Only entrenched channels dissected into the surface are subject to flooding in undisturbed areas.

O - Early Pleistocene to late Pliocene alluvial fans, > 1,000 ka.

Alluvial fan surfaces and deposits of inferred early Pleistocene to late Pliocene age. This unit occupies the highest topographic positions on the White Tank Mountains piedmont and occurs only on the upper piedmont. The deposits are characteristically poorly sorted subangular gravels containing minor amounts of finer material. Deposits range in thickness from greater than 15 m to only a thin veneer (<2 m) over bedrock pediments. The surfaces are deeply dissected (10-15 m). Interfluve

areas are well-rounded ridges with intervening swales or ravines; original depositional surfaces are rarely preserved. Degraded surfaces are typically covered with abundant fragments of pedogenic carbonate derived from exposed brecciated laminar petrocalcic horizons. The petrocalcic fragments commonly impart a light colored appearance to these surface remnants as observed on aerial photographs. Soils are generally stripped by erosion down to exposed remnants of stage IV to VI petrocalcic horizons. Soil great groups are Durorthids. Flooding is restricted to entrenched channels, although hillside slope wash is probable.

Axial Drainage Units

Y2r - Active channels and low terraces along axial drainages, < 3 ka.

Basin axis river channels and deposits of the Gila River, Hassayampa River, Wagner Wash, and Trilby Wash. Active channels on the present river bottoms were not separately mapped as channel positions frequently shift across the entire surface. Deposits range from silt to coarse sands but well rounded cobble bars are common along the Gila River and Hassayampa River. Flooding occurs frequently in basin axis channels.

Y1rt - Late to early Holocene terraces along axial drainages, 1 to 10 ka.

Deposits are typically fine silt and sand with common gravel lenses of well rounded cobbles. Terrace surfaces are smooth and typically less than 1.5 m above the active basin axis drainages (Y2r). These areas could potentially be flooded during very large flow events or after an extended period of aggradation in the active basin axis channels (Y2r).

M1bt - Middle to late Pleistocene river terraces, 150 to 300 ka.

High terrace of the Hassayampa River. This surface is mapped in only one area along the eastern edge of the Hassayampa River at the northern end of the Daggs Tank quadrangle. The terrace surface is flat and dissected up to 30 m by small tributaries flowing into the Hassayampa. The surface is inset 10 m below the adjacent Org deposits. Flooding may occur in entrenched channels and locally along the margin with the topographically higher Org deposits.

Ort - Early Pleistocene to late Pliocene river terraces, > 1,000 ka.

Highest terrace along the Hassayampa River. The well rounded gravel found at the surface is typically darkly varnished. In small localized areas, much of the surface is covered by petrocalcic fragments derived from underlying petrocalcic horizons. The terrace surfaces are dissected up to 30 m by small tributaries flowing into the Hassayampa River. Elsewhere the surface is very flat with a wide spacing between broad shallowly dissected (<2 m) drainages developed on the surface. Flooding restricted to entrenched channels.

Org - Early Pleistocene to late Pliocene river deposits, > 1,000 ka.

Deposits of well-rounded, well-sorted gravel and cross-stratified sand representing bedload material of major axial drainages. This unit is currently exposed along the margins of the

Hassayampa River. The deposits exhibit zones (>1 m) strongly indurated with carbonate cement. The original depositional surface (Ort) is completely eroded in these areas exposing the underlying deposits (Org). Flooding restricted to entrenched channels, although hillside slope wash is probable.

Bedrock Units* -

T - Tertiary volcanics

TK - Tertiary or Cretaceous intrusive and volcanic rocks

X - Early Proterozoic gneiss and granite

* - Bedrock units are generalized to show lithologies and ages. Detailed lithologic contacts and structures are not shown. Rock ages from Reynolds (1988).

Key to Map Symbols

Surficial geologic contact (dashed where inferred)

Basinward pediment boundary

Upslope edge of agricultural fields

Distribution of Surficial Deposits and the Quaternary Evolution of the White Tanks Piedmonts

In general, relatively young alluvial surfaces become increasingly extensive downslope on the piedmonts of the White Tank Mountains. The oldest surfaces (O and M1a) are found along the mountain front while the youngest surfaces (Y) are dominant adjacent to the basin axis drainages. This distribution suggests a general tendency toward erosion throughout the Quaternary punctuated by periods of equilibrium or aggradation.

Thick alluvial-fan deposits associated with the early Pleistocene to late Tertiary (O) surfaces probably represent the final stage of basin-filling sedimentation associated with the Basin and Range disturbance. All of the younger surfaces are associated with thin veneers of sediment, typically several meters thick or less, overlying older deposits. As a result of erosion throughout the Quaternary, only small, deeply dissected remnants of the early Pleistocene to late Tertiary surfaces are exposed along the mountain front. The change from an aggradational to a primarily erosional phase is most likely related to the cessation of tectonic activity in the region, although integration of the major basin axis drainages and climate changes probably played a minor role.

Middle to late Pleistocene surfaces (M1a and M1b) extend from the upper to lower piedmont and cover much of the White Tank Mountains piedmonts. These relatively thin but areally extensive deposits represent pulses of deposition that punctuated the long-term tendency toward downcutting and erosion on the piedmonts. Distinct differences in surface characteristics and soil development between M1a and M1b indicate that the interval between deposition of these units was probably hundreds of thousands of years long. However, the amount of relief between M1a and M1b typically is negligible, so the net downcutting in the middle Pleistocene was minimal. As a result, distinguishing between these two surfaces is sometimes difficult and they remain undifferentiated in some areas (M1).

The younger surfaces (M2, Y1, and Y2) are found predominantly in the lower and middle piedmont areas. Associated deposits indicate these surfaces are largely the product of erosion of M1 surfaces. Most drainages supplying sediment to the younger surfaces on the lower piedmont head on M1 surfaces and do not extend into the mountains. Sediment thickness on the young surfaces is extremely thin and it is common to see small pods of older units poking through the younger surfaces.

The presence of relatively small, active distributary flow areas on the middle piedmont suggest that loci of deposition has not shifted significantly since the latest Pleistocene. Active distributary flow areas are alluvial fans that become reconfined between older deposits at their downstream ends. They are characterized by distributary channel networks and extensive, young (Y2 and Y1) deposits. Late Pleistocene surfaces (M2) are restricted for the most part to the middle piedmont, where they usually flank younger distributary flow areas.

Deep entrenchment of the Hassayampa River has occurred during the Quaternary, as the present river bottom (Y2r) is over 30 m below the early Pleistocene to Late Tertiary river terrace (Ort). Entrenchment evidently has preceded relatively continuously throughout the Quaternary as no major terraces of intermediate height are observed except for a small middle Pleistocene terrace (M1bt) in the northern portion of the study area. The piedmont surfaces appear largely unaffected by the entrenchment of the Hassayampa River as even the youngest surfaces are graded to the high river

terrace (Org). Only minor dissection has occurred along the downslope edges of the piedmont units as newly formed drainages graded to the present river bottom erode headward.

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G.2 AZGS Geologic Mapping of Flood Hazards in Arizona

Photocopies of *Geologic Mapping of Flood Hazards in Arizona: An Example From the White Tank Mountains Area, Maricopa County* report and mapping

FCD Contract No. 99-02, Assignment No. 2
July 2000
Technical Data Notebook
Appendix G.2 AZGS Open File Reports

Open-File REPORT

Geologic Mapping of Flood Hazards in Arizona: An Example From the White Tank Mountains Area, Maricopa County

by

John J. Field and Philip A. Pearthree

Arizona Geological Survey
Open-File Report 91-10

March, 1992

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Prepared in cooperation with
the Flood Control District of Maricopa County
and the Arizona Department of Water Resources

This report is preliminary and has not been edited
or reviewed for conformity with Arizona Geological Survey standards

Introduction

Assessment of the character of flood hazards and the extent of flood-prone areas on the piedmonts of Arizona is an increasingly important concern to floodplain managers as urban areas continue to expand. Piedmonts are the low-relief, gently sloping plains between mountain ranges and the streams or playas that occupy the lowest portions of the valleys. Proper management of flood hazards on piedmonts is important because much of southern, central, and western Arizona is composed of piedmonts; they comprise most of the developable land around Phoenix and other rapidly expanding population centers of the State.

Management of flood hazards in Arizona and elsewhere in the western United States is complicated because portions of many piedmonts are composed of active alluvial fans. During floods, these fans are subject to widespread inundation and local high-velocity flow, and substantial changes in channel patterns may occur. Development that proceeds on piedmonts without regard to the locations of active alluvial fans is likely to place people and property at risk during large floods.

Geomorphic analyses and geologic mapping of piedmonts provide the best data for determining if active alluvial fans exist on a given piedmont and which portions of that piedmont may be subject to alluvial-fan flooding. Active alluvial fans have distinctive physical characteristics, including distributary drainage networks and laterally extensive, geologically young alluvial surfaces (Pearthree, 1989; Pearthree and Pearthree, 1989). Typically, large portions of piedmonts in Arizona have not been subject to flooding for many thousands of years and thus are not active alluvial fans. These areas can be distinguished from active alluvial fans by examining differences in drainage patterns, topographic relief, soil development, and surface characteristics (Christenson and others, 1978; Pearthree, 1991; Pearthree and others, in prep).

The principal objective of this study was to use geomorphic analyses and geologic mapping to delineate different flood-hazard zones on the piedmonts around the White Tank Mountains. Flood hazard designations on piedmonts obtained through geomorphic analyses and mapping are more reliable than those generated by hydrologic and hydraulic models currently available. These models, by necessity, make assumptions about rainfall intensity and duration, runoff characteristics, and flow behavior during floods. The validity of flood-hazard assessments derived through hydrologic modeling thus depends on the validity of the underlying assumptions and input parameters (Baker and others, 1990). In contrast, geologic mapping of flood hazards is based on analysis of surface characteristics and drainage patterns that actually exist on piedmonts. Geomorphic studies typically cannot resolve the details of individual floods, but they document which areas have actually been subject to significant flooding over thousands of years. Detailed geologic maps derived from these studies thus provide a long-term perspective on the distribution of flood-prone areas.

This report outlines the methods used to map and characterize flood hazard zones

the piedmonts around the White Tank Mountains. Studies of this kind could be used to ineate flood hazards on any undeveloped or sparsely developed piedmont in Arizona. Because of their wide applicability, the procedures used to map alluvial surfaces of different ages and to develop flood-hazard maps are described in some detail. The distribution of flood-prone areas around the White Tank Mountains is representative of many piedmonts in Maricopa County and elsewhere in Arizona. The report, therefore, also describes typical differences in the character and distribution of flood hazards in the upper, middle, and lower piedmont areas.

Methods Used to Map Alluvial Surfaces of Different Ages

The distribution of alluvial surfaces of different ages was the fundamental data set used to develop flood-hazard maps for this study. Interpretation of aerial photographs and field surveys provide much of the data used in our analyses, because surface characteristics evident on photographs and on the ground are related to the age of the surface. (See Table 1 for sources of data.) Aerial photographs depict surface color, dissection, vegetation density, and drainage patterns over large areas, some of which are inaccessible to motor vehicles. Subsequent ground surveys more thoroughly define the surface characteristics identified on aerial photographs and supply additional information on desert pavement, ck varnish, soil development, depositional topography, and vegetation.

Interpretation of Aerial Photographs

For this study, we interpreted 1:24,000-scale stereo-paired color aerial photographs provided by the U.S. Bureau of Land Management. Many surface characteristics are also evident on high-quality black-and-white photographs. Widely available, 1:24,000-scale, black-and-white orthophotoquads offer less resolution of surface characteristics, but they serve as an excellent base map for transferring information to 7.5' USGS topographic maps. Three characteristics that are visible on aerial photographs reflect surface age: surface color, drainage patterns, and depth of dissection and surface relief.

Surface Color. The color of alluvial surfaces depicted on aerial photographs is primarily controlled by soil color, and to a lesser extent, rock varnish. Significant soil development begins on an alluvial surface after it becomes isolated from active flooding and depositional processes (Gile and others, 1981, Birkeland, 1984; Birkeland and others, 1991). Over thousands of years, distinct soil horizons develop. Two typical soil horizons in old (> 10,000 years) alluvial sediments of Arizona are reddish brown argillic horizons and white calcic horizons. (See further description of soil formation below.) As a result, on color aerial photographs older alluvial surfaces characteristically appear redder or whiter (on more eroded surfaces) than younger surfaces.

Older surfaces have a dark brown color where darkly varnished desert pavements are well preserved. This colors is present in only small areas on the White Tank Mountain

Topographic Maps
Drainage patterns
Drainage spacing
Depth of dissection
Relief between surfaces

Aerial Photographs
Surface Color
Drainage patterns
Drainage spacing
Depth of dissection
Relief between surfaces

Ground Survey
Surface color
Drainage spacing
Depth of dissection
Relief between surfaces
Desert pavement
Rock varnish
Soil development
Depositional topography
Vegetation types and distributions

SCS Soil Maps
Soil development

Vegetation Maps
Vegetation distributions

Table 1. Data sources for geomorphic analyses and mapping of alluvial surfaces on piedmonts of Arizona. Note that there are sometimes multiple sources of information for a single characteristic (i.e. depth of dissection).

piedmonts, probably because desert pavements have been disturbed by animal burrowing and uprooting of large vegetation. These activities expose the underlying white and red soils.

Drainage Patterns. Differences in the drainage patterns between surfaces provide clues to surface age and potential flood hazards. Young alluvial surfaces that are subject to flooding commonly display a distributary (branching downstream) or braided channel pattern; young surfaces may have very little developed drainage if unconfined shallow flooding predominates. Dendritic tributary (branching upstream) drainage patterns are characteristic of older surfaces that are not subject to extensive flooding. (See Plates 1a through 1d for examples of drainage patterns on young and old alluvial surfaces.) Tributary drainage networks typically extend headward with time, and the spacing between drainages tends to decrease with time as the drainage network becomes better developed.

Depth of Dissection and Surface Relief. Relief between adjacent alluvial surfaces and the depth of entrenchment of channels can be determined using stereo-paired aerial photographs and topographic maps. Young flood-prone surfaces appear nearly flat on aerial photographs and are less than 1 m (3 ft) above channel bottoms. On these young surfaces, channel infilling or bank erosion might redirect floodwaters anywhere on the surface. Active channels are typically entrenched 1 to 10 m (3 to 30 ft) below older surfaces. In these areas, floodwaters are conveyed in the entrenched channels and have not affected the adjacent old surfaces for 10,000 years or more.

Younger surfaces are commonly inset into and topographically lower than older surfaces in upper piedmont areas (Figure 1a). Long-term climatic, tectonic, and base-level changes have resulted in lower surface gradients on younger surfaces, so the depth of dissection on older surfaces generally decreases away from the mountain front. In some middle and lower piedmont areas, relief between surfaces of different ages is minimal (figure 1c), so other surface characteristics are needed to estimate surface ages.

Field Investigations

Field investigations provide additional information on surface characteristics and topographic relationships between surfaces of different ages. Characteristics that are best observed on the ground are used to refine map units and to further describe surfaces already identified through interpretation of aerial photographs. These characteristics include development of desert pavements, rock varnish, and soils; preservation of small-scale depositional topography; and vegetation types.

Desert Pavement. Desert pavement is a concentration of pebbles and cobbles at the surface, which forms as windblown silt and clay accumulates between pebbles and cobbles. Repeated wetting of the surface by rain causes the silt and clay to swell, thereby lifting and pushing more cobbles and pebbles towards the surface. Repeated drying of the surface causes the formation of cracks in which more silt and clay can accumulate. Over thousands of years a surface mantling of closely packed pebbles and cobbles develops over

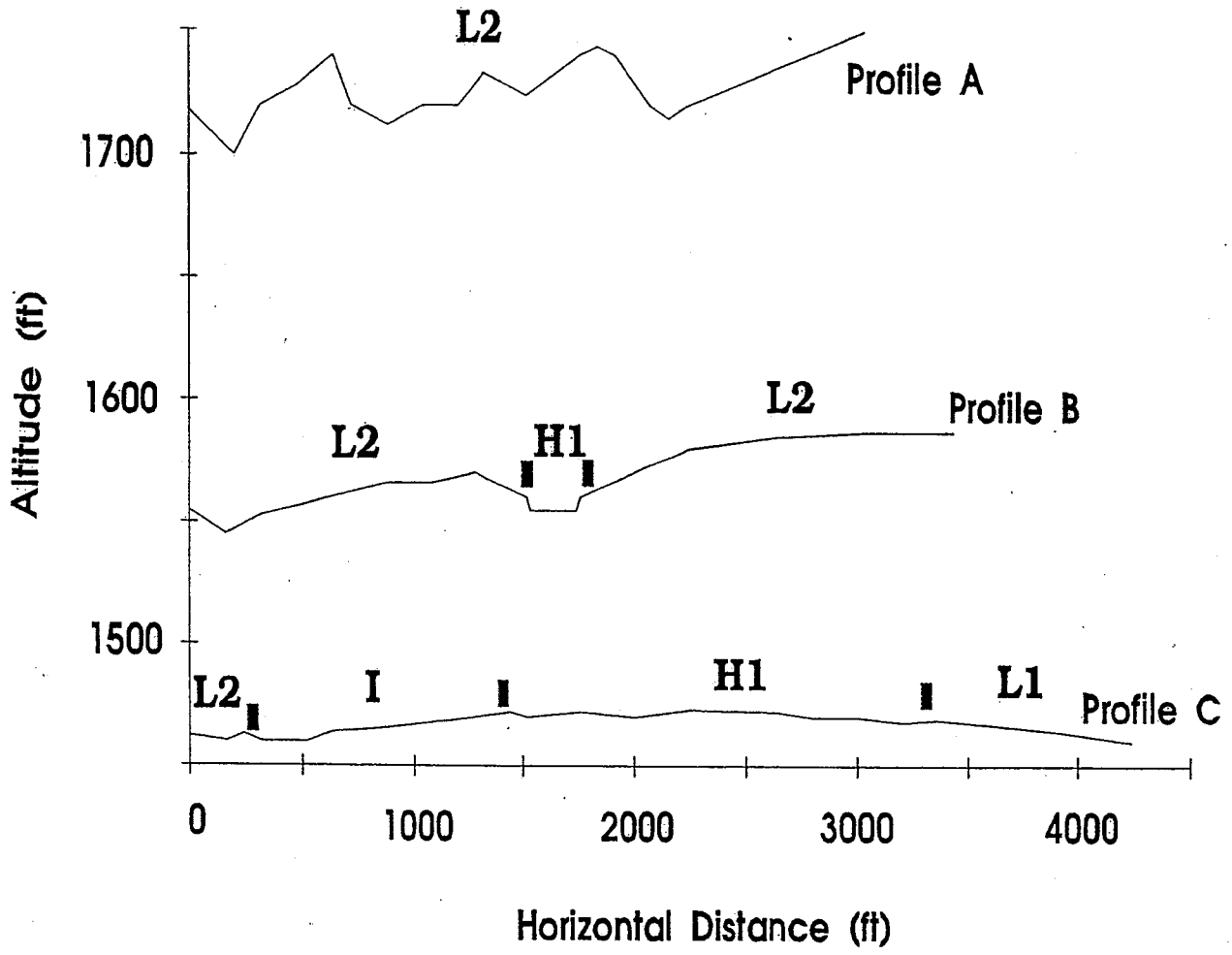


Figure 1. Topographic profiles showing changes in the extent of flood-prone areas downstream and away from the mountains. Profiles were constructed perpendicular to a large stream draining the western side of the White Tank Mountains. Flood-hazard zones are discussed in the text.

a) Upper piedmont area, where channels are deeply entrenched and flood-prone areas are very limited.

b) Transition to the middle piedmont, where flood-prone areas are still of limited extent but topographic confinement of channels is much less.

c) Middle piedmont area, where flood-prone areas are extensive, there is minimal topography on active alluvial fans, and there is little relief between areas that have been flooded recently and those that have not been flooded for 10,000+ years.

a silt- and clay-rich soil layer (Dohrenwend, 1987; Vanden Dolder, 1992). Desert pavements are generally most closely packed on relatively old alluvial surfaces; they are more open and poorly developed on intermediate aged surfaces. Young alluvial surfaces that have been flooded within the past few thousand years do not have desert pavements because surface sediments have been recently reworked by floodwaters. As noted above, desert pavements can be disrupted by animal activity or vegetation. The best developed desert pavements in Arizona are in relatively arid areas, where little vegetation grows on the alluvial surfaces.

Rock Varnish. Rock varnish forms on pebbles and cobbles at the land surface; these pebbles and cobbles are often incorporated into a desert pavement. Rock varnish that forms on rock surfaces exposed to the atmosphere is a brown to black patina composed of manganese oxides and clay minerals precipitated on the rock surface by microbial organisms (Dorn and Oberlander, 1982; Vanden Dolder, 1992). As the surface exposed to the atmosphere darkens, the undersides of the pebbles and cobbles are simultaneously reddened by the accumulation of iron oxides and clay minerals. The varnishing process is very slow in arid regions and only occurs on gravel that is continuously exposed at the surface and has not been moved for thousands of years. Rocks with weakly developed varnish indicate that a surface has not been subject to significant flooding for thousands of years; rocks with well-developed varnish have not been disturbed by flooding for tens to hundreds of thousands of years. Young surfaces that have been flooded in the past few thousand years are unvarnished because the rocks have not been in place long enough to develop varnish.

Soil Development. Soil development generally increases with the age of an alluvial surface. When the accumulation of stream deposits on a land surface ceases, the sediment beneath the surface begins to be altered into distinct horizons by soil-forming processes. The most important process that leads to the development of soils on the piedmonts of Arizona is the accumulation of material from the atmosphere (windblown dust and calcium carbonate dissolved in rainwater) in the first 1 to 2 m (3 to 6 ft) below the land surface. The ages of these soils can be roughly estimated from the amount of silt, clay, and calcium carbonate that has accumulated in them (Table 2).

Because of accumulation of windblown dust, the first 1 to 10 cm (1 to 4 in.) of sediment beneath alluvial surfaces is typically silt-rich even if the parent material (the original stream deposit) is sand and gravel. Beneath this surface horizon, rainwater percolates into the sediment and alters the parent material, producing a weak fabric in the soil (soil structure) or slight soil reddening or both; this horizon is called a cambic horizon. Suspended clay is also carried from the surface and concentrated in this portion of the soil. As the amount of clay increases with time, the cambic horizon develops into an orange to reddish brown, clay-rich argillic horizon. The strength of cambic or argillic horizon development depends on the age of the surface and climate. Cambic horizons probably form in a few thousand years to 10,000 years in Arizona. Weak argillic horizons probably forme in 10,000 years or more in most areas, and strongly developed argillic horizons have developed over hundreds of thousands of years (Gile and others, 1981; Pearthree and

Estimated Age	Soil Development			Drainage Patterns	Surface Dissection	Surface Topography	Rock Varnish
	Color	Texture	Calcic Horizon				
Late Holocene (< 3 ka)	brown	sand	thin, discontinuous rock coatings	distributary	< 1 m	bars and swales channels	none
Mid- to early Holocene (3-10 ka)	brown to orange	sand to sandy loam	discontinuous to continuous rock coatings	distributary or tributary	< 1 m	bars and swales obvious	minimal brown/ orange
Late Pleistocene (10-150 ka)	brown to orange	loamy sand sandy loam	continuous coatings whitened matrix	tributary	< 3 m	bars and swales well preserved	moderate dark brown/ orange
Late to Middle Pleistocene (150-300 ka)	orange to reddish brown	sandy loam loam	continuous coatings whitened matrix	tributary	< 6 m	bars and swales moderately to poorly preserved	moderate black/ reddish brown
Middle Pleistocene (300-800 ka)	reddish brown	clay	thick coatings locally cemented matrix	tributary	< 6 m	smooth, bars and swales poorly preserved	strong black/ reddish brown
Early Pleistocene (> 800 ka)	orange to white	loam	cemented very thick coatings	tributary	10 to 15 m	erosionally rounded ridges	variable poorly preserved

Table 2. Selected surface properties that change with increasing alluvial surface age around the White Tank Mountains. Estimated ages are in thousands of years old (ka); soil colors and soil textures reported are from the zone of silt and clay accumulation; rock varnish colors are from exposed surfaces/undersides of cobbles.

Calvo, 1987; Bull, 1991). The presence of reddened, clay-rich argillic horizons thus indicate that surfaces have not been subject to significant flooding for at least 10,000 years, and commonly much longer than that.

Comparisons of calcic horizon development on the White Tank Mountains piedmont with other soil sequences in the western United States provide one of the few methods of estimating the ages of the different alluvial surfaces. Calcium carbonate from dust and rainwater gradually precipitates in soils, forming a whitish calcic horizon. Geomorphologists and soil scientists recognize six morphologic stages of calcic-horizon development and have linked these states to soil ages in several areas in the southwestern United States (Machette, 1985; Birkeland and others, 1991). Calcic horizon development varies from fine white filaments of calcium carbonate in young soils to soil horizons completely plugged with calcium carbonate (caliche) in very old soils.

Soil horizons lie beneath the surface and thus must be examined in natural stream cuts, hand-dug soil pits, or backhoe trenches. Although soil development is a very useful characteristic in producing a geologic flood-hazard map, care must be exercised when interpreting soil- and surface-age relationships. A soil exposed beneath a surface may be a buried soil and unrelated to the surface that it is presently beneath. Young deposits on the lower piedmont are commonly only a thin veneer (<30 cm, or 1 ft) over much older soils. As a result, the presence of a well developed calcic horizon on the lower piedmont does not necessarily indicate that the overlying surface has not been flooded for a long time, unless other surface characteristics confirm that the surface is old.

Depositional Topography. The degree of preservation of original depositional surface features is another key to determining the age of an alluvial surface. One such feature, bar-and-swale topography, is common on alluvial surfaces of Arizona. Gravel bars deposited during large floods are separated by intervening sand-filled channel swales or troughs. After a surface is isolated from major flood events,it is gradually smoothed as bars are eroded and swales are filled in by windblown dust and sediment derived from adjacent bars. Bar-and-swale topography is readily apparent on alluvial surfaces that have been deposited within the past 10,000 years, but is more subdued on increasingly older alluvial surfaces; very old surfaces typically are quite smooth. It is important to note, however, that development of bar-and-swale topography also depends on the size of bedload particles conveyed by a stream. Streams that convey coarse bedloads (cobbles and boulders) typically have obvious, well-developed bars and swales. This topography is not evident on young, flood-prone surfaces on the lower piedmont because very little coarse-grained bedload is present far from the mountains.

Vegetation. The distribution of plant types is commonly associated with the age of alluvial surfaces. Vegetation is also controlled by elevation and rock type, however, so vegetation patterns are not as clear an indicator of surface ages as are some of the aforementioned characteristics. On the White Tank Mountains piedmonts, creosote and brittle bush are pervasive on all surfaces; thus their distributions cannot be used as an indicator of surface age. Saguaro, palo verde, ironwood, cane cholla, and barrel cactus are not as pervasive,

but do not correlate definitively with alluvial surfaces of different ages. Jumping cholla, however, is abundant only on old flood-free surfaces; its distribution probably correlates with clay-rich soils.

Alluvial-Surface Characteristics -- Indicators of Recency of Flooding

The surficial characteristics discussed above impart a distinctive appearance to alluvial surfaces of a given age. In general, alluvial surfaces that have been flooded within the past 10,000 years are dominated by characteristics related to primary depositional processes. These characteristics include (1) distributary drainage patterns, (2) minimal entrenchment of stream channels below the surface, (3) brown surface colors, (4) little or no soil development, (5) obvious bar and swale topography; and (6) no desert pavement or rock varnish; . Old alluvial surfaces that have not been subject to substantial flooding for hundreds of thousands of years are typically characterized by (1) well-developed, moderately to deeply entrenched, dendritic tributary drainages, (2) reddish, whitish, or dark brown surface colors, (3) strongly developed soil profiles, (4) subdued, smoothed bar-and-swale topography, and (5) dark-brown to black varnish on exposed rock surfaces and orange to red varnish on the undersides of rocks. If local conditions are conducive, old alluvial surfaces may also have well-developed desert pavements. Characteristics of surfaces of intermediate age, which have not been flooded for tens of thousands of years, fall within the two extremes.

We estimated the ages of alluvial surfaces around the White Tank Mountains by comparing their characteristics, especially soil development (Table 2), with those of dated surfaces in similar climatic regions. Other means of directly dating surfaces include radiocarbon dating when carbon fragments are found and archaeological remains when present.

A single surface characteristic is insufficient to conclusively estimate surface age, because some of the characteristics mentioned above as distinctive of young surfaces may be attributes of old surfaces and vice versa. Not all the characteristics distinctive of surfaces of a certain age need be present to assign a surface that age designation, however. For example, deep dissection of a surface clearly indicates that it is not flood prone, but the absence of dissection does not necessarily mean the surface is young and flood prone. Large areas on the lower and middle piedmonts of the White Tank Mountains have not been disturbed by flooding for more than 10,000 years, even though the surfaces are less than 1 meter (3 ft) above the channel bottoms. In these areas, well-developed pavement, varnish, and soils are better indicators of surface age. In general, certain characteristics are only present on a surface of a given age, and are reliable indicators of the time since a surface was last flooded. Other characteristics are not always present or are attributes of surfaces of different ages (Table 3). A final surface-age designation is based on all of the surface characteristics outlined above.

Alluvial surfaces on the piedmonts of the White Tank Mountains range in age from

Flood Hazard	Surface Age	Characteristic Category*	Surface Characteristic
Low	10,000+	1	Mod. to well developed pavement Mod. to well developed varnish Mod. to strong soil development
		2	Deep dissection (>4 ft.)
		3	Abundant jumping cholla Reddish or whitish surface Mod. to closely spaced drainage Dendritic tributary drainage Absent or subtle bar and swale
Intermediate	1,000-10,000	1	Weak to mod. soil development Weakly developed pavement
		2	Incipient desert varnish Obvious bar and swale
		3	Dendritic tributary drainage Shallow dissection (<3 ft.) Mod. to widely spaced drainage
High	0-3,000	1	Incipient soil development No desert pavement
		2	Distributary drainage Fresh bar and swale
		3	Shallow dissection (<3 ft.) No desert varnish

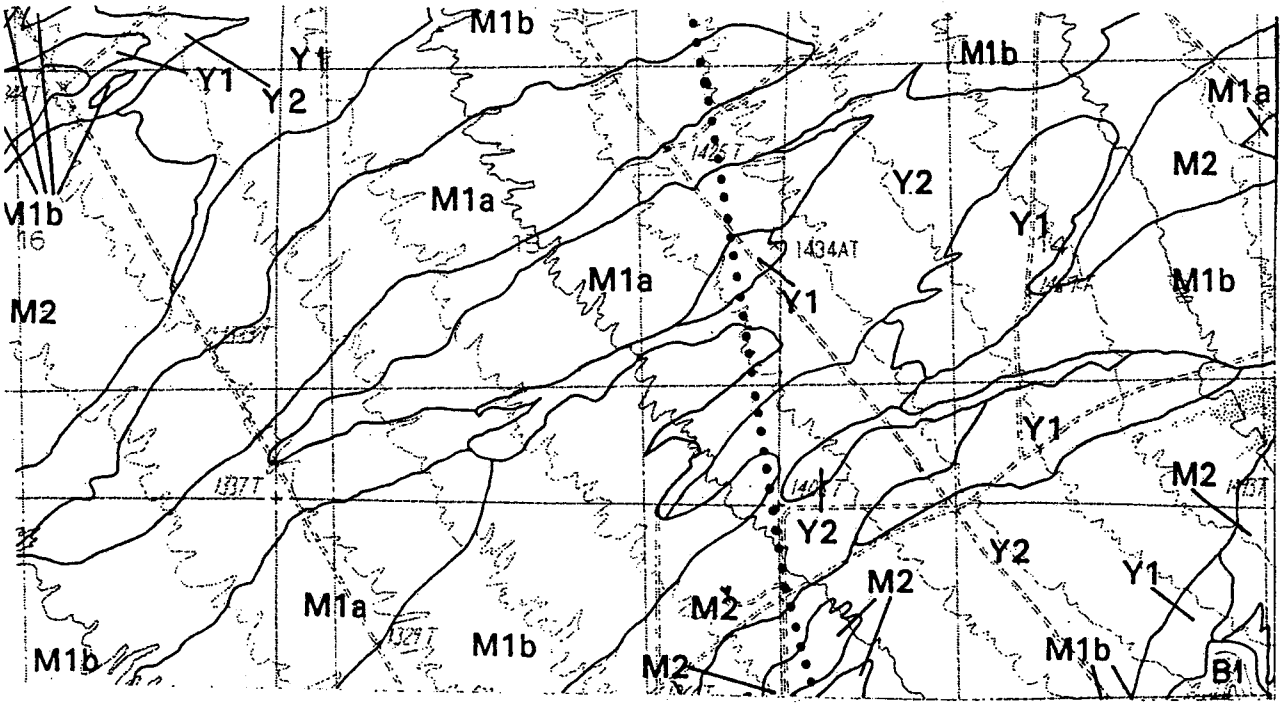
* Characteristic Category 1 - These characteristics are indicative of surface age and are almost always present on the surfaces of given age. If the characteristic is absent, the surface is most likely of a different age.

Characteristic Category 2 - These characteristics are indicative of surface age but are not always present. Absence of these characteristics from the surface does not imply the surface is of another age (as in Category 1).

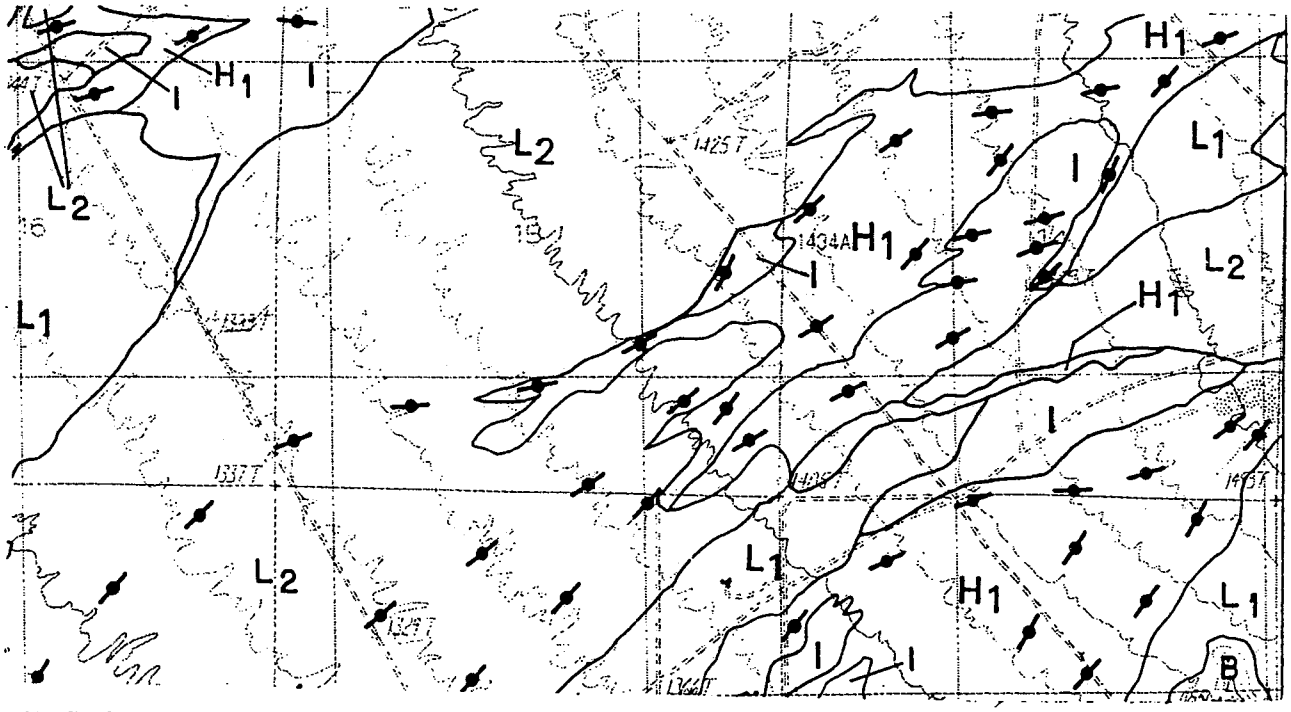
Characteristic Category 3 - These characteristics are almost always present on the surface but are not indicative of surface age, because they are found on other surfaces as well. However, if the characteristic is absent the surface is most likely of another age.

Table 3. Characteristics used to delineate three flood hazard zones on alluvial piedmonts around the White Tank Mountains. Note that the opposite of a characteristic does not necessarily imply the opposite flood hazard (i.e. shallow dissection does not always imply the surface is flood prone).

Figure 2. Development of a flood-hazard map using geologic and geomorphic data.



a) Map of alluvial surfaces covering part of the western piedmont of the White Tank Mountains. Surfaces ages (in years) are as follows: Y2, <3,000; Y1, 1,000 to 10,000; M2, 10,000 to 150,000; M1b, 150,000 to 300,000; M1a, 300,000 to 800,000.



b) Geologic flood-hazard map of the same area. Heavy dots with lines show approximate locations of channels of major drainages that head in adjacent mountains. Surface age, proximity to major drainages, local topographic relief, and evidence of channelized flow were used to delineate flood-hazard zones. See text for description of flood-hazard categories.

modern to 1,000,000 years old or more (Table 2; see Field and Pearthree, 1991, for a more complete discussion of surface characteristics and surface-age estimates). We differentiated and mapped the following alluvial surfaces: late Holocene, < 3,000 years old; late to early Holocene, 1,000 to 10,000 years old; late Pleistocene, 10,000 to 150,000 years old; late middle Pleistocene, 150,000 to 300,000 years old; early middle Pleistocene, 300,000 to 800,000 years old, and early Pleistocene, > 800,000 years old.

Development of Flood-Hazard Zones

We integrated maps of alluvial surfaces of different ages (Field and Pearthree, 1991) with other geomorphic information to delineate flood-hazard zones around the White Tank Mountains (Figure 2; Plate 1). Assessments of flood hazards were based on (1) the age of the alluvial surface; (2) local topographic relief between the surface and active channels; (3) proximity to active channels, especially channels of major distributary flow systems; and (4) the size, number, and character of active channels in the area.

The most important data we used to develop the flood hazard maps was the distribution of surfaces of different ages. The critical assumption of our analysis is that areas that have been subject to flooding over the past few thousand years are the areas that are likely to be flood prone. The potential for flooding in areas that have not been flooded for at least 10,000 years is considered to be very low, unless local circumstances suggest flow patterns have changed very recently. Areas composed of surfaces of 1,000 to 10,000 years old are considered to have intermediate or high flood potential, depending on their proximity to active channels or active alluvial fans.

Our delineation of flood-hazard zones was also based on drainage patterns, local topography, and the character of active channels. We considered areas that are within or near distributary drainage networks of the larger washes to be relatively more flood prone than areas that are spatially separated from these networks. We also incorporated local topographic relief between active channels and adjacent alluvial surfaces into our assessments. The flood potential on old surfaces that are several meters or more (5 to 10+ ft) higher than adjacent active channels is considered to be very low. In contrast, if little relief separates old surfaces and active channels, the flood potential on the old surfaces is considered to be higher because of the possibility that flooding patterns might change and affect the old surface. We subdivided flood potential in areas of extensive young alluvial surfaces based on the size and abundance of channels. Large or abundant channels indicate that relatively deep, high velocity flows are an important element of flooding. Furthermore, the positions of these channels may shift occasionally during large floods (CH2MHill, 1991), subjecting the areas covered by young deposits between the existing channels to sheet flooding or channelized flooding. Areas of extensive young deposits where channels are not evident are subject primarily to shallow sheetflooding. These areas are clearly flood prone, but the character of the flooding is far less threatening.

The characteristics of the five flood-hazard zones are summarized below.

H1 - Very high flood potential. Extensive young deposits; distributary channel system very evident. Potential for localized, high-velocity, relatively deep, channelized flows and sheetflooding; some potential for drastic shifts in channel positions.

H2 - High flood potential. Extensive young deposits, but channels are small or nonexistent. Predominantly shallow sheetflooding; channelized flow very limited in extent; broad areas probably inundated in large floods.

I - Intermediate flood potential. Areas have not been flooded recently. Near or within distributary drainage systems, and little topographic relief separates these areas from active alluvial fans or channels. Could become flood prone with relatively modest changes in channel configurations.

L1 - Relatively low flood potential. Areas have not been flooded for at least 10,000 years. Flooding has been confined to channels and immediately adjacent terraces for that long. However, these areas are near or within distributary drainage networks, and typically little topographic relief separates L1, I, H2, and H1 areas. L1 areas should be carefully evaluated to determine if potential for shifts in channel configurations or depositional patterns could result in these areas becoming flood prone.

L2 - Very low flood potential. Areas have not been flooded for at least 10,000 years, and typically for much longer. Drained by tributary streams that head on the piedmont. Streams entrenched 1 to 10 m (3 to 30 ft) below inactive alluvial surfaces; spatially separate from or topographically isolated from distributary drainage networks. Flood-prone areas limited to channels and adjacent low terraces.

Distribution of Flood Hazards on the Piedmonts of the White Tank Mountains

The distribution of flood hazards varies widely across the piedmonts of the White Tank Mountains. On upper piedmonts, flood-prone surfaces are restricted to channel bottoms and low terraces set well below older flood free surfaces (Figure 1a, 1b; Plate 1). Only the largest channel bottoms are mappable at this scale (1:24,000), but smaller, unmapped channel bottoms are also subject to high-velocity channelized flow (H1 flood hazard).

The largest areas with the highest flood potential (H1) are associated with active alluvial fans on the middle piedmont west and south of the White Tank Mountains (Figure 1c; Plate 1). These are areas where entrenched large drainages become unconfined downstream, distributing floodwaters into several smaller channels and sheetfloods. Extensive very young deposits (<3,000 years old) and distributary channel networks indicate that these areas are active alluvial fans. Some areas within the distributary-flow

networks have not been subject to significant flooding for at least 1,000 years and are somewhat isolated from the distributary channels; the potential for flooding in these areas is less (intermediate flood potential; category I). Downstream from the active alluvial fans, distributary channels typically become reconfined into fairly narrow passages between older surfaces that have not been flooded significantly for at least 10,000 years. We have assigned a low flood hazard potential (L1) to areas where the relief between the reconfined channels and adjacent old alluvial surfaces is less than one meter (3 ft); we assigned the lowest flood potential (L2) to areas where the relief is more than one meter (3 ft). Widespread zones of fairly high flood hazards (H2) are present on the middle piedmont north of the White Tank Mountains (Plate 1a and 1b). In this area several large drainages become unconfined and floodwaters spread out into low-velocity sheetfloods.

On the lower piedmont, many of the major drainages again become unconfined and floodwaters spread out into sheetflows (Plate 1). High-velocity, channelized flood hazards (H1) are restricted to very small portions of the lower piedmont, but areas prone to shallow flooding (H2) are ubiquitous. A single large flood probably will not inundate the entire lower piedmont, but the absence of substantial relief across the lower piedmont makes it difficult to predict where the next sheetflow will occur.

Conclusions

The White Tank Mountains flood hazard map demonstrates the value of using geomorphic analyses and mapping to delineate flood potential on desert piedmonts. A single geomorphic characteristic, by itself, cannot conclusively establish the age of a piedmont surface. Suites of characteristics identifiable on aerial photographs and in the field, however, are diagnostic of surface age. Alluvial surfaces of different ages on desert piedmonts can be readily mapped using these diagnostic suites of characteristics. By integrating surface age information with topographic data and the character of drainage networks, geologists can reliably delineate flood potential zones across the entire piedmont. Similar detail and reliability is not possible with current numerical hydraulic models. Geologic and geomorphic studies, therefore, should be an integral part of any flood hazard management project on desert piedmonts.

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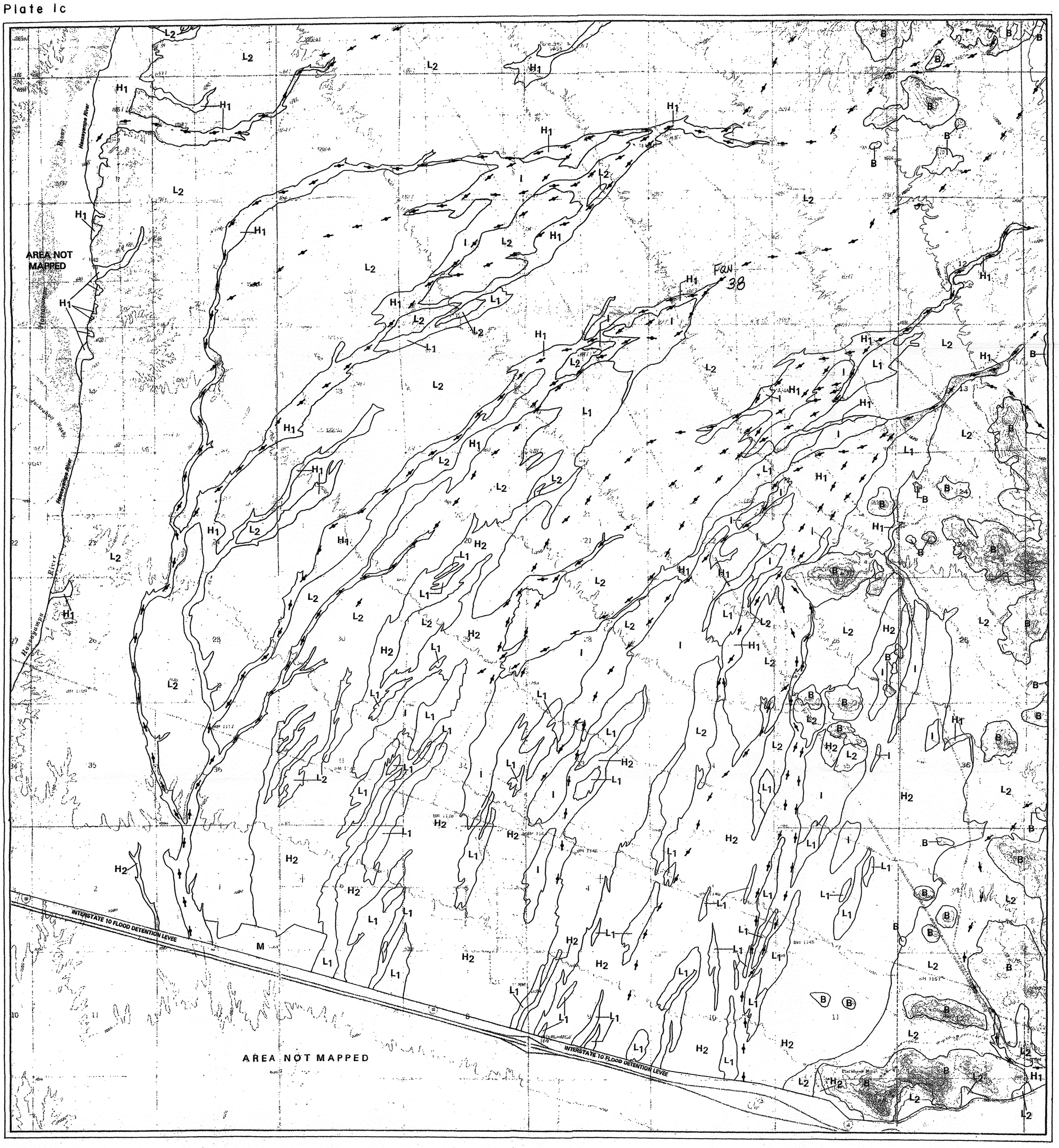
Plate Ic



White Tank Mountains Flood Hazard Map - SW Section

by
John J. Field and Philip A. Pearthree
1991

E X P L A N A T I O N

Map Unit Description

H_1 **Flood Hazard:** Highest; high-velocity channelized flow and sheetflow

Distribution: *Entrenched reaches of major drainages and distributary flow areas on middle and lower piedmont*

Soil Group*: Torrifluvents

Channel Pattern: Braided (anastomosing) or distributary

Surface Relief: Less than 2 ft; bar and swale topography

Surface Texture: Silt to very gravelly sand

Surface Color: Dull yellow-orange (10YR 6/4)

Desert Varnish: Unvarnished gravel

Vegetation:** Brittle bush, rabbit bush, bunch grass, creosote

Estimated Surface Age: Historical to late Holocene (0 to 2,000 yrs old)

H_2 **Flood Hazard:** Moderately high; dominantly sheetflow with minor channel flows

Distribution: Restricted to lower piedmont and small drainages heading on the piedmont

Soil Group: Torrifluvents

Channel Pattern: Distributary; incipient dendritic drainage in less active areas

Surface Relief: Less than 2 ft with uncommon, 4-ft arroyo cuts; smooth surface

Surface Texture: Sandy silt with 10% scattered gravel; less active areas have granule to pebble lag

Surface Color: Dull yellow-orange (10YR 6/4)

Desert Varnish: Unvarnished gravel

Vegetation: Creosote, brittle bush

Estimated Surface Age: Historical to late Holocene (0 to 2,000 yrs old)

I **Flood Hazard:** Intermediate; has not been subject to significant flooding for more than 1,000 yrs, but lack of topographic relief between these surfaces and active surfaces (H_1 and H_2) suggests that they could become flood prone with channel filling, avulsion, or human disturbance

Distribution: Adjacent to H_1 and H_2 in distributary flow areas and on lower piedmont

Soil Groups: Torrifluvents and Camborthids

Channel Pattern: Widely spaced, dendritic tributary drainages

Surface Relief: Less than 4 ft in distributary flow areas and less than 3 ft on lower piedmont; bar and swale topography well preserved in distributary flow areas

Surface Texture: Open desert pavement consisting of granules and small cobbles

Surface Color: Dull yellow-orange (10YR 6/4)

Desert Varnish: Unvarnished to weakly developed over 10% of the surface - brownish black (7.5YR 3/1) on top and orange (7.5YR 7/6) on undersides

Vegetation: Brittle bush, creosote, palo verde

Estimated Surface Age: Late Holocene to latest Pleistocene (1,000 to 15,000 yrs old)

L_1 **Flood Hazard:** Low; localized sheetflooding possible; flooding might occur if channels are altered by human disturbance because of low relief downslope from major distributary flow areas

Distribution: Downslope from and adjacent to distributary flow areas on middle and lower piedmont

Soil Groups: Camborthids and Haplargids

Channel Pattern: Moderately spaced, dendritic tributary drainages

Surface Relief: 1 to 10 ft; fairly smooth subdued bar and swale topography

Surface Texture: Open to closed desert pavement consisting of granules and cobbles

Surface Color: Bright brown (7.5YR 5/6) to orange (7.5YR 6/6)

Desert Varnish: Weakly to moderately developed over 50% of surface - brownish black (7.5YR 2/2) to grayish brown (7.5YR 4/2) on top and dull orange (5YR 6/4) to reddish brown (2.5YR 4/6) on undersides

Vegetation: Brittle bush, creosote, cane cholla

Estimated Surface Age: Latest Pleistocene to middle Pleistocene (15,000 to 250,000 yrs old)

L_2 **Flood Hazard:** Lowest; restricted to small channels and localized sheetflooding

Distribution: Upper and middle piedmont and adjacent to Hassayampa River

Soil Groups: Haplargids and Durorthids

Channel Pattern: Closely to widely spaced, dendritic tributary drainages; rounded interfluves in areas of highest relief

Surface Relief: 5 to 40 ft; fairly smooth surface; uncommon bar and swale topography

Surface Texture: Closed desert pavement consisting of cobbles and pebbles; uncommon salt-shattered cobbles; in places, surface is denuded and pedestalled

Surface Color: Dull orange (7.5YR 6/4 to 5YR 6/3)

Desert Varnish: Well developed over 50 to 100% of undenuded surfaces - black (5YR 1.7/1) on top and dark red (10R 3/6) to dull orange (7.5YR 7/4) on undersides

Vegetation: Jumping cholla, brittle bush, creosote

Estimated Surface Age: Late Pleistocene to Pliocene (50,000 to 1,000,000+ yrs old)

M **Flood Hazard:** Mechanized disturbance; flood hazard unknown

B **Flood Hazard:** Bedrock outcrops; flood hazard low, but localized slope wash and debris flows possible in steepest areas

* Soil groups are taken from the Soil Conservation Service survey of the Aguila-Carefree area

** Only dominant plant types are listed

Channel bottoms of larger drainages heading in the White Tank Mountains

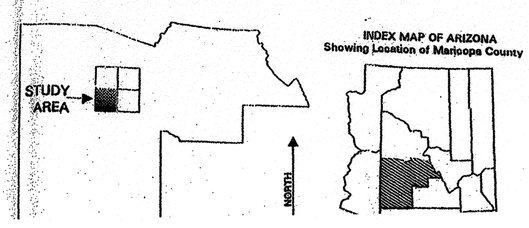
SCALE 1:24,000

1 .5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

TOPOGRAPHIC CONTOUR INTERVAL 5, 10, 20, 40 FEET



G.3 Ayres Associates Stage 1 and Stage 2 Analysis and Mapping

Pertinent excerpts of the *Final Report Geomorphic Evaluation and Landform Stability Assessment Buckeye/Sun Valley Area Drainage Master Study* (Stage 1 Sub-task 2.6.2.2 and Stage 2 Sub-task 2.6.3.2) Contract No. FCD 2002C027 May 2005 prepared by Ayres Associates

FINAL REPORT

Geomorphic Evaluation and Landform Stability Assessment
Buckeye/Sun Valley Area Drainage Master Study

Contract No. FCD 2002C027

Prepared for:

Flood Control District of Maricopa County
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May 2005

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TABLE OF CONTENTS

1. PURPOSE 1.1
2. SCOPE OF WORK 2.1
3. PROJECT BACKGROUND 3.1

3.1 Piedmont Landform Delineation 3.2
3.2 Landform Stability Assessment 3.2
3.3 Existing Conditions Assessment of Primary Washes 3.7

3.3.1 Caliche (Calcic Soils) 3.7

4. METHODOLOGY 4.1

4.1 Landform Identification, Delineation, and Mapping 4.1
4.2 Aerial Photography Analysis 4.1
4.3 Field Reconnaissance 4.3

5. PIEDMONT LANDFORM DELINEATIONS AND VERIFICATION 5.1

5.1 Verification Site #1 ..... 5.3
5.2 Verification Site #2 ..... 5.3
5.3 Verification Sites #3, #4, and #5 ..... 5.3
5.4 Verification Sites #6, #7, and #8 ..... 5.5
5.5 Summary 5.7

6. LANDFORM STABILITY ASSESSMENT 6.1

6.1. Active Alluvial Fans 6.1

6.1.1 BSV Site 1 ..... 6.3
6.1.2 BSV Site 2 ..... 6.4
6.1.3 BSV Site 3 ..... 6.5
6.1.4 BSV Site 4 ..... 6.5
6.1.5 BSV Site 5 ..... 6.6
6.1.6 BSV Site 6 ..... 6.8
6.1.7 BSV Site 7 ..... 6.9
6.1.8 BSV Site 8 ..... 6.10
6.1.9 BSV Site 9 ..... 6.11
6.1.10 BSV Site 10 ..... 6.11
6.1.11 BSV Site 11 ..... 6.12
6.1.12 BSV Site 12 ..... 6.13
6.1.13 BSV Site 13 West 6.13
6.1.14 BSV Site 13 East 6.15
6.1.15 BSV Site 14 ..... 6.15
6.1.16 BSV Site 15 ..... 6.17
6.1.17 USGS Site 36 (White Tank Fan) 6.17
6.1.18 USGS Site 37 ..... 6.18
6.1.19 US GS Site 38 ..... 6.19
6.1.20 USGS Site 39 ..... 6.20

TABLE OF CONTENTS (continued)

6.1.21 Skyline Wash Fan 6.21
6.1.22 Skyline Wash Tributary Fan 6.22

6.2 Other Unstable Areas 6.22
6.3 Summary 6.26

7. EXISTING CONDITIONS ASSESSMENT OF PRIMARY WASHES 7.1

7.1 Flow Splits, Braiding, and Multiple Flow Paths 7.1
7.2 Aerial Photography Analysis 7.1
7.3 Field Reconnaissance 7.26
7.4 General Descriptions of Primary Washes 7.31
7.5 Summary 7.43

8. REFERENCES 8.1

APPENDIX A - Piedmont Landform Delineation Maps ..... --
APPENDIX B - Piedmont Landform Stability Assessment Maps ..... --
APPENDIX C - Existing Conditions Assessment of Primary Washes Figures ..... --
APPENDIX D - Soils Map Example and Soils Descriptions ..... --
APPENDIX E - Surficial Geology Map Example and Geologic Unit Descriptions ..... --
APPENDIX F - Flood Hazards Map Example and Hazard Descriptions ..... --

LIST OF FIGURES

Figure 1.1. Location map for Areas 2 and 3 of the Buckeye/Sun Valley ADMS 1.1

Figure 4.1. Annual and monthly maximum precipitation (1905-2003) for Buckeye, Arizona 4.2

Figure 4.2. All-Terrain-Vehicle (ATV) used for field verification of piedmont landforms, identification of stable and unstable areas, and primary wash assessments. 4.4

Figure 4.3. Trimble GeoXT handheld GIS-based GPS unit (arrow) mounted on an ATV. 4.4

Figure 5.1. View looking downstream at Verification Site #1 south of USGS Site 36 alluvial fan 5.3

Figure 5.2. View looking east showing inactive fan surface of Verification Site #2 ..... 5.4

Figure 5.3. Drainage texture of Verification Site #2 ..... 5.4

Figure 5.4. Tremant soils of the inactive alluvial fan at Verification Site #2 ..... 5.5

Figure 5.5. Drainage texture at Verification Site #5 ..... 5.5

Figure 5.6. Drainage texture at Verification Site #6 ..... 5.6

Figure 5.7. Well-developed desert pavement and desert varnished stones on a relict fan surface (Verification Site #6) 5.6

Figure 5.8. Close-up of desert pavement and stones with well-developed desert varnish on a relict fan surface (Verification Site #6) 5.7

Figure 5.9. View looking south showing the pediment surface at Verification Site #7 ..... 5.8

Figure 6.1. View looking downstream from the apex of the active alluvial fan at BSV Site 1 ..... 6.4

Figure 6.2. Panoramic view to northwest from hill overlooking BSV Site 1 ..... 6.4

Figure 6.3. View looking downstream from the middle of BSV Site 2 ..... 6.4

Figure 6.4. View looking downstream from the hydrographic apex of BSV Site 4 ..... 6.5

Figure 6.5. View looking downstream from the middle of the active zone of BSV Site 4 ..... 6.6

Figure 6.6. View looking upstream from the middle of BSV Site 4 ..... 6.7

Figure 6.7. View looking downstream from the hydrographic apex of the fan at BSV Site 5 ..... 6.7

LIST OF FIGURES (continued)

Figure 6.8. View looking downstream from the main diffluence of the inset fan at BSV Site 5 ..... 6.7

Figure 6.9. Panoramic view looking upstream from the Sun Valley Parkway culvert crossing showing the active fan at BSV Site 6 ..... 6.8

Figure 6.10. Aerial photo (2003) of the active alluvial fan of BSV Site 6 on the upstream side of Sun Valley Parkway 6.8

Figure 6.11. View looking downstream toward the Sun Valley Parkway culvert crossing showing the extensive aggradation of the culvert barrels from the active fan at BSV Site 6 ..... 6.9

Figure 6.12. View looking downstream from the hydrographic apex at BSV Site 7 ..... 6.9

Figure 6.13. View looking downstream from the hydrographic apex at BSV Site 8 ..... 6.10

Figure 6.14. View east-southeast from a hill overlooking the inset fan at BSV Site 9 ..... 6.11

Figure 6.15. View looking downstream from the hydrographic apex at BSV Site 10 ..... 6.12

Figure 6.16. View looking downstream from the hydrographic apex at BSV Site 11 ..... 6.12

Figure 6.17. Aerial Photo (2003) showing the active fan areas of BSV Sites 13 West and East 6.14

Figure 6.18. View looking west from a hill overlooking the downstream end of the active fan at BSV Site 13 West 6.14

Figure 6.19. View looking downstream from the hydrographic apex of BSV Site 13 East fan 6.15

Figure 6.20. Aerial photograph from 1953 showing the active fan area of BSV Site 14 ... 6.16

Figure 6.21. View downstream from the apex of the active fan at BSV Site 14 ..... 6.16

Figure 6.22. Aerial photograph from 1953 showing the active fan area of BSV Site 15 ... 6.17

Figure 6.23. View downstream from the apex of the active fan at BSV Site 15 ..... 6.18

Figure 6.24. View looking downstream from the hydrographic apex of the active White Tank Fan (USGS Site 36) 6.18

Figure 6.25. View looking downstream from the hydrographic apex at USGS Site 37 ..... 6.19

Figure 6.26. View looking downstream from the apex of USGS Site 38 ..... 6.19

LIST OF FIGURES (continued)

Figure 6.27. Aerial photo (2003) showing the mapped active fan (purple), inactive fan (green), relict fan (orange) areas at USGS Site 38 ..... 6.20

Figure 6.28. View looking downstream from the hydrographic apex at USGS Site 39 ..... 6.21

Figure 6.29. View looking west from the southern branch of the USGS Site 39 active alluvial fan in the area that was revised during the field investigation..... 6.22

Figure 6.30. View looking upstream showing the braided pattern of a wash entrenched into a relict fan 6.23

Figure 6.31. View of a well defined throughflow channel that diverges into two primary channels and several smaller channels 6.24

Figure 6.32. View of a throughflow channel that diverges into multiple braided channels, but still confined within well-defined boundaries (yellow lines) before converging downstream..... 6.24

Figure 6.33. View of a throughflow channel that diverges into braided and undefined flow paths as a result of localized aggradation, loss of channel capacity, and anthropogenic changes 6.25

Figure 6.34. Aerial photos from 1953 and 2003 showing area of anastomosed flow distribution (yellow boundaries) with zones of braided and split flow..... 6.27

Figure 6.35. Schematic of 2003 aerial photo from Figure 5.5 showing area of anastomosed flow distribution with zones of braided and split flow 6.28

Figure 6.36. View looking upstream showing the loss of channel capacity and undefined overland flow on an inactive alluvial fan surface 6.28

Figure 6.37. Aerial view of the loss of channel capacity and undefined overland flow on an inactive alluvial fan surface in Area 4 just east of Sun Valley Parkway and Wagner Wash 6.29

Figure 7.1. Comparison of 1953 and 2003 aerial photos for area around Primary Wash 3 between BSV Site #1 and BSV Site #2 active alluvial fans (red) showing unstable areas of high (orange) hazard 7.3

Figure 7.2. Comparison of 1953 and 2003 aerial photos for area around Primary Wash 3 downstream of the BSV Site #1 active alluvial fan (red) showing unstable areas of high (orange) hazard 7.4

Figure 7.3. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 6, 7, and 7 East showing unstable areas of moderate (yellow) and high (orange) hazard and a dam on Primary Wash 6 ..... 7.5

LIST OF FIGURES (continued)

Figure 7.4. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 7, 9, and 10 showing unstable areas of moderate (yellow), high (orange), and extreme (red) hazard 7.6

Figure 7.5. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 13 and 14 showing unstable areas of moderate (yellow) hazard..... 7.7

Figure 7.6. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 16 and 17 showing unstable areas of moderate (yellow) and high (orange) hazard 7.9

Figure 7.7. Comparison of 1953 and 2003 aerial photos for parts of Primary Wash 16 and surrounding areas showing unstable areas of moderate (yellow) hazard and wing dam 7.10

Figure 7.8. Comparison of 1953 and 2003 aerial photos for parts of Primary Wash 16 and surrounding areas showing unstable areas of moderate (yellow) and high (orange) hazard 7.11

Figure 7.9. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 17 and 17T and surrounding areas showing unstable areas of moderate (yellow) and high (orange) hazard 7.12

Figure 7.10. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 18 and 19 and surrounding areas showing unstable areas of moderate (yellow), high (orange), and extreme (red) hazard 7.13

Figure 7.11. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 18 and 19 and surrounding areas showing unstable areas of moderate (yellow), high (orange), and extreme (red) hazard 7.15

Figure 7.12. Comparison of 1953 and 2003 aerial photos for parts of Primary Wash 19 and surrounding areas showing unstable areas of moderate (yellow) and high (orange) hazard 7.16

Figure 7.13. Comparison of 1953 and 2003 aerial photos for parts of Primary Wash 21 and surrounding areas showing unstable areas of moderate (yellow), high (orange), and extreme (red) hazard 7.17

Figure 7.14. Comparison of 1953 and 2003 aerial photos for parts of Primary Wash 22 and surrounding areas showing unstable areas of moderate (yellow), high (orange), and extreme (red) hazard 7.18

Figure 7.15. Comparison of 1953 and 2003 aerial photos for parts of Primary Washes 23, 24 and 25 and surrounding areas showing unstable areas of moderate (yellow) and high (orange) hazard 7.20

LIST OF FIGURES (continued)

Figure 7.16. Comparison of 1953 and 2003 aerial photos for White Tank Wash (Primary Wash 20) at the confluence with Primary Wash 22 ..... 7.21

Figure 7.17. Comparison of 1953 and 2003 aerial photos for White Tank Wash (Primary Wash 20) upstream of the West Tonopah-Salome Highway 7.22

Figure 7.18. Comparison of 1949, 1953, and 2003 aerial photos for White Tank Wash (Primary Wash 20) downstream of the West Tonopah-Salome Highway 7.23

Figure 7.19. Comparison of 1949, 1953, and 2003 aerial photos for White Tank Wash (Primary Wash 20) upstream of Buckeye FRS #1 ..... 7.23

Figure 7.20. Comparison of 1949, 1953, 1992, and 2003 aerial photos for the area bound by White Tank Wash (Primary Wash 20), Sun Valley Parkway, the West Tonopah-Highway, and Buckeye FRS #1 ..... 7.24

Figure 7.21. Magnified 2003 aerial photo of the development along Primary Wash 24 shown in Figure 7.20 ..... 7.25

Figure 7.22. Magnified 2003 aerial photo of the development and dairy farm along Primary Wash 25 as shown in Figure 7.20 ..... 7.27

Figure 7.23. View looking upstream showing a 3-foot high headcut at the confluence of Primary Wash 25 with Buckeye FRS #1 ..... 7.29

Figure 7.24. View looking downstream on Primary Wash 25 toward Buckeye FRS #1 showing the extensive gullying upstream of the incised channel reach of the wash 7.29

Figure 7.25. View looking upstream showing eroding banks on Primary Wash #3 ..... 7.32

Figure 7.26. View upstream showing high cutbank in relict fan deposits of right valley wall on Primary Wash #21 ..... 7.32

Figure 7.27. View looking upstream showing bank undercutting and failure associated with channel incision on Primary Wash #9 ..... 7.33

Figure 7.28. View looking downstream showing undercut bank in caliche on left bank of Primary Wash #23 due to abrupt change in flow path 7.33

Figure 7.29. View looking upstream on Primary Wash #25 showing high, undercut left bank in relict fan deposits due to flow deflection around sediment and debris deposits (bar) in channel along right bank 7.34

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LIST OF TABLES

Table 3.1. Principle Landforms, Common Soil Types, Typical Geologic Map Units, and Significant Characteristics of Piedmonts in Maricopa County 3.3

Table 3.2. Steps for Identification of Piedmont Landforms 3.4

Table 3.3. Selected Indicators of Stable and Unstable Areas 3.5

Table 3.4. Selected Characteristics of Stable and Unstable Flood Hazards of Piedmont Landforms 3.6

Table 3.5. Stages of Calcium Carbonate Morphology in Calcic Soils 3.8

Table 5.1. Landform Verification Sites: Description, Landform, Latitude, and Longitude 5.1

Table 5.2. Representative Landform Sites: Mapped Surficial Geology 5.2

Table 5.3. Representative Landform Sites: Drainage Texture, Drainage Pattern, Desert Pavement and Varnish Development, and Vegetation 5.2

Table 6.1. Location of the Hydrographic Apex for each Mapped Unstable Area 6.2

Table 6.2. Direction of Flow on the Active Alluvial Fan and the Area of Instability of Each Region 6.3

Table 7.1. Factors Associated with Degree of Hazard for Conditionally Unstable Areas 7.2

Table 7.2. Knickzones on Primary Washes 7.28

Table 7.3. Headcuts on Primary Washes 7.28

Table 7.4. Sun Valley Parkway Bridge Culvert Data (Upstream Side) 7.30

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1. PURPOSE

This report is submitted to the Flood Control District of Maricopa County (District) by Ayres Associates in support of Subtask 2.6.6 of the Buckeye/Sun Valley (BSV) Area Drainage Master Study (ADMS) Scope of Work (Contract FCD 2002C027).

The Buckeye/Sun Valley ADMS is being performed for the Flood Control District of Maricopa County and the Town of Buckeye. The purpose of the Buckeye/Sun Valley ADMS is to quantify the extent of drainage, flooding, and erosion problems, sources, and hazards in the Buckeye/Sun Valley area, and develop preliminary solutions to mitigate the identified concerns. Arizona Revised Statutes Title 48, Chapter 21, requires the Board of Directors to identify flood control problems and prepare plans that, when implemented, will eliminate or minimize flooding problems.

Task 2.6 represents the Geomorphic Evaluation and Landform Stability Assessment portion of the Scope of Work (SOW). The purpose of Task 2.6 is to provide a qualitative assessment of potential erosion and sedimentation hazards of primary washes, lateral and vertical stream instability, and piedmont landform stability within the drainage networks of Area 3 (Buckeye Structures) and Area 4 (North Sun Valley) of the Buckeye/Sun Valley ADMS watershed (**Figure 1.1**).

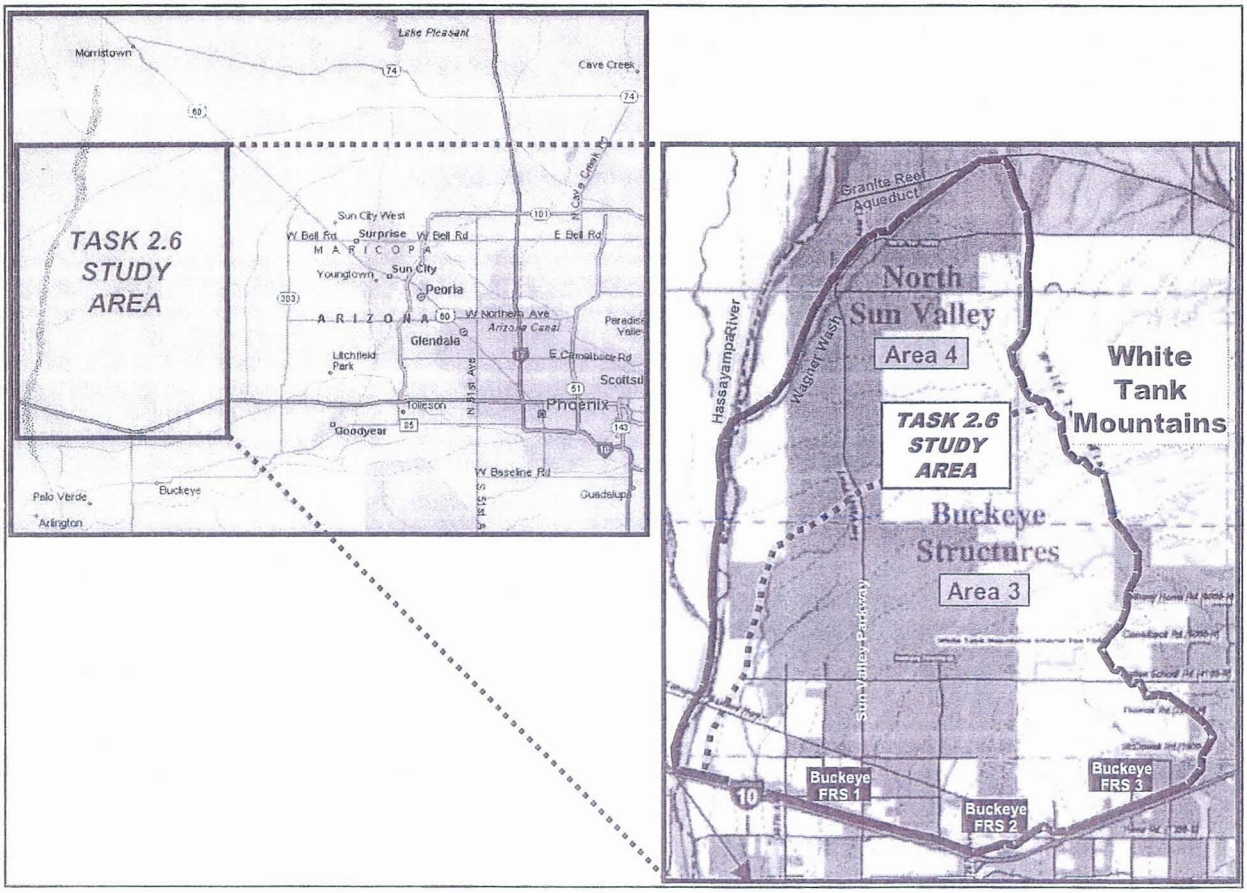

Figure 1.1. Location map for Areas 2 and 3 of the Buckeye/Sun Valley ADMS.

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2. SCOPE OF WORK

This report is a combination of three technical memos previously submitted to the District in fulfillment of Subtasks 2.6.2, 2.6.3, and 2.6.4 of the BSV ADMS Scope of Work. The following report documents the methodology and factors measured by Ayres Associates using the Stage 1 and 2 Analyses of the Piedmont Flood Hazard Assessment For Flood Plain Management User's Manual (PFHAM) (Hjalmarson 2003) per SOW Subtasks 2.6.2 and 2.6.3, and documents the qualitative assessment of the existing conditions for 46 primary washes within Areas 3 and 4 per SOW Subtask 2.6.4. Also included is supporting documentation for the Stage 1 and 2 analyses with examples of the various measurements used to identify each landform and unstable area and the conditions along each wash.

The PFHAM Stage 1 methodology provides guidelines for delineating the lateral limits of the various piedmont landforms (Subtask 2.6.2.1). The results of the Stage 1 analysis and mapping included in this report are submitted in fulfillment of Subtask 2.6.2.2. A field verification using the factors listed in the PFHAM was conducted on 2 representative sites for each landform under Subtask 2.6.2.3. Preliminary maps (original scale = 1:18,000) delineating the lateral limits of the piedmont landforms in Areas 3 and 4 are also included as attachments (**Appendix A, Plates 1 through 5**).

The PFHAM Stage 2 methodology provides guideline for assessing piedmont landform stability and delineating unstable landforms (Subtask 2.6.3.1). The results of the Stage 2 analysis and mapping included in this report are submitted in fulfillment of Subtask 2.6.3.2. A field verification using the factors listed in the PFHAM was conducted at sites where unstable landforms were identified under Subtask 2.6.3.3. Preliminary maps (1:18,000) delineating the lateral limits of the stable and unstable landforms in Areas 3 and 4 are also included as attachments (**Appendix B, Plates 1 through 5**).

The primary washes assessed under SOW Subtask 2.6.4 are defined as those intermittent streams and washes delineated by a combination dot and dash blue line on the USGS 7.5-minute topographic quadrangle maps for the study area. All primary washes including White Tank Wash and its primary tributaries are included in the assessment and are shown on Plate 1 of **Appendix C**. The washes covered under the White Tank Fan study (Wood, Patel & Associates 2001) and the Skyline Fan study (DEI-HEC 1997), Wagner Wash and its right bank (northern) tributaries, and the primary streams north of the Granite Reef Aqueduct are not included in the assessment. The total length of the 46 primary washes that were assessed is approximately one hundred and sixty one (161) miles. The assessment was conducted using field investigations, aerial photographs, maps, and existing studies and reports. Detailed subsurface or geotechnical analyses are not part of this subtask. Preliminary maps (original scale = 1:18,000) delineating the stable and unstable landforms were submitted as Plates 1 through 5 in Appendix B and include the unstable channel reaches identified in Areas 3 and 4.

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3. PROJECT BACKGROUND

Piedmonts are the broad, gently sloping and low relief plains that are located between mountains and axial drainages. Much of Maricopa County is piedmont landforms. The Stage 1 Analysis methodology of the PFHAM was used for delineating the lateral limits of the various piedmont landforms. There is a three-stage process in defining and assessing piedmont landforms provided by the PFHAM:

- Stage 1 - Recognizing and characterizing the kind and extent of piedmont landforms and showing these landforms on a map. The four main landforms on piedmonts of Maricopa County requiring identification and delineation are pediments, relict fans, alluvial fans and alluvial plains. Procedures for identifying piedmont landforms are described in Chapter 2 of the PFHAM.
- Stage 2 - Defining the nature of the piedmont landform environment, identifying unstable and stable components of the piedmont, and showing those areas subject to various flood hazards on a map. For example, flood hazards of alluvial fan landforms in Maricopa County consist of fans with stable flow paths and fans with unstable flow paths. Procedures for identifying unstable and stable components of the piedmont are described in Chapter 3 of the PFHAM.
- Stage 3 - Identifying and applying methods for defining and characterizing areas affected by the 100-year flood and showing these areas on a map. Realistic methods for definition of 100-year flood hazards are discussed in Chapter 4 of the PFHAM.

For the purposes of Task 2.6 of the SOW, only Stage 1 and Stage 2 analyses were performed. This report provides a summary of the Stage 1 Piedmont Landform Delineation (per SOW Subtask 2.6.2) and Stage 2 Piedmont Landform Stability Assessment (per SOW Subtask 2.6.3). The PFHAM Stage 1 and 2 methodologies provide the procedures for identifying the nature and location of flood hazards on the four major piedmont landforms.

The PFHAM defines *Stable Areas* as those in which "the relative state of the location, geometry and roughness of a channel, network of channels, or landform where any changes of flow path, geometry, and roughness during floods are likely to be minor and can be set aside in realistic assessments of flood risk." Common stable areas are hillsides, relict fans, pediment areas, and inactive alluvial fans.

The PFHAM defines *Unstable Areas* as those in which "the relative state of the location, geometry and roughness of a channel, network of channels, or landform where major changes of flow path, geometry, and roughness are possible during floods and cannot be set aside in realistic assessments of flood risk." Common unstable areas are active alluvial fans, some multi-channel (distributary) areas below active alluvial fans, alluvial plains with active sedimentation, split or braided flow channels where flow is wide and shallow, and areas of recent sediment deposition and erosion.

The assessment of the existing conditions of the primary washes was conducted in conjunction with the Stage 1 and Stage 2 analyses. Discussions for both the Stage 1 and Stage 2 analyses in the PFHAM provide some general information and guidance for assessing the stability of the primary washes that drain these landforms. However, an extensive knowledge of fluvial geomorphology, and more specifically the geomorphic characteristics of desert washes, is necessary for accurately conducting this task.

3.1 Piedmont Landform Delineation

The four principle landforms delineated under the PFHAM methodology are relict fans, pediments, alluvial fans, and alluvial plains. A *relict fan* is the erosion remnant of an old alluvial fan formed in a previous epoch and hardened by cementation. A broad, flat or gently sloping, rock-floored erosion surface located at the base of an abrupt mountain front or plateau escarpment is a *pediment*. An *alluvial fan* is a fan-shaped (either partially or fully extended) sediment deposit located at a topographic break, such as a mountain front, that is made up of stream flow and/or debris flow sediments. A nearly flat or gently sloping area or a slightly rolling land surface produced by deposition of sediment is an *alluvial plain*. Alluvial plains are generally located adjacent to a river that occasionally overflows its banks and might be on a floodplain, a delta, or at the toe of an alluvial fan.

Each of the landforms has distinctive topographic, surface, and soil characteristics, and the landforms can be reliably identified using several combined criteria. The identification and delineation of these characteristics are discussed in detail in Chapter 2 and the Appendices of the PFHAM (Hjalmarson 2003). In general, distinctive characteristics that assist in delineating pediments and relict fans are the products of erosion, and distinctive characteristics that assist in delineating alluvial plains and many alluvial fans are the products of sediment accumulation. A summary of the general characteristics of the four principle piedmont landforms is listed in **Table 3.1** and the steps required for the identification of the landforms are provided in **Table 3.2**.

3.2 Landform Stability Assessment

The procedures in Chapter 3 (Stage 2 methodology) of the PFHAM (Hjalmarson 2003) use many of the readily observable indicators described in Chapter 2 (Stage 1 methodology) of the PFHAM to assess landform stability. These indicators are used to delineate areas of potential flooding on each of the landforms. Many of the stability indicators are simple measures of relative surface age and weathering like desert pavement and rock. Most of the indicators used to identify the type of landform such as surface texture, surface geology, rock varnish, desert pavement, cementation of deposits, drainage pattern and channel shape are also used to identify stable and unstable areas. Specifically, the following indicators are used to define stable and unstable areas:

- Flow path movement
- Surface geology
- Desert pavement and varnish
- Surface texture
- Channel capacity
- Degree of flood hazard
- Soils (carbonate zones)
- Soil surveys
- Surface color
- Drainage pattern
- Channel shape
- Vegetation
- Bed material size
- Donoring
- Shear stress
- Drainage basin

Table 3.3 shows several selected indicators of stable and unstable areas. **Table 3.4** provides select characteristics of stable and unstable flood hazards of piedmont landforms.

Table 3.1. Principle Landforms, Common Soil Types, Typical Geologic Map Units, and Significant Characteristics of Piedmonts in Maricopa County (Hjalmarson 2003).

Landform	Component Landform (common soil types)[1] *(typical geologic units)*[4]	Significant characteristics[2]
Relict Fan	Erosion Fan remnant (Mohall-Contine, Gunsight-Chuckawalla- Rillito, Pinamt, Tremant-Ebon- Momoli-Carefree, Eba-Pinaleno, Laveen, Mohave-Continental) *(Qo, Qmo, Qm)*	Typically incised channels in cemented conglomerate of cobbles and boulders. Drainage typically is tributary but small pockets of distributary channels may occur. Some relict fans have a ridge-valley morphology. Incised throughflow streams typically are more than 10 ft. deep and less than 20 ft. deep with steep banks. Desert pavement and rock varnish are common on flat interfluves. General slope typically is 1-6 percent.
	Inset Alluvial Fan (Carrizo, Gilman, Antho, Estrella, Glenbar) *(Qy, Qy2, Qy1)*	Generally small and confined between relict fan remnants. Fluvial deposit that can act like a floodplain with high potential for scour and fill. Much of the alluvial fan material may be from gulling of the relict fan and such material may be bouldery.
Pediment	Bedrock remnant (Gran-Rock outcrop, Gran-Wickenburg complex, Cherioni-Rock outcrop association) *(various bedrock units)*	Incised channels generally formed in bedrock and old soils. Drainage typically is tributary but distributary channels may be present especially on lower slopes. There are many first order tributary channels. Parent rock typically is granite with large granite boulders on the upper slopes near the mountains. The crests of transverse slopes are small and shoulders are steep. General slope typically 2-5 percent.
	Inset Alluvial Fan (Anthony-Arizo complex, possibly Eba-Pinaleno and Carrizo) *(Qy, Qy2, Qy1)*	Generally small alluvial fan confined between pediment. Fan typically widens like a partially opened fan and lower part typically narrows as distributary channels rejoin. Fluvial deposit that typically is actively aggrading and eroding with possible balance of sediment over past few hundred years.
Alluvial Fan	Active Alluvial Fan (Carrizo, Gilman, Antho, Brios, Estrella, Glenbar, Coolidge, Valencia, Torrifluvents, Maripo) *(Qy, Qyc, Qy2, Qy1)*	Fluvial deposits with little, if any, calcium carbonate development. Fan shaped in plan view with hydrographic apex at topographic break. Typically no desert varnish. Stream channels are wide with little incision or channels are very small. Active portions of alluvial fans in Maricopa County typically are a small part of an alluvial fan that is mostly inactive. General slope 1-10 percent.
	Inactive Alluvial Fan (Laveen, Anthony, Antho, Momoli, Mohave, Pinamt, and other soils of relict fans) *(Qm, Qm1, Qm2, Ql, Qly)*	Fluvial deposits with much carbonate in K soil horizon. Fan shaped typically with distributary network of incised-throughflow channels. Transverse slopes of interfluves are flat. Interfluves typically drained by small channels that are tributary to throughflow streams. Interfluve slopes are stable and throughflow streams typically are incised less than 3 ft.. General slope typically 1.5 - 4 percent.
Alluvial Plain	Piedmont Toe (Gilman, Estrella[3], Glenbar, Momoli, Denure, Antho, Contine, Mohall, Avondale) *(Qy, Qy2, Qy1, Qyf)*	Aggrading or rather stable fluvial deposit with little transverse relief and small throughflow channels. Channels typically are less than 1 ft. deep. Few tributary channels head on the surface. Little, if any, rock varnish but possibly some desert pavement. Can be channel incision of a few feet where there has been general head cutting of base- level stream. General slope is 0-3 percent.

[1] Soil complexes on NRCS maps include one or more of the soil types associated with the indicated landform.
[2] These characteristics may be observed on topographic maps, aerial photographs and by field inspection.
[3] Some of this soil is associated with alluvial fans by Camp (1986) and with alluvial plains in this manual. This soil is associated with alluvial plains for this manual because Estrella loam (Soil type 50) typically is at the toe of piedmonts, the slope is small and the landform does not meet the criteria for alluvial fans (NRC, 1996). This is an example of a few minor inconsistencies between this manual and NRCS soil surveys that have no effect on the reliability of the method.
[4] Surficial geologic map units commonly used by AZGS geologists to describe deposits associated with the various landforms.

Table 3.2. Steps for Identification of Piedmont Landforms (Hjalmarson 2003).

Recognizing landforms	Data information source
1. Define general setting (Geology, tectonics, soils, surficial geology, relief)	Geologic, topographic, aerial photos, soil maps. General reference.
Type of landform.	Detailed surficial geology maps, soil maps and geology maps
2. Define physical setting and type of landform.	
Geomorphology of source area (relief, slopes, feeder channel geometry, vegetation distribution, size of source area, drainage pattern)	Topographic maps, aerial photographs.
Geomorphology of piedmont (size, relief, slopes, channel geometry, vegetation type and distribution, surface color and soil)	Topographic maps, soil maps, aerial photographs.
Location of landform (Is there a topographic break? Is it at a mountain front? Is it at an isolated remnant or *inselberg*? Is it inset on a larger landform?)	Topographic maps and aerial photographs.
3. Verify and refine landform characteristics and boundaries.	Field work using geologic maps and soil survey maps.
Composition and age (bedrock or a sedimentary deposit, soil development, desert varnish, desert pavement, surface color and caliche)	
Morphology (plan view shape, drainage pattern and spacing, channel incision and geometry, ridges and valleys)	Field work using topographic maps and aerial photographs.
Location of landform (Is it at a topographic break? Is it at a mountain front? Is it an isolated remnant or *inselberg*? Is it inset on a larger landform?)	Fieldwork using topographic maps and aerial photographs.

Table 3.3. Selected Indicators of Stable and Unstable Areas (Hjalmarson 2003).

INDICATOR	LANDFORM AGE[1]	LANDFORM STATE[2]	FLOOD FREQUENCY[3]	SIGNIFICANCE FOR IDENTIFYING LANDFORM AND STABILITY (TYPICAL)
Morphology				
ridge & valley	O	S	--	On relict fans and pediments.
Throughflow Channels[4]				
incised > 10 ft.	O	S	> Q_{100}	On relict fan surfaces where side-slope shoulders are convex and foot slopes are smooth and concave.
incised < 3 ft.	I	S	> Q_5	On inactive fans where transverse foot slopes are steep and shoulders are smooth and convex and summits between channels are smooth and flat.
incised < 2 ft.	Y	U	Q_2	On unstable surfaces where banks are steep and channel width-depth ratio > 10 at bank full stage.
incised <1 ft.	Y	?	any	On alluvial plains with smooth surfaces and very little cross-drainage relief
Drainage pattern				
tributary				
parallel channels	O	S	> Q_{50}	On relict fans and pediments where ridges between first and second order streams are parallel.
dendritic channels	I	S	> Q_{10}	On relict fans and pediments and inactive areas of alluvial fans.
distributary	I,Y	?	--	On active and inactive alluvial fans and, in places, on granite or granite-like pediments
faint with wide areas between flow paths	Y	U	any	On alluvial plains where the slope is not great enough to override any influence of minor topographic irregularities.
Vegetation				
Creosote bush	O	S	> Q_{50}	Predominant vegetation on stable calcium carbonate rich soil.
	I,Y	?	any	Not the predominant plant.
Saguaro	O	S	> Q_{50}	On stable surfaces.
Desert trees	I,O	MS, S	> Q_5	Along channel banks.
	Y	U	any	Scattered over area.
Soil development				
Reddish color	I,O	MS	?	On pediments, relict fans, inactive alluvial fans and alluvial plains and may indicate the surface is stable.
B horizon	O	S		May indicate the surface is stable.
Weak B horizon	I	S		Can form in a few thousand years.
Calcic horizon	O	S		Crystals on gravel indicates surface has been stable for hundreds of years
Desert varnish				
None	?	?	?	May indicate the surface is unstable. Does not form on granite or limestone and where ground cover vegetation is dense.
Some	O, I	MS, S	>Q_{10}	Varnished rocks may be reworked from older upslope surfaces such as bedrock. Also, surface may be removed by erosion.
Much	O	S	> Q_{100}	Varnished boulders and larger cobbles with few varnished smaller stones.
Desert pavement	O	S	> Q_{50}	Dense "pavement" with smooth surface.

1 Y=young (<300 years), I = intermediate (>300 and <10,000 years), O = old (>10,000 years) and ? = inconsistent indicator of age.
2 S = stable (flow paths not expected to change over regulatory period), MS = moderately stable (flow paths may change in places during regulatory period of 100 years), U = unstable (flow paths expected to change in places during large floods) and ? = not a consistent indicator of state.
3 Approximate recurrence interval at bank full level. May include small adjacent overflow areas.
4 Values are for drainage basins less than 5 mi^2.

Table 3.4. Selected Characteristics of Stable and Unstable Flood Hazards of Piedmont Landforms (Hjalmarson 2003).

Landform	Component Landform (State)	Significant stability and flood characteristics
Relict Fan	Erosional Fan remnant (Stable)	Remnants of broad coalescent plains or bajadas that have been incised by streams for thousands of years. The presence of large areas of varnished desert pavement and soils with substantial clay or carbonate suggests the surface of this landform is very stable in many places and flood flow has been conveyed past these stable areas for thousands of years. The 100-year flood is confined to throughflow channels and small over bank areas adjacent to the defined channels.
	Inset Alluvial Fan (Unstable)	These typically bouldery fluvial deposits can have a great aggradation and erosion potential and are unstable. The 100-year flood can spread over much of these areas.
Pediment	Bedrock remnant (Stable)	Nearly all of these landforms are eroding and stable. Relatively small areas along larger channels subject to scour and fill. The 100-year flood typically is confined to defined channels of throughflow streams and streams that head on the pediment.
	Inset Alluvial Fan (Unstable)	These fluvial deposits resemble flood plains except the inset fan may be subject to more erosion and deposition than typical flood plains. Inset deposits of sediment can be the "apex" of distributary channels.
Alluvial Fan	Active Alluvial Fan (Unstable)	Fluvial deposit with little or no calcium carbonate soil development, no insitu rock varnish development, and seldom any desert pavement. The surface typically is a light tan or grey color that is indicative of recent abrasion of the weathered surface during sediment transport. Some areas not recently eroded or that have received sediment may be darkened by weathering. Typical channels are poorly defined with large width-to-depth ratios and may have a braided pattern in addition to a general radiating pattern below the hydrographic apex. Typical clasts are angular, sorted and unweathered. Both the maximum and average clast size of the sediment deposits decreases rapidly down fan. Deposits are mounded across the fan unless there has been erosion and/or co-mingling with adjacent alluvial fans.
	Inactive Alluvial Fan (Stable)	Fluvial deposit with much carbonate in K soil horizon, reddish upper soil horizon, desert pavement, rock varnish, incised throughflow channels, trees along the throughflow channels and developed tributary drainage systems that head on the fan surface. Very old inactive alluvial fans that have lost their shape are relict fans.
Alluvial Plain	Piedmont Toe (Generally stable but some areas may be unstable.)	Rather stable or possibly aggrading fluvial deposit with little transverse relief except where channels are incised as the result of lowering of base-level stream. Floodwater of the 100-year flood may spread over large areas like that shown in Appendix G. Areas with low slopes, lack of flow confinement, little aggradation and developed caliche soil that resists erosion are stable. Areas may be unstable where there is much aggradation. Where channels are incised the gully walls may be unstable and head cutting may progress upslope.

4. METHODOLOGY

4.1 Landform Identification, Delineation, and Mapping

The Stage 1 methodology for identification and delineation of the characteristics of piedmont landforms are described in detail in Chapter 2 and the Appendices of the PFHAM (Hjalmarson 2003). Chapter 3 (Stage 2 methodology) of the PFHAM provides the methodology used in this project for identification of stable and unstable flood hazard areas of piedmont landforms. The described procedure is complementary to the procedure used to identify landform types in Chapter 2 of the PFHAM.

ArcGIS was the Geographic Information System (GIS) software used for the piedmont landform delineation, the landform stability assessment, the stability assessment of the primary washes, and the associated mapping. Ten-foot contour topography and 2003 MrSID orthophotography were obtained from the District and overlaid in ArcGIS. The soils mapping from the National Resources Conservation Service (NRCS), in the form of a GIS shapefile, was then used to guide the initial in-house landform mapping and delineation. **Appendix D** provides an example of the typical NRCS soils maps and soil descriptions for the BSV area. The landform mapping was based on the soil associations related to each landform (PFHAM). The aerial photography and the 2003 topographic maps (10-ft contour interval) provided by the District were then examined in detail to refine the landforms and assist in identifying stable and unstable areas.

Compared to color photography, black and white orthophotography was more difficult to use in identifying subtle differences in surface color and tone. However, the black and white photography was still useful in viewing the lighter active alluvial fans and other unstable areas, the ground surface texture, and drainage patterns. The 10-foot contours from the 2003 District contour maps provided a better picture of the drainage patterns, allowed calculation of the drainage texture in the relict fans and inactive fans, assisted in defining topographic breaks, and provided a clearer view of the relative depths of channel incision.

The Arizona Geological Survey (AZGS) surficial geology mapping (Field and Pearthree 1991) and flood hazard mapping (Field and Pearthree 1992) for the White Tank Mountains area were then used to refine the landforms even further. Both the surficial geology maps (**Appendix E**) and the flood hazard maps (**Appendix F**) were scanned and converted to digital images. These images were then registered in ArcGIS using the USGS 7.5-minute topographic quadrangle maps and the 2003 aerial photography as the base system. Once these maps were georeferenced, the maps could be viewed with the soils, topography, and delineated landforms overlain on them.

Two primary methods were used to assess current conditions on the primary washes. One method required the comparison of historic and contemporary aerial photography to identify reaches and areas of potential and existing stream instability. The other method was to conduct an on-site field reconnaissance of each of the primary washes whereby unstable reaches could be identified and delineated in real-time in the field using the portable GPS unit. Both methods were used to identify, delineate, and verify stability problems along the primary washes.

4.2 Aerial Photography Analysis

A comparison of sequential aerial photography can identify potentially dangerous landforms and stream reaches that are stable or unstable or that have changed significantly in planform due to aggradation, degradation, or migration as a result of major events, especially if a major event

has occurred sometime between subsequent photos or immediately prior to a photo date. In the case of the Buckeye/Sun Valley area, a major storm event that occurred in 1951 created significant changes in the landscape and to reaches of some of the primary washes within the project area.

The 1951 storm event is identified in precipitation records for the Buckeye weather gage (NCDC COOP station number 021026), which is located in the town of Buckeye to the south and has been in operation since 1893. The largest single day precipitation recorded at the gage since 1907 occurred on August 28, 1951. The total volume on that day was 2.6 inches and the total recorded precipitation from August 27 to the August 30, 1951, was more than 4.6 inches. Although 1951 was not an unusually wet year, the monthly total for August of that year was 6.89 inches, which is the wettest month on record (**Figure 4.1**). In comparison, the mean monthly precipitation for August is only 1.13 inches. Thus, aerial photographic coverage that encompasses this date or was taken immediately after that year will be valuable in assessing changes that occurred then and subsequently.

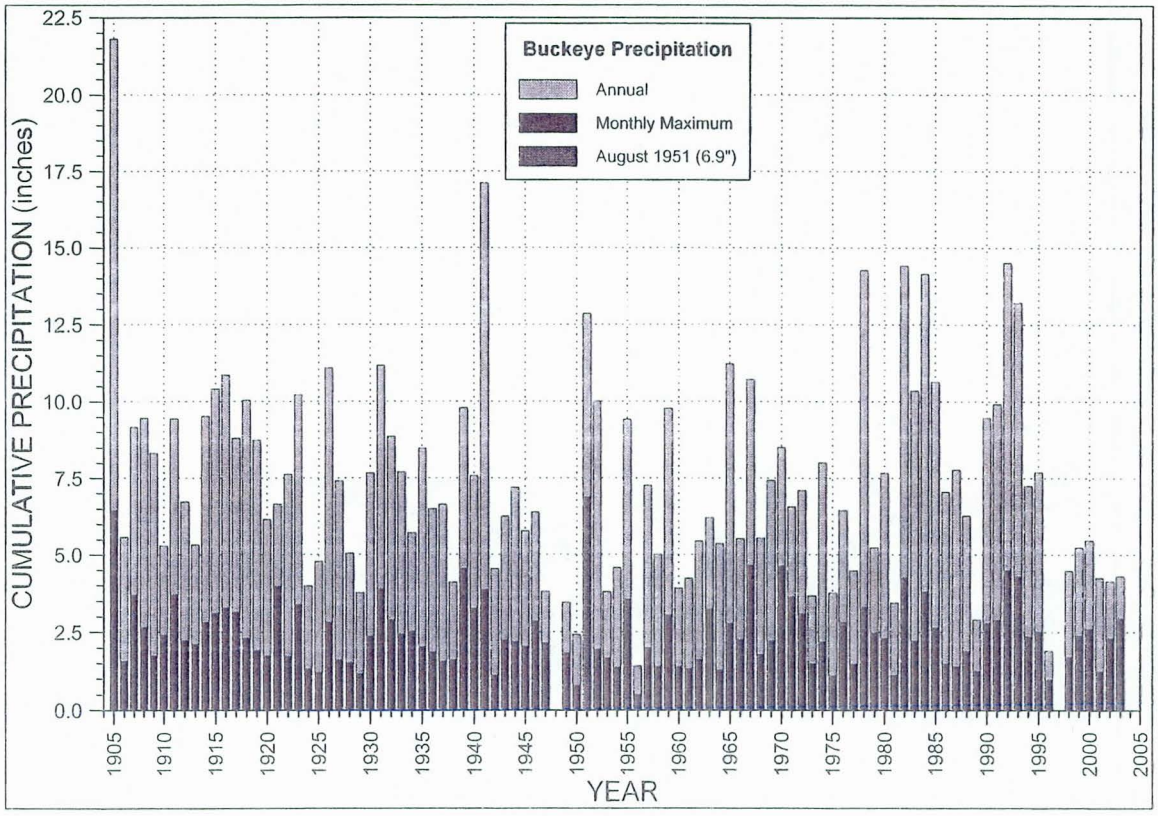

Figure 4.1. Annual and monthly maximum precipitation (1905-2003) for Buckeye, Arizona.

There are no aerial photos taken of the study area prior to 1949 that were available. With regard to the 1951 event, black and white aerial photography taken in 1949 is available for areas a short distance north of the Buckeye Flood Retarding Structures (FRS), but coverage for most of the project area north of the structures is not available in the 1949 aerial photography. However, black and white 1953 aerial photographic coverage is available for the entire study area. In addition, 1973, 1992, 1997, 1999, and 2003 aerial photographic coverage is available.

The digital versions of the 1973 aerial photos are of poor quality and the 1997 and 1999 aerial photos show no major changes compared to the 1992 and 2003 aerial photos. Only the 1949, 1953, and 2003 aerial photographs were used in this study for comparative purposes since there have been no storm events that have produced any identifiable changes in the study area after 1951.

The active alluvial fans and other unstable areas that were identified and mapped using the aerial photo comparison are included in the GIS database submitted to the District as part of this report.

4.3 Field Reconnaissance

All-Terrain-Vehicles (ATVs) with utility racks were the main mode of transportation used in the field reconnaissance and verification of the piedmont landforms and the areas of instability, and the assessment of the existing conditions of each of the primary washes (**Figure 4.2**). The ATVs were used because of the large extent and relative inaccessibility of the study area, and allowed for quick and efficient movement across the landscape to verify landforms and check uncertain or questionable areas in a short amount of time. Having less travel time allowed for more time to accurately verify landform types and boundaries.

The Trimble GeoXT, which is shown mounted on an ATV in **Figure 4.3**, is part of the Trimble GeoExplorer CE Series, a handheld Windows CE device with an integrated Trimble GPS receiver. The GPS system uses the Wide Area Augmentation System (WAAS) for free real-time connections. The WAAS was created by the Federal Aviation Administration (FAA) as a free-to-air differential correction service. With Windows CE, the device is capable of incorporating mobile GIS field software. ESRI's ArcPad 6.0, which is the mobile form of ArcGIS with GPSCorrect, was used for this project.

Using ArcPad with the georeferenced aerial orthophotography and the pre-defined landforms GIS files, the Trimble GeoXT enabled quick navigation to a verification site or questionable feature and proper identification and delineation of the boundaries and location of the landform or feature. The Trimble GeoXT provides the accuracy of a survey grade GPS with the portability of a fully editable mobile GIS database.

The portability of the Trimble GeoXT for use with the ATVs was accomplished using a GPS mount placed on the front utility rack of the ATV. The mounted GPS was readily visible and allowed for easy tracking of the current location and navigation to a specific site.

Field verification of the areas of instability was accomplished by configuring the Trimble handheld GPS to display the boundaries of the unstable area previously delineated in the office. With the mapped boundaries visible on the ATV-mounted GPS, the mapped boundaries were verified by tracking the boundary using the ATVs and observing the path using the GPS track log. Verification of the boundaries required knowledge of the specific characteristics unique to stable and unstable landforms and any deviation of the mapped boundary from the location of the observed true boundary in the field was edited in real time in the ATV-mounted GPS. The correct boundary was delineated by driving the ATV with the GPS along the correct location of the boundary and recording the path of the ATV as a new track log. Where changes or corrections to the boundaries were necessary, the new ATV track log was used to guide and document alteration of the original mapping.

5. PIEDMONT LANDFORM DELINEATIONS AND VERIFICATION

Although the District has performed full piedmont landform delineation and stability assessments on a number of piedmont surfaces prior to this study using the methodology provided in the current version of the PFHAM (Hjalmarson 2003), the methodology has not been used to conduct assessments on areas similar in size to the combined area of Areas 3 and 4 of the BSV ADMS (184 mi^2). Therefore, the District determined that verification sites would be an appropriate means of fully evaluating and documenting in detail the characteristics of specific representative sites for each type of landform found on the piedmont. The detailed characteristics documented for each type of landform should be essentially similar for the same landform types found within the watershed.

Based on the District's requirements under Subtask 2.6.2.2, eight locations, two for each landform, were chosen as landform verification sites. The verification sites were chosen because there were discrepancies or contradictions in the characteristics that generally define the landform, several characteristics were not common to the landform, or the boundaries were not easily delineated or clearly definable. These sites were initially identified during the mapping effort in the office. For the verification sites that were mapped or delineated incorrectly, the landform or site was correctly identified based on the defining characteristics identified in the PFHAM, and the boundaries were properly delineated in the field by making the appropriate real-time corrections to the GIS database stored in the Trimble GeoXT handheld GPS unit.

Table 5.1 provides the description of each site and landform designation, including the latitude and longitude of each site. **Table 5.2** shows how each site was mapped relative to surficial geology (Field and Pearthree 1991), flood hazards (Field and Pearthree 1992), and soils (Hartman 1977). **Table 5.3** provides the drainage pattern and texture, the desert pavement and varnish development, and the vegetation for each verification site.

Table 5.1. Landform Verification Sites: Description, Landform, Latitude, and Longitude (Northing and Easting Coordinates are in State-Plane Arizona Central zone).

Site #	Description	Landform	Northing (ft)	Easting (ft)
1	Active alluvial fan south of the White Tank Fan (USGS Site 36)	Alluvial Fan	907260.60	484461.72
2	Inactive alluvial fan immediately south of Sun Valley Parkway	Alluvial Fan	966329.56	480823.51
3	Site is south of southern intersection of Sun Valley Parkway and Wagner Wash	Alluvial Plain	958546.01	464198.14
4	Site is south of Wagner Wash at the Hassayampa River	Alluvial Plain	942661.37	456163.98
5	Site is immediately south of USGS Site 39	Relict Fan	925808.36	474959.37
6	Site is west of Sun Valley Parkway, southwest of USGS Sites 38 & 39	Relict Fan	904417.67	460790.10
7	Site is southwest of north edge of White Tank Mountains, east of Sun Valley Parkway	Pediment	950524.26	478971.90
8	Site is north of the end of Buckeye FRS #2	Pediment	893537.00	491246.42

Table 5.2. Representative Landform Sites: Mapped Surficial Geology (Field and Pearthree 1991), Flood Hazards (Field and Pearthree 1992), and Soils (Hartman 1977).

Site #	Surficial Geology Mapping	Flood Hazard Mapping	NRCS Soils
1	Y2 – Late Holocene	H1 - Very High Hazard	Antho-Carrizo-Maripo Complex
2	Y2 - Late Holocene	H2 - Moderate Flood Hazard	Tremant Gravelly Loams
3	Y – Undifferentiated Holocene	I – Intermediate Flood Potential	Gilman Loams
4	Y1 – Late to early Holocene	Not Mapped	Antho Gravelly Sandy Loams
5	M1b – Mid to Late Pleistocene	L2 - Very Low Flood Potential	Carrizo Very Gravelly Sands
6	M1b – Mid to Late Pleistocene	L2 - Very Low Flood Potential	Pinamt-Tremant Complex
7	TK - Tertiary or Cretaceous intrusive and volcanic rocks	L2 - Very Low Flood Potential	Vaiva Very Gravelly Loams
8	X - Early Proterozoic gneiss and granite	B - Bedrock	Gunsight-Pinamt Complex

Table 5.3. Representative Landform Sites: Drainage Texture, Drainage Pattern, Desert Pavement and Varnish Development, and Vegetation.

Site #	Landform	Drainage Texture	Drainage Pattern	Desert Pavement and Varnish	Vegetation
1	Alluvial Fan	NA (indefinable on topo maps)	Distributary	None	Stippled pattern, scattered desert bushes and trees throughout
2	Alluvial Fan	Relatively constant	Distributary	None	Desert trees along main channels, abundant desert bushes, scattered saguaros
3	Alluvial Plain	NA	Tributary	None	Desert trees along small channels, abundant scattered desert bushes
4	Alluvial Plain	NA	Tributary	None	Desert trees along small channels, abundant scattered desert bushes
5	Relict Fan	Decreasing upslope	Tributary	Moderately Developed	Relatively sparse desert trees and bushes only concentrated along channels
6	Relict Fan	Decreasing upslope	Tributary	Well Developed	Desert trees and bushes only concentrated along channels, no saguaros, abundant creosote
7	Pediment	NA (indefinable on topo maps)	Tributary	NA	Desert trees and bushes concentrated along entrenched channels
8	Pediment	NA (insufficient contours)	Tributary	Not Observed*	Desert trees and bushes concentrated along entrenched channels
*Site #8 – not accessible for field verification					

5.1 Verification Site #1

Verification Site #1 (Appendix A, Sheet 5) is an alluvial fan region located south of the White Tank Fan (USGS Site 36). **Figure 5.1** provides a view looking downstream from the hydrographic apex of the active portion of the alluvial fan. The site has all the characteristics of an active alluvial fan including multiple unconfined flow paths, extensive sedimentation, and little to no soil development or desert pavement.

Figure 5.1. View looking downstream at Verification Site #1 south of USGS Site 36 alluvial fan.

5.2 Verification Site #2

Verification Site #2 (Appendix A, Sheet 1) is an alluvial fan region located in the northern part of Area 4 just south of Sun Valley Parkway (**Figure 5.2**). Initially this region was mapped as an alluvial fan, but then changed to relict fan because the topography appeared to have deeper drainage incision than that usually associated with alluvial fan areas. However, this was again reversed and mapped as an alluvial fan based on the surficial geology map showing this area as being late Holocene in age and having a relatively constant drainage texture (**Figure 5.3**).

The field verification of Site #2 also confirmed the presence of the weakly developed Tremant soil, a lack of significant desert pavement (**Figure 5.4**), and areas of confined and sheet flow. The Tremant Series is a weakly developed gravelly loam soil that is slightly effervescent and is found on fan terraces, stream terraces or relict basin floors.

5.3 Verification Sites #3, #4, and #5

Verification Site #3 (Appendix A, Sheet 1) is an alluvial plain region that is immediately south of the southern intersection of Wagner Wash and Sun Valley Parkway. Verification Site #4 (Appendix A, Sheet 2) is an alluvial plain region that is south of Wagner Wash near the Hassayampa River. These sites have the characteristic flat relief, little or no desert pavement, small or poorly defined throughflow channels, and a stippled vegetative pattern resulting from regularly spaced creosote bushes.

Verification Site #5 (Appendix A, Sheet 2) is a relict fan region that is immediately south of USGS Site 39. The drainage texture (contour crenulations versus elevation) for Verification Site #5 is shown in **Figure 5.5**. This site has the characteristics typical of a relict fan including entrenched throughflow streams, desert pavement and desert varnish on interfluves, well-developed soils, and abundant cactuses.

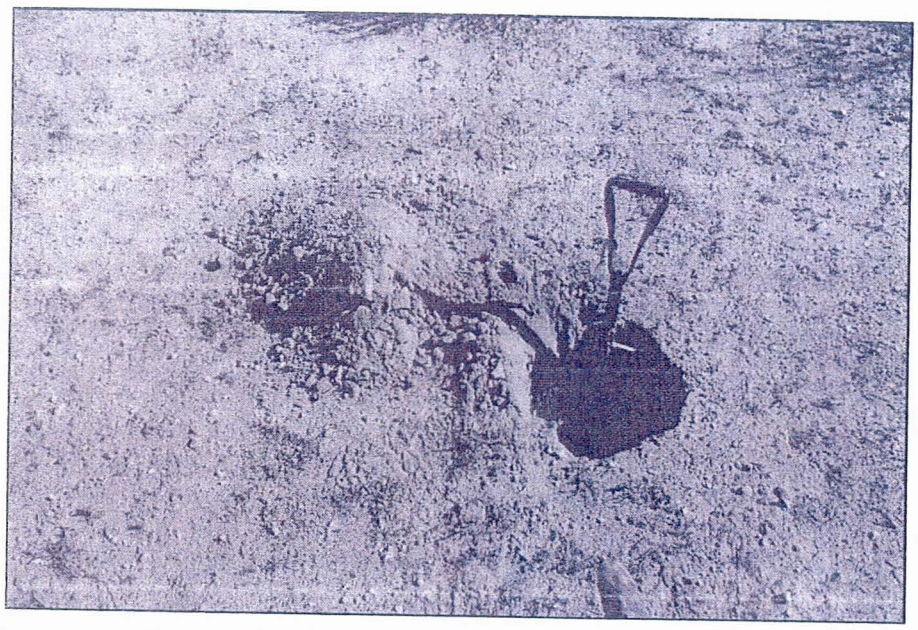

Figure 5.4. Tremant soils of the inactive alluvial fan at Verification Site #2.

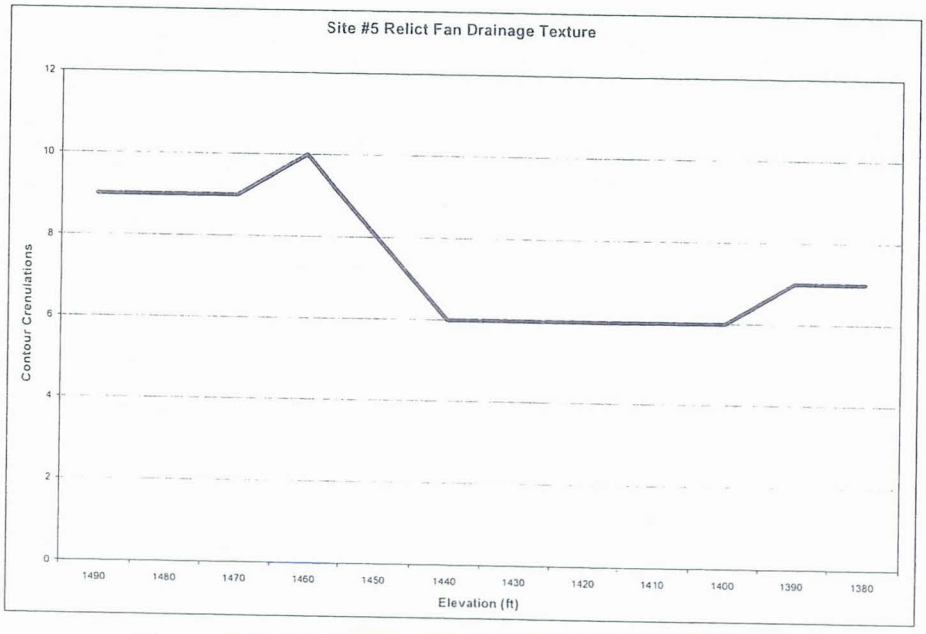

Figure 5.5. Drainage texture at Verification Site #5.

5.4 Verification Sites #6, #7, and #8

Verification Site #6 (Appendix A, Sheet 4) is a relict fan region that is west of Sun Valley Parkway and southwest of USGS Sites 38 and 39. The drainage texture of Site #6 is shown in **Figure 5.6**. This site has the characteristics typical of a relict fan including entrenched throughflow streams, desert pavement and desert varnish on interfluves, well-developed soils, and abundant cactuses. **Figure 5.7** shows the well-developed desert pavement in this area. **Figure 5.8** provides a close-up of the desert pavement on the relict fan surface, as well as some stones coated with well-developed desert varnish.

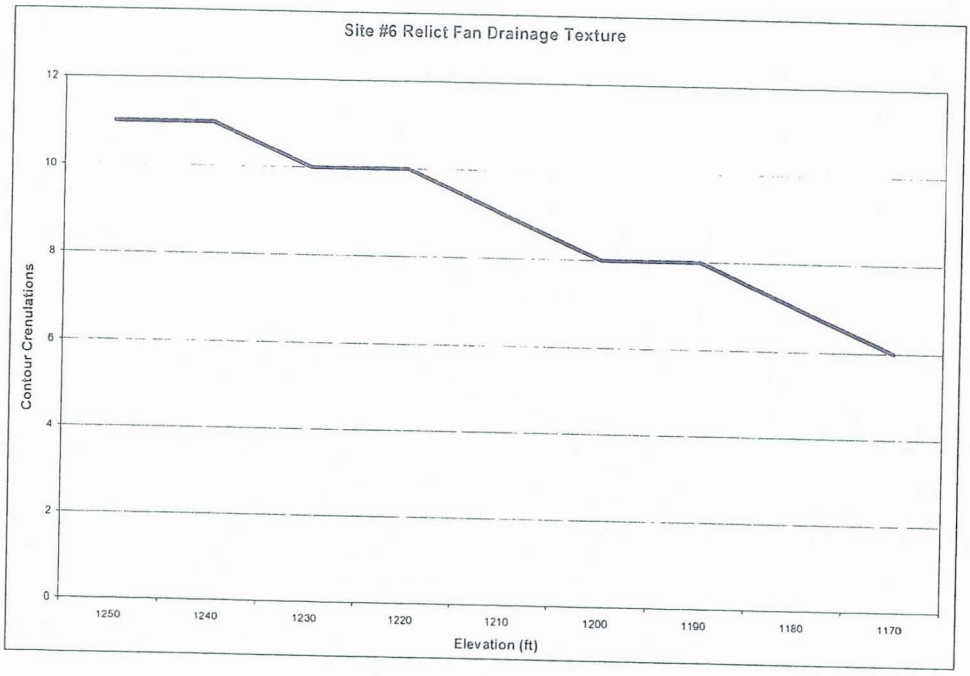

Figure 5.6. Drainage texture at Verification Site #6.

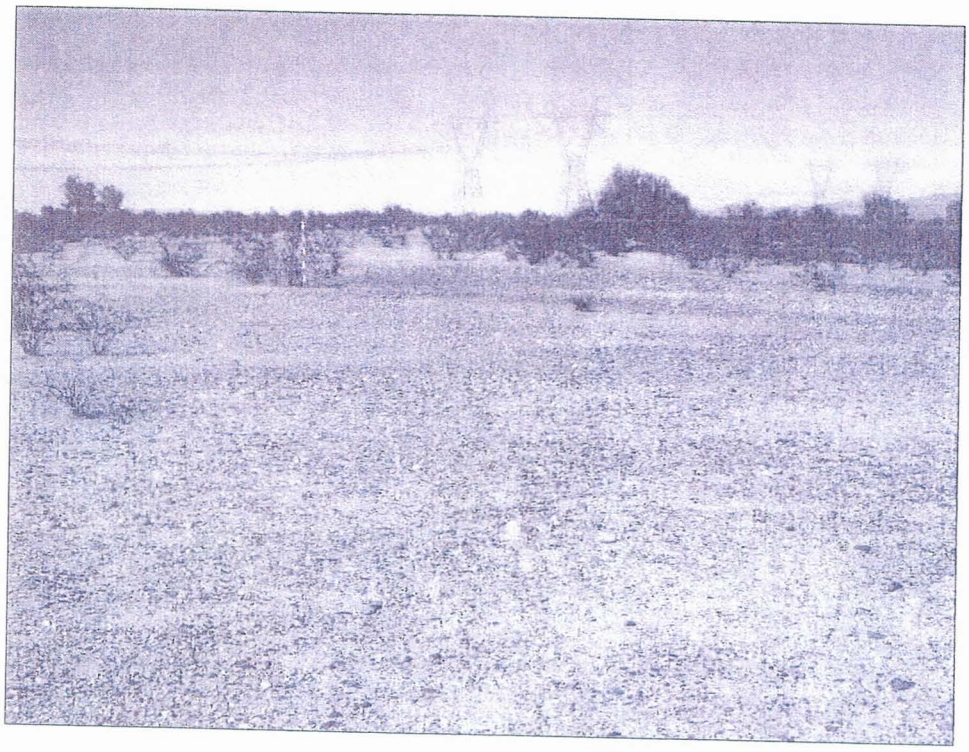

Figure 5.7. Well-developed desert pavement and desert varnished stones on a relict fan surface (Verification Site #6).

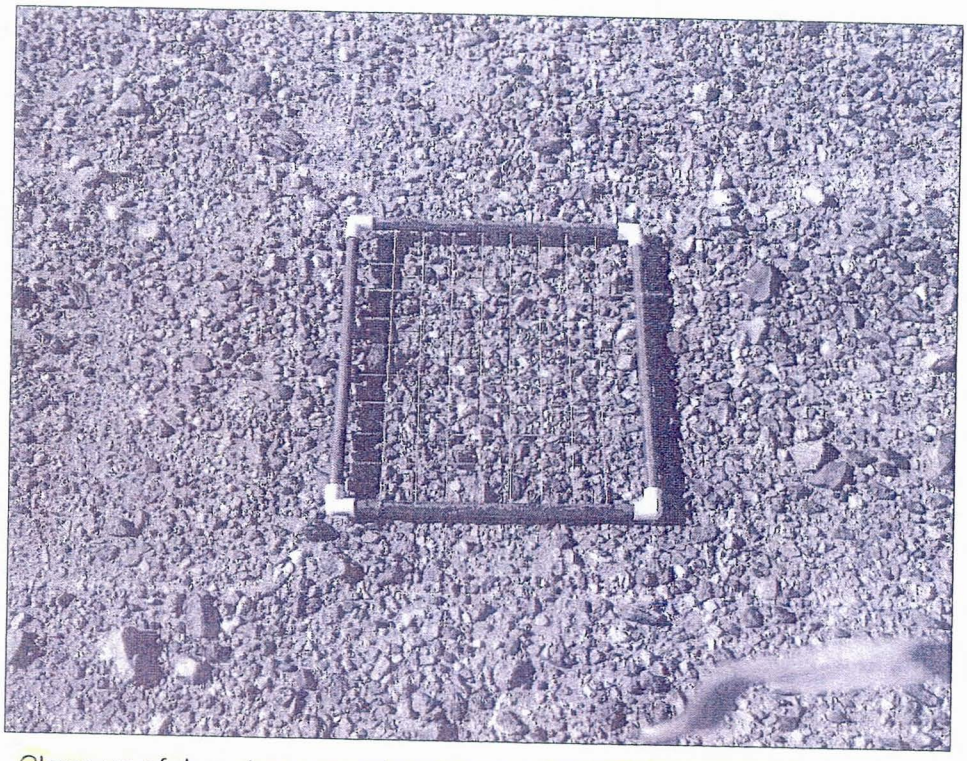

Figure 5.8. Close-up of desert pavement and stones with well-developed desert varnish on a relict fan surface (Verification Site #6). Internal grid squares are 2-inch square.

Verification Site #7 (Appendix A, Sheet 1) is a pediment region that is east of Sun Valley Parkway and southwest of the north edge of the White Tank Mountains (**Figure 5.9**). Verification Site #8 (Appendix A, Sheet 5) is a pediment region that is north of the west end of Buckeye FRS #2. Both sites have the typical characteristics of pediments including extensive shallow bedrock mantled with a thin and discontinuous veneer of alluvium, exposed bedrock along deeply entrenched tributary channels, extensive desert pavement and varnish on interfluves, and abundant cactuses.

5.5 Summary

The lateral limits of the four principle piedmont landforms were delineated for the Buckeye/Sun Valley area using the Stage 1 Analysis defined in the PFHAM (Hjalmarson 2003). The landforms were identified and mapped in-house using geologic, flood hazard, topographic, and soils maps as well as aerial photography. A total of eight landform sites were identified for verification, two from each landform type. Seven of the sites were visited in the field to document and verify the characteristics for each landform type. Where there were discrepancies or contradictions in the characteristics that generally define the landform, where several characteristics were not common to the landform, or where the boundaries were not easily delineated or clearly definable, the landform or site was correctly identified based on the defining characteristics identified in the PFHAM, and the boundaries were properly delineated in the field and changes were made to the GIS database. Of the 184 mi^2 of total area mapped, 4.46 mi^2 are mapped as pediment surfaces, 34.6 mi^2 are mapped as alluvial plains, 38.26 mi^2 are mapped as alluvial fan surfaces, 79.14 mi^2 are mapped as relict fan surfaces, and 27.49 mi^2 are mapped as bedrock. The landform mapping has been provided to the District in ArcGIS format and is included as Appendix A of this report.

6. LANDFORM STABILITY ASSESSMENT

Under the PFHAM Stage 2 methodology, the nature and location of flood hazards on the four major piedmont landforms are to be identified and classified as either *stable* or *unstable* hazards. The SOW states that stable and unstable areas of the piedmont landforms will be defined using the PFHAM Stage 2 analysis. Common areas identified as stable under the PFHAM Stage 2 methodology are:

- Hillsides
- Relict fans
- Pediment
- Inactive alluvial fan
- Throughflow channel with a movable bed
- Some sheet flow and split flow areas

Common unstable areas identified under the PFHAM Stage 2 methodology are:

- Active alluvial fans
- Some multi-channel areas below active alluvial fans
- Alluvial plain with active sedimentation
- Multi-channel pocket along a throughflow cannel
- Area of recent sediment deposition and erosion
- Split flow channel where flow is wide and shallow
- Areas of low relief where minor development such as roads can divert floodwater and cause significant erosion in areas otherwise not susceptible to flood hazard

It should be noted that, although the PFHAM distinguishes between active alluvial fans and other unstable areas, they are lumped together under the *unstable* designation. Although the SOW states that "potentially unstable areas include active or inset alluvial fans with unstable channel reaches as well as areas with high potential for avulsion or significant shift," the SOW does not specifically state that active fans should be mapped separately from other unstable areas. However, we have accommodated the District's request to map the active fans separately. As a result, the mapping effort includes the delineation of active alluvial fans separately from other unstable areas, and the other unstable areas are reaches of washes that we have further delineated and classified as having a moderate or high geomorphic hazard. This more detailed delineation is not defined or included in the PFHAM Stage 2 methodology. The plates in Appendix B show the unstable areas mapped in red. Areas in solid red represent active alluvial fans and open areas outlined in red represent other unstable areas.

6.1. Active Alluvial Fans

Numerous areas were identified as being unstable, active alluvial fans. **Table 6.1** provides the location of the hydrographic apex for each identified site in northing-easting (State Plane NAD83) and latitude-longitude coordinates. **Table 6.2** displays the direction of flow and the area of instability in acres for each of the unstable areas. Studies were previously completed on the White Tank Fan (Hjalmarson and Kemna 1991; Hjalmarson 1994; Wood-Patel 2000), also known as USGS Site 36, and the Skyline Wash Fan and tributaries (DEI-HEC 1997). Other previously identified active fans include USGS Sites 37, 38, and 39 (Hjalmarson and Kemna 1991; Hjalmarson 1994). Although a discussion of these areas will not be included in this document, they were examined and their characteristics were field checked during the field verification of unstable areas.

Table 6.1. Location of the Hydrographic Apex for each Mapped Unstable Area.

Unstable Site	Description	North (ft)	East (ft)	Lat. (dd)	Long. (dd)
BSV Site 1	Small fan north of the White Tank Mountains (Eastern Area 4)	960445	487493	33.638	112.615
BSV Site 2	Small fan north of the White Tank Mountains (Eastern Area 4)	959472	490774	33.636	112.604
BSV Site 3	Fan in southern part of Area 4, SE of Wagner Wash	956199	482420	33.626	112.631
BSV Site 4	Small fan north of BSV Site 6	940436	472030	33.583	112.665
BSV Site 5	Inset fan north of USGS Site 39	939479	478896	33.580	112.643
BSV Site 6	Small fan on east side of Sun Valley Parkway and NW of USGS Site 39	929797	468825	33.554	112.675
BSV Site 7	Small fan south of USGS Site 36	907676	484235	33.493	112.624
BSV Site 8	Small fan southeast of BSV Site 7	901188	486927	33.475	112.615
BSV Site 9	Small inset fan near the start of Buckeye FRS #1	886736	489291	33.436	112.607
BSV Site 10	Small fan near middle of Buckeye FRS #2	889640	496686	33.444	112.583
BSV Site 11	Small fan east of BSV Site 10 near middle of Buckeye FRS #2	889831	498447	33.444	112.577
BSV Site 12	Small fan south of BSV Site #8 and north of BSV Site #9	893687	487162	33.455	112.615
BSV Site 13 E	Small fan north of BSV Site #3 and east of BSV Site #13 West	958787	482281	33.634	112.632
BSV Site 13 W	Small fan north of BSV Site #3 and west of BSV Site #13 East	958834	481148	33.634	112.636
BSV Site 14	Small fan SW of USGS Site 39, west of Sun Valley Parkway	920817	464522	33.529	112.689
BSV Site 15	Small Fan west of BSV #16, southwest of USGS Site 38	914052	465260	33.510	112.687
USGS Site 36 (White Tank Fan)	Hassayampa Tributary #1	914760	484982	33.513	112.622
USGS Site 37	Hassayampa Tributary #2	918160	484049	33.522	112.625
USGS Site 38	Hassayampa Tributary #3	920143	475736	33.527	112.653
USGS Site 39	Hassayampa Tributary #4	926491	476428	33.545	112.650
Skyline Wash Fan	Skyline Wash	900475	504260	33.474	112.559
Skyline Wash Tributary Fan	East Tributary to Skyline Wash Fan	897517	512488	33.466	112.532

6.1.16 BSV Site 15

The small active alluvial fan at BSV Site 15 is an unstable area that is located west of Sun Valley Parkway, just west of BSV Site 16, and one mile southwest of USGS Site 38. The BSV Site 15 area is 23.6 acres in size and extends roughly 3,000 feet from northeast to southwest.

BSV Site 15 is mapped as a very high flood hazard (Field and Pearthree 1992) and late Holocene in age (Field and Pearthree 1991). Although the surface encompassing this area was originally mapped as an inactive alluvial fan surface, an examination of the 1953 aerial photo (**Figure 6.22**) indicates that the area was an active fan at that time, probably as a result of the major storm event of 1951. The current aerial photography shows the elongate fan shape of the active area, which contains numerous well defined flow paths, but also still shows a few signs of continued active alluvial fan processes. A field reconnaissance later confirmed that this area is an active alluvial fan. **Figure 6.23** is a view looking downstream from near the apex of the active fan.

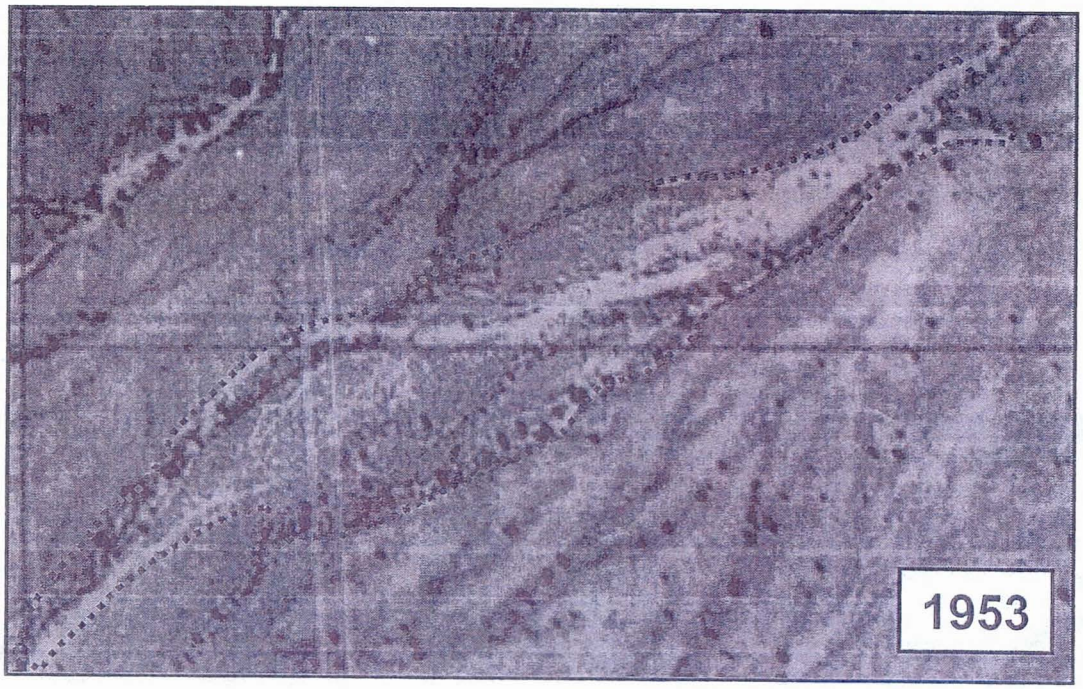

Figure 6.22. Aerial photograph from 1953 showing the active fan area of BSV Site 15.

6.1.17 USGS Site 36 (White Tank Fan)

The USGS Site 36 active alluvial fan, also known as the White Tank Fan, is an unstable area that is located directly south of USGS Site 37 and is three miles east of Sun Valley Parkway. The White Tank Fan has been mapped in detail and its characteristics have been well documented in an approximate floodplain delineation study conducted by Wood-Patel (2001). The fan is the largest active fan in the area at more than 898.6 acres in size and it extends about two miles from northeast to southwest. **Figure 6.24** shows the fan downstream of the hydrographic apex.

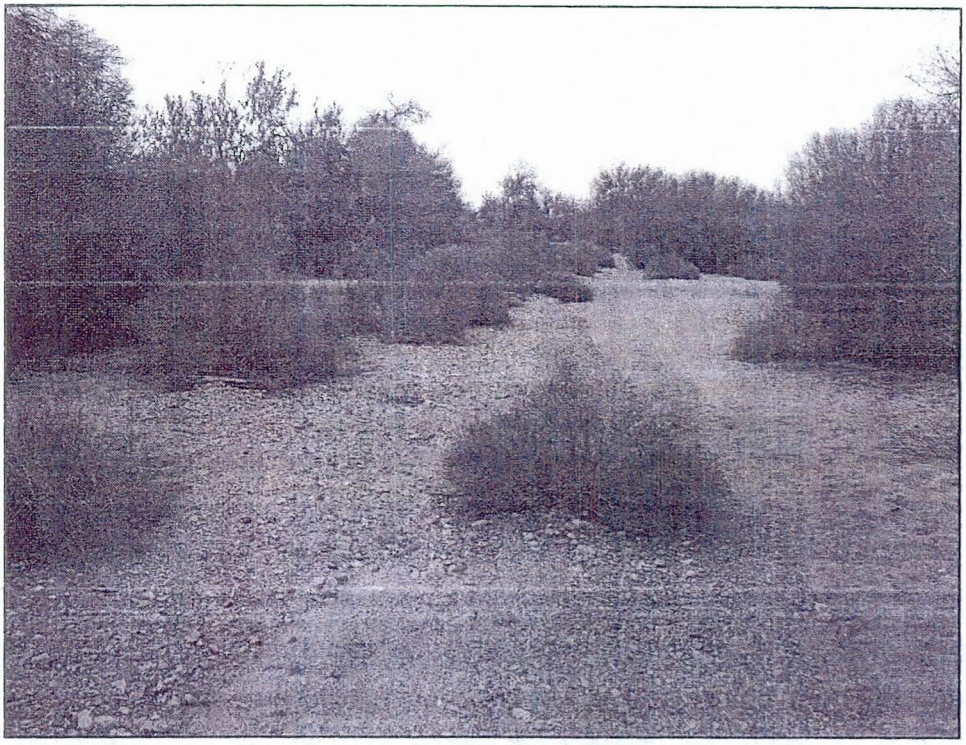

Figure 6.23. View downstream from the apex of the active fan at BSV Site 15.

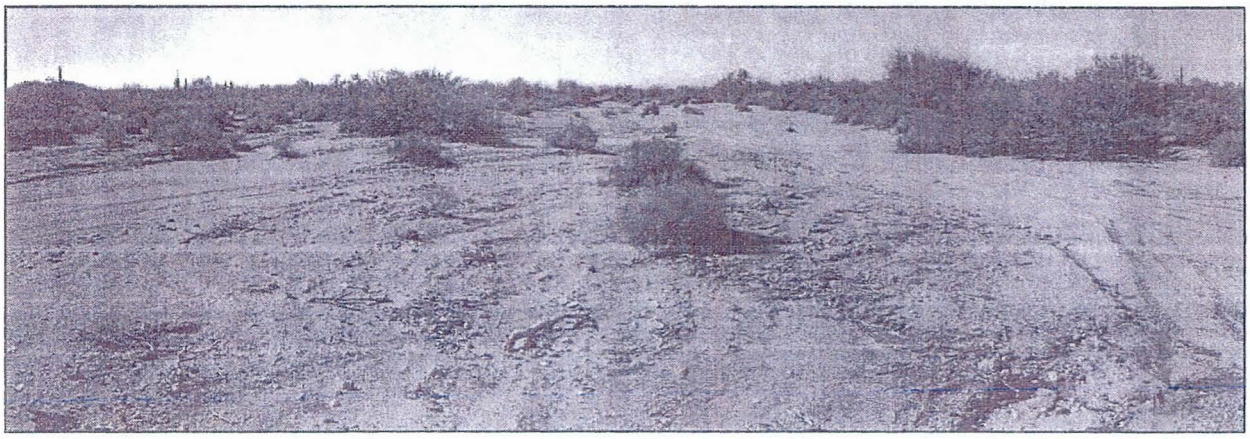

Figure 6.24. View looking downstream from the hydrographic apex of the active White Tank Fan (USGS Site 36).

6.1.18 USGS Site 37

The USGS Site 37 active alluvial fan is an unstable area that is located directly north of the White Tank Fan (USGS Site 36) and is three miles east of Sun Valley Parkway. The USGS Site 37 fan was previously identified as Hassayampa Tributary #2 (Hjalmarson and Kemna 1991; Hjalmarson 1994). The site extends about two miles from northeast to southwest. **Figure 6.25** shows the fan downstream of the hydrographic apex.

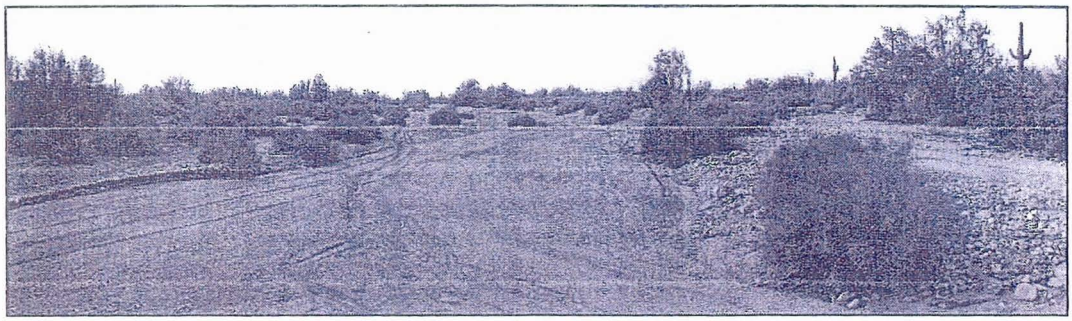

Figure 6.25. View looking downstream from the hydrographic apex at USGS Site 37.

The USGS Site 37 active area is the third largest active site in this area spanning 466.2 acres. Only the Skyline Wash Fan and the White Tank Fan are larger. The area is mapped almost entirely as a late Holocene surface, except for two smaller areas that are mapped as late to early Holocene (Field and Pearthree 1991). USGS Site 37 is also mapped almost entirely as a high flood hazard except for the areas mapped as late to early Holocene, which are classified as an intermediate flood hazard (Field and Pearthree 1992). The distributary flow pattern and undefined flow path areas are readily visible on the aerial photography. The topographic analysis reveals a wide, undissected landscape with very few contour crenulations and almost no channel incision. There are two main arms of instability at the lower end of the active area.

6.1.19 USGS Site 38

The USGS Site 38 active alluvial fan is an unstable area that is located northwest of USGS Site 37 and terminates to the west at the Sun Valley Parkway. The apex of the site is one and one half miles east of the Sun Valley Parkway. The USGS Site 38 fan was previously identified as Hassayampa Tributary #3 (Hjalmarson and Kemna 1991; Hjalmarson 1994). The site is 466.2 acres in size and extends almost two miles from northeast to southwest. **Figure 6.26** shows the fan downstream of the hydrographic apex.

Figure 6.26. View looking downstream from the apex of USGS Site 38.

The unstable portion of USGS Site 38 covers 348.2 acres. Except for two smaller areas that are mapped as late to early Holocene in age, most of the area is mapped as late Holocene in age (Field and Pearthree 1991). The USGS Site 38 area is split by the Sun Valley Parkway with an eastern portion and a western portion that is split into two branches (**Figure 6.27**). In the upstream (eastern) portion, the northwest half of the area is delineated as late Holocene in age, while the southeast half is delineated as late to early Holocene in age (Field and Pearthree 1991). The two downstream (western) branches are mapped as late Holocene in age (Field and Pearthree 1991). Relative to the flood hazard mapping (Field and Pearthree 1992), in the upstream (eastern) portion, the northwest half of the area is mapped as a high flood hazard, while the southeast half of the area is mapped as an intermediate flood hazard. The two downstream (western) branches are mapped as high flood hazards (Field and Pearthree 1992).

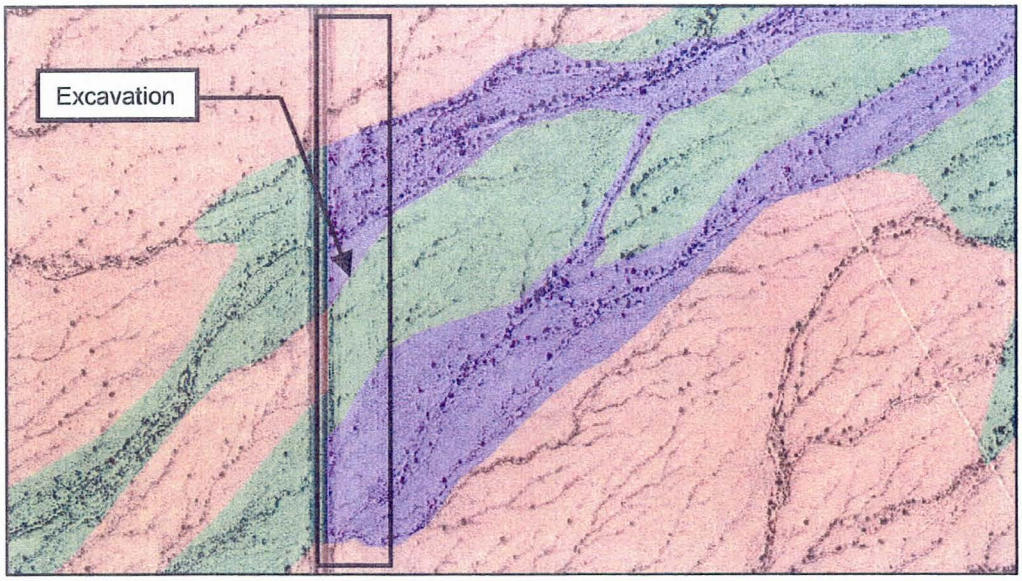

Figure 6.27. Aerial photo (2003) showing the mapped active fan (purple), inactive fan (green), and relict fan (orange) areas at USGS Site 38. Note the apparent excavation area along the east side of Sun Valley Parkway.

The unstable area of the USGS Site 38 active alluvial fan appears to have a narrower active zone relative to the other USGS sites in the current aerial photography (2003), with desert trees confined mainly to the margins of the primary channels. The site is a distributary flow zone with areas of undefined flow paths, but the channels are slightly more incised than those at other sites. The vegetation patterns are identifiably different from the areas delineated as relict fan and as inactive areas that surround the active area. The active area appears slightly lighter on the black and white aerial photography and the desert bushes appear more patchy and scattered. The boundary along the south edge of the north branch was adjusted northward in the field with less active area than was initially mapped. A small part of the area originally mapped as active appeared during the field investigation to be slightly higher in elevation than the rest of the active area and had a different surface texture composed of poorly developed desert pavement.

There appears to have been some recent shallow excavation (or surface scraping) along the east side of the Sun Valley Parkway at the western ends of the active areas of USGS Site 38 as defined by the lighter rectangular area visible in Figure 6.27. The reason for the excavation is unknown.

6.1.20 USGS Site 39

The USGS Site 39 active alluvial fan is an unstable area that extends roughly two miles from northeast to southwest, is located directly north of USGS Site 38, and terminates at the Sun Valley Parkway. The hydrographic apex of the site is one and two-thirds miles east of Sun Valley Parkway. The USGS Site 39 fan was previously identified as Hassayampa Tributary #4 (Hjalmarson and Kemna 1991; Hjalmarson 1994). **Figure 6.28** shows the fan downstream of the hydrographic apex.

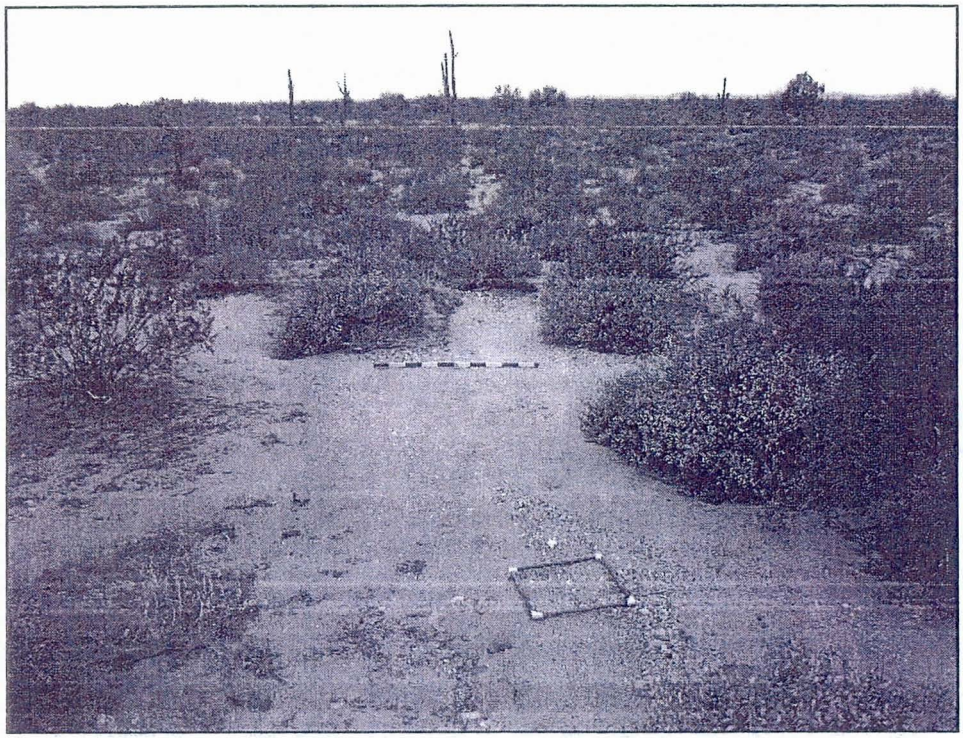

Figure 6.29. View looking west from the southern branch of the USGS Site 39 active alluvial fan in the area that was revised during the field investigation.

6.1.22 Skyline Wash Tributary Fan

The Skyline Wash tributary fan is an unstable area encompassing about 62 acres that extends roughly 2,200 feet from north to south and is located at the southeast corner of the Skyline Wash Fan and directly north of Buckeye Flood Retarding Structure #3 where it ends. The active alluvial fan was mapped as part of the approximate floodplain delineation study conducted by DEI-HEC (1997).

6.2 Other Unstable Areas

There are a number of other non-active alluvial fan areas that can be considered conditionally unstable. These areas were identified as part of Task 2.6.4 (Existing Conditions Assessment of Primary Washes), but a brief discussion of these areas is provided here.

The conditionally unstable areas are outlined in red on the attached plates (Plates 1 through 5). Most of the areas are located along washes, floodways, or through-flow channels that are confined or entrenched within relict or inactive fan surfaces. They may be identified as inset active alluvial fans, but in most cases they are the result of any number of causes such as a loss of conveyance or channel braiding due to changes in slope or localized aggradation, flow deflection around obstructions, a reduction in stream gradient associated with extensive shallow or exposed caliche or bedrock across the floodway, a natural widening of an entrenched floodway that allows for lateral adjustments, or localized backwater sedimentation associated with sharp downstream bends, dense vegetation, or severe floodway constrictions.

Most of the conditionally unstable areas are reaches containing multiple channels or defined flow paths that produce a braided or anastomosed pattern, whereby flow passes through a given confined reach along one or more paths (**Figure 6.30**). Although these reaches are considered as being unstable areas under the PFHAM methodology, they pose little hazard outside the confining margins of the defined floodway since it is likely that most of these areas would be contained within the 100-year flood boundary. However, in some cases, evidence exists that indicates flow breakouts along low-lying areas have occurred in the past or may occur in the future.

Figure 6.30. View looking upstream showing the braided pattern of a wash entrenched into a relict fan. The left bank area is a low terrace that is being dissected by overbank flows.

The conditionally unstable throughflow channel reaches generally fall into one of three categories: (1) individually confined split or distributary flow paths, (2) multiple split or braided flow paths confined within a single reach, and (3) confined localized aggradational reaches with split, braided, or undefined flow paths. The first category is associated with well-defined throughflow channels that may diverge or split into numerous smaller channels, which may rejoin, while still remaining well confined (**Figure 6.31**). The second type of channel reach is one that has a confined braided or multiple channel appearance similar to that shown in **Figure 6.32**. The third type of channel is one that bifurcates or diverges into two or more flow paths as a result of localized aggradation, possibly associated with an obstruction in the flow path, but is still generally confined within a well-defined boundaries (**Figure 6.33**). This type of channel reach is sometimes described as an inset active alluvial fan, although it is technically not an alluvial fan.

Figure 6.31. View of a well defined throughflow channel that diverges into two primary channels and several smaller channels. The confined flow split converges downstream.

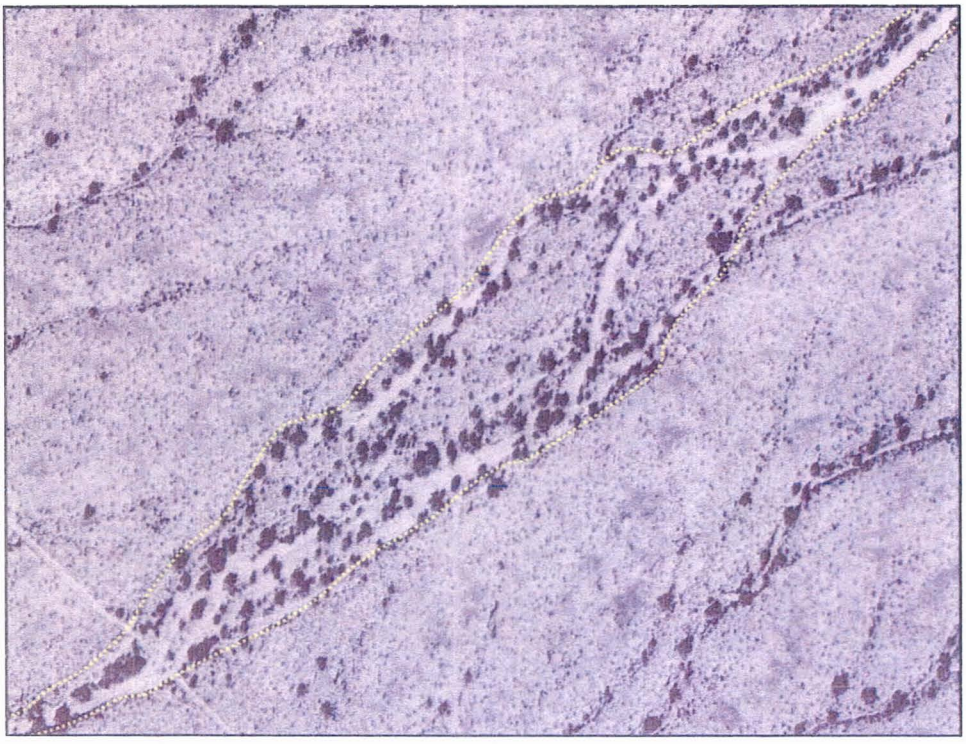

Figure 6.32. View of a throughflow channel that diverges into multiple braided channels, but still confined within well-defined boundaries (yellow lines) before converging downstream.

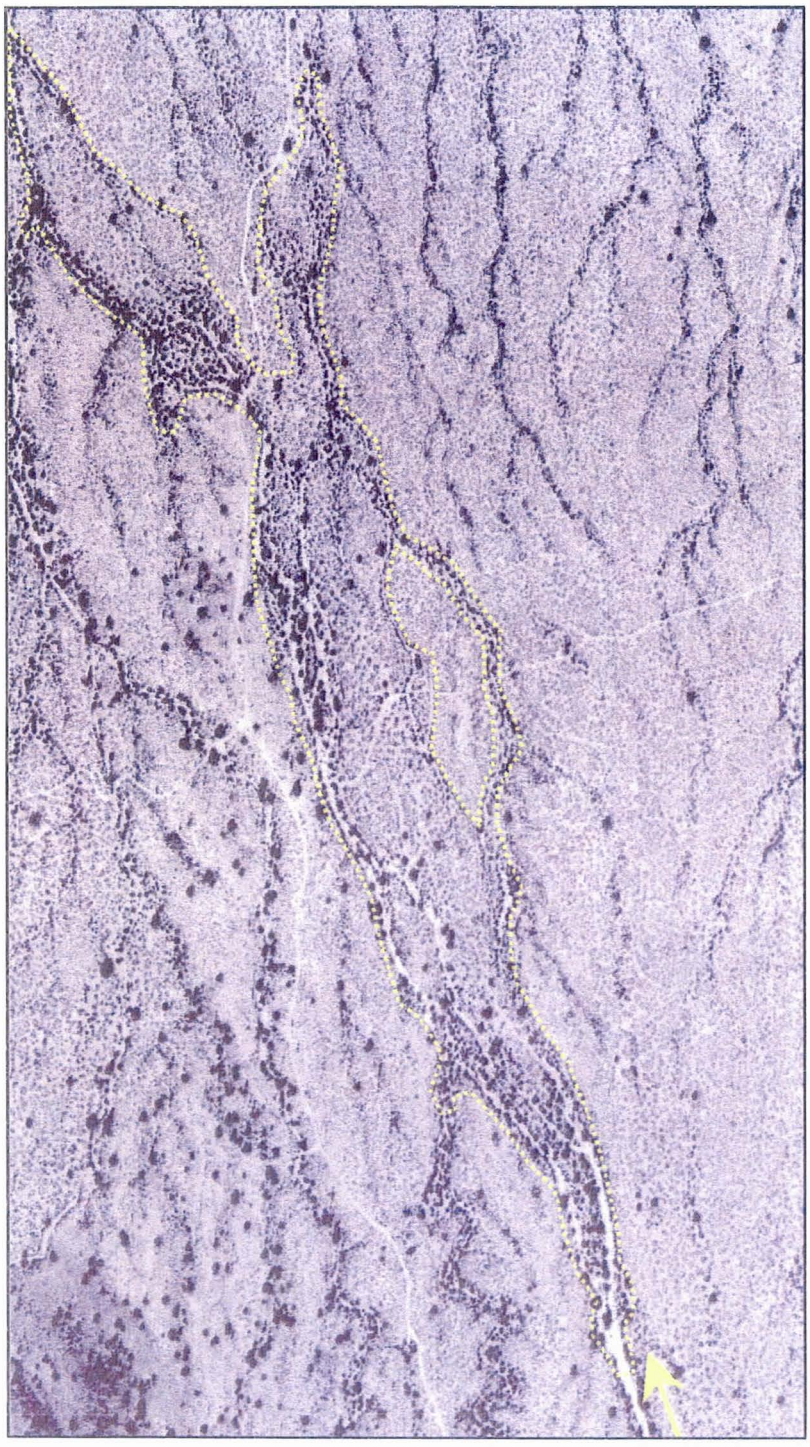

Figure 6.33. View of a throughflow channel that diverges into braided and undefined flow paths as a result of localized aggradation, loss of channel capacity, and anthropogenic changes. Most of the reach is still confined within relatively well-defined boundaries (yellow lines).

In several locations within the BSV ADMS study area, there are inset or entrenched conditionally unstable areas of anastomosed flow distribution, which are defined by oval-shaped multiple braided or split flow zones that have a diffluence at their upstream ends (**Figure 6.34**). The braided or split flow pattern within the individual zones is likely caused by stream capture, avulsions, obstructions, flow ramping, and/or localized aggradation at the diffluence points. The oval shape is attributed to flow path divergence at the upstream end followed by flow path convergence at the downstream end (**Figure 6.35**). Although these areas may be identified as active inset alluvial fans, for the purposes of this report they are mapped as being conditionally unstable – high hazard (see Section 7).

The flow patterns and characteristics of the conditionally unstable areas are similar to those discussed by Wertz (1963 1966) for steep, ephemeral, mountain stream channels in southern and southwestern Arizona. Ayres Associates (1996) identified similar patterns, characteristics, and process along Yuma Wash near Yuma, Arizona. Although most of Wertz's work deals with mountain stream channels that exit onto a gently sloping piedmont, many of the processes he describes may be applicable to the channels in the BSV study area.

In a number of other locations, conditionally unstable areas are areas or reaches where the primary flow path, which is situated on an inactive alluvial fan and alluvial plain surface and is not entrenched or well confined, loses capacity and flow is distributed across the ground surface along undefined flow paths (**Figure 6.36**). These are not active alluvial fan areas because the channel does not transport any appreciable sediment into the unconfined zoned, and the sediment that is deposited in the unconfined zone is deposited in a thin veneer over a very limited area. In almost all cases, the upstream channel capacity is very small and the amount of flow transported in these reaches is minimal. The predominant hazard associated with these areas is from sheet flooding and poorly defined, shallow surface flow generally much less than 1 foot deep. Several of the small channels located on the inactive alluvial fan surfaces at the southwest end of Area 3, in area 4 south and east of the Sun Valley Parkway (**Figure 6.37**), and on the north side of the urbanized area just north of Buckeye FRS #1 terminate in this way.

6.3 Summary

Historic aerial photography, topographic maps, surface geology maps, flood hazard maps, soils maps, the PFHAM Stage 1 landform delineations, and the PFHAM Stage 2 methodology were used to identify, delineate, and map the areas of landform instability. Unstable areas were verified in the field using a handheld GIS-based GPS receiver. Common unstable areas include active alluvial fans, some multi-channel areas below active alluvial fans, alluvial plain with active sedimentation, multi-channel pocket along a throughflow channel, areas of recent sediment deposition and erosion, split flow channel where flow is wide and shallow, and areas of low relief where minor development such as roads can divert floodwater and cause significant erosion in areas otherwise not susceptible to flood hazard. A total of 16 new active alluvial fans were identified in addition to the three identified by the USGS and the previously studied White Tank and Skyline Wash fans. Since the exact boundaries of the three USGS fans (Sites 37, 38, and 39) were not delineated as part of previous studies, their boundaries were delineated as part of this project.

The areas of instability are identified on the accompanying mapping as those areas delineated in red. The solid red areas on the mapping represent areas of extreme hazard associated with active alluvial fans. The open areas outlined in red on the maps represent other unstable areas. The other unstable areas are further defined in Section 7 as being either a moderate or high hazard depending on the features associated with the area.

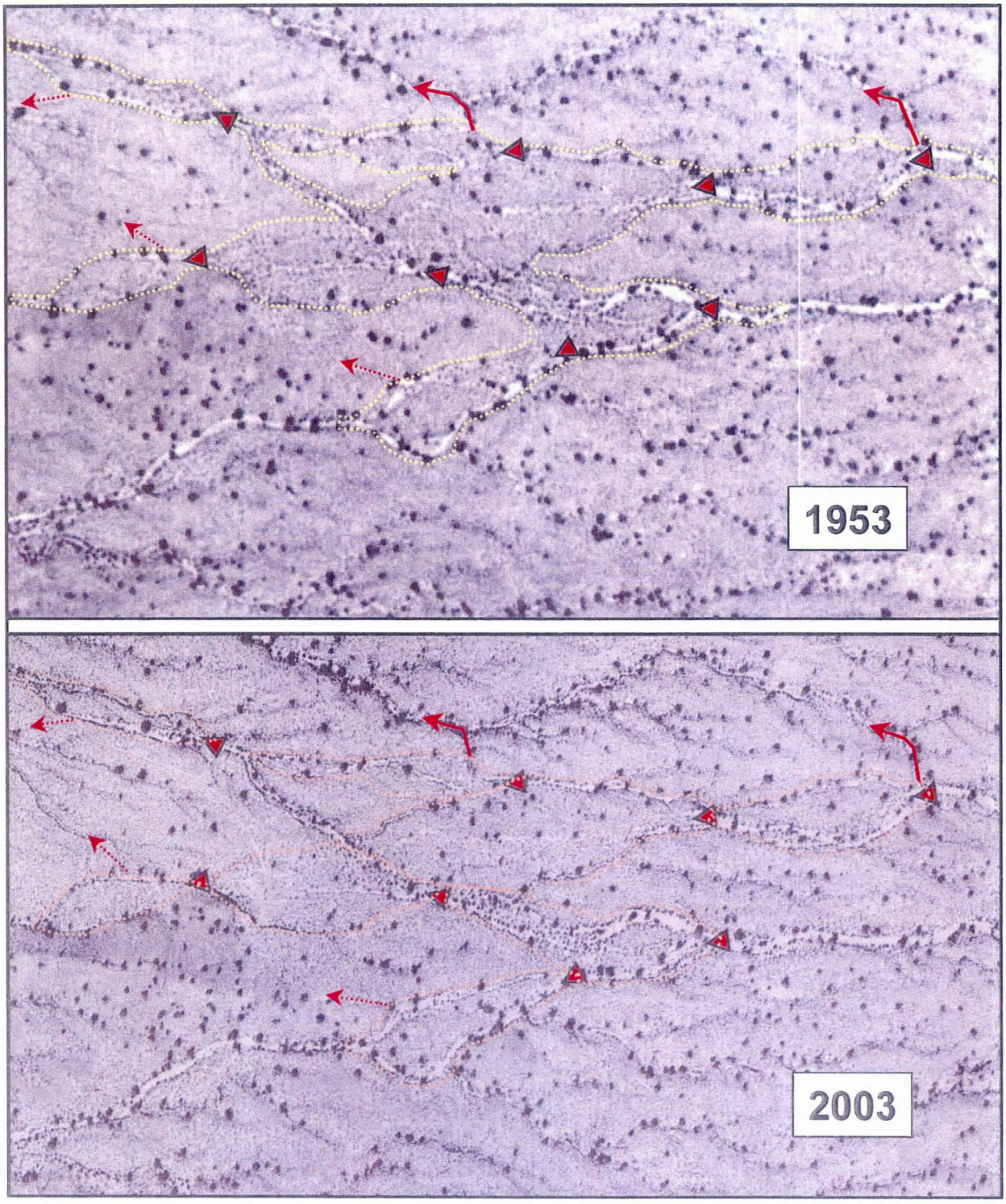

Figure 6.34. Aerial photos from 1953 and 2003 showing area of anastomosed flow distribution (yellow boundaries) with zones of braided and split flow (orange boundaries). Diffluence of individual zones marked by red triangles. Solid red arrows show additional flow distribution and dotted red arrows show locations of past or potential future flow breakout points.

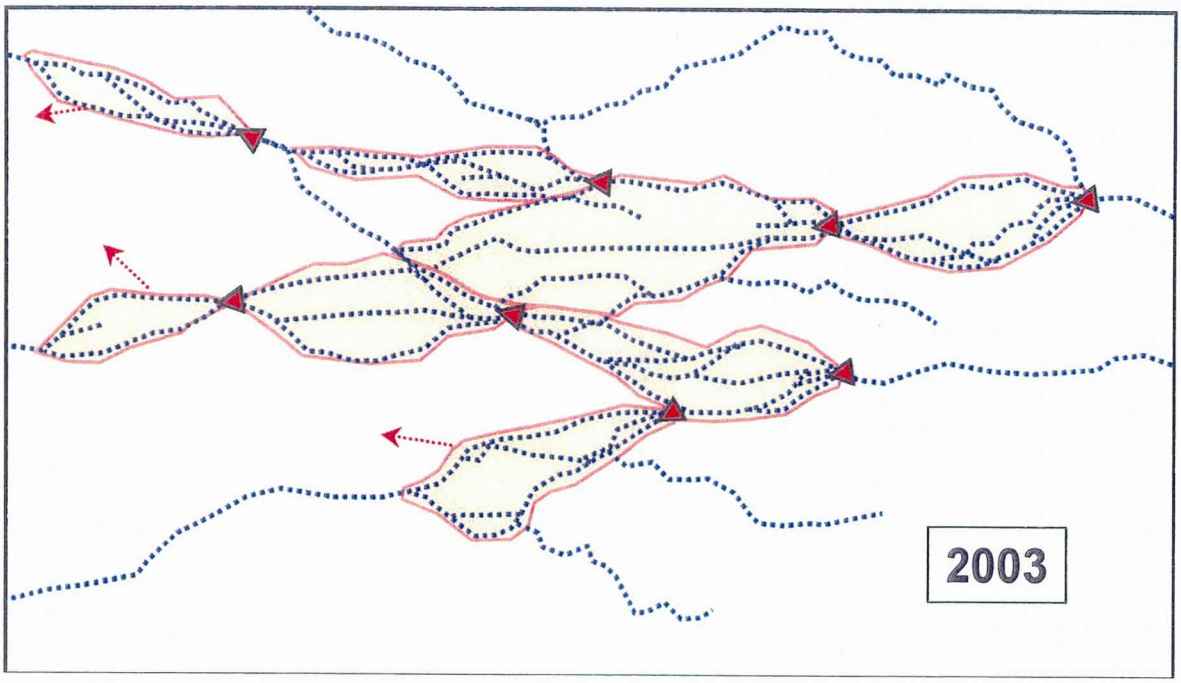

Figure 6.35. Schematic of 2003 aerial photo from Figure 5.5 showing area of anastomosed flow distribution with zones of braided and split flow (orange boundaries). The blue lines represent well-defined flow paths identified on the photos. Major diffluences are marked by red triangles.

Figure 6.36. View looking upstream showing the loss of channel capacity and undefined overland flow on an inactive alluvial fan surface.

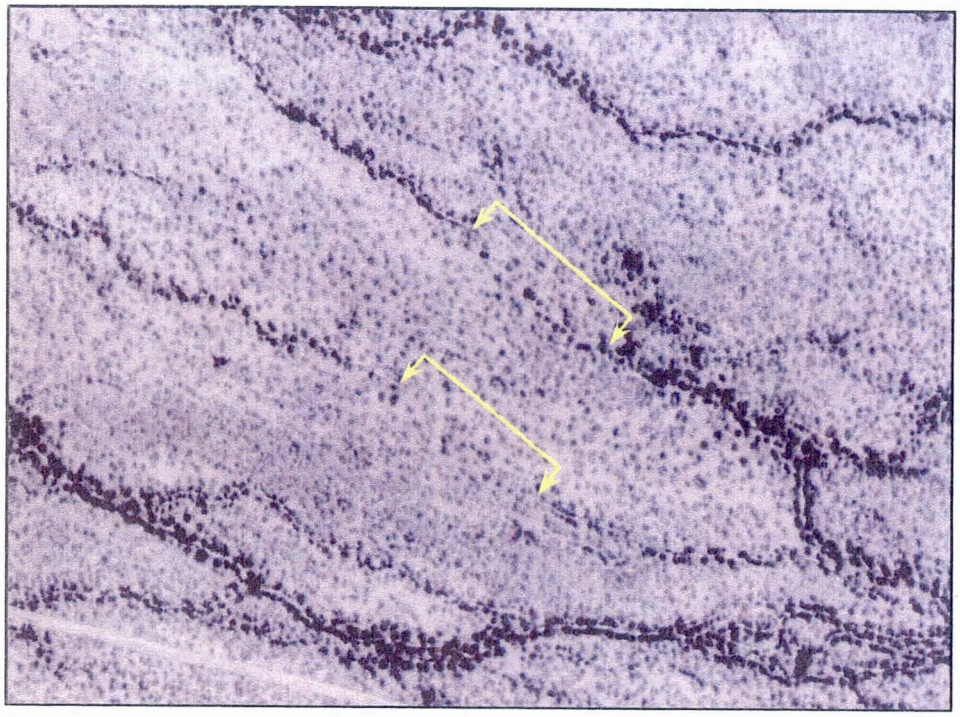

Figure 6.37. Aerial view of the loss of channel capacity and undefined overland flow on an inactive alluvial fan surface in Area 4 just east of Sun Valley Parkway and Wagner Wash.

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945000 940000 935000 930000 925000 920000 915000

WAGNER WASH

VERIFICATION SITE #4

WHITE TANK MOUNTAINS

SUN VALLEY PARKWAY

HASSAYAMPA RIVER

USGS SITE 39

VERIFICATION SITE #5

WHITE TANKS WASH

USGS SITE 38

WHITE TANK FAN (USGS SITE 36)
Approximate Floodplain Delineation Study (2001)
Wood, Patel & Associates, Inc. and
JE Fuller/Hydrology & Geomorphology, Inc.

USGS SITE 37

DATE OF AERIAL PHOTOGRAPHY: 2003

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BUCKEYE/SUN VALLEY AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD2002C027
TASK 2.6.2

STAGE 1
PIEDMONT LANDFORM DELINEATION

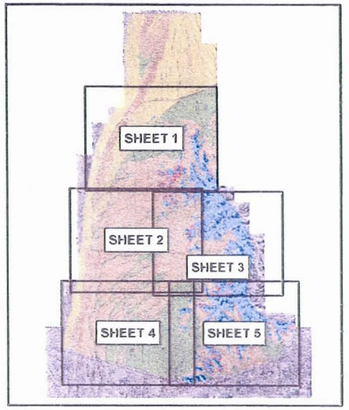
LEGEND

50ft Contours

Landform

- Alluvial Fan
- Alluvial Plain
- Relict Fan
- Pediment
- Bedrock

INDEX MAP



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SCALE: 1" = 1,500 ft

COORDINATE SYSTEM:
STATE PLANE CENTRAL ZONE

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
20868
WILLIAM J.
SPITZ
Date Signed
ARIZONA, U.S.A.

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SUBMITTED BY

DATE: 05/12/05

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: _____ DATE: _____

APPROVED BY: _____ DATE: _____

CHIEF ENGINEER AND GENERAL MANAGER

445000 450000 455000 460000 465000 470000 475000 480000

915000 910000 905000 900000 895000 890000 885000

HASSAYAMPA RIVER

VERIFICATION SITE #6

USGS SITE 37

VERIFICATION SITE #1

WHITE TANK FAN (USGS SITE 36)
Approximate Floodplain Delineation Study (2001)
Wood, Patel & Associates, Inc. and
JE Fuller/Hydrology & Geomorphology, Inc.

WHITE TANKS WASH

FLOOD RETARDING STRUCTURE #1

I-10

DATE OF AERIAL PHOTOGRAPHY: 2003

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BUCKEYE/SUN VALLEY AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD2002C027
TASK 2.6.2

STAGE 1
PIEDMONT LANDFORM DELINEATION

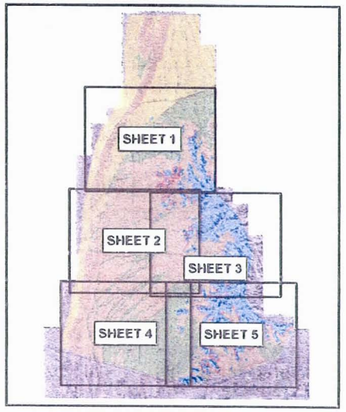
LEGEND

50ft Contours

Landform

- Alluvial Fan
- Alluvial Plain
- Relict Fan
- Pediment
- Bedrock

INDEX MAP



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WAGNER WASH

BSV SITE #4

BSV SITE #5

WHITE TANK MOUNTAINS

SUN VALLEY PARKWAY

HASSAYAMPA RIVER

BSV SITE #6

USGS SITE 39

BSV SITE #14

WHITE TANKS WASH

USGS SITE 38

WHITE TANK FAN (USGS SITE 36)
Approximate Floodplain Delineation Study (2001)
Wood, Patel & Associates, Inc. and
JE Fuller/Hydrology & Geomorphology, Inc.

USGS SITE 37

BSV SITE #15

DATE OF AERIAL PHOTOGRAPHY: 2003

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BUCKEYE/SUN VALLEY AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD2002C027
TASK 2.6.3

STAGE 2
PIEDMONT LANDFORM STABILITY ASSESSMENT

LEGEND

50ft Contours

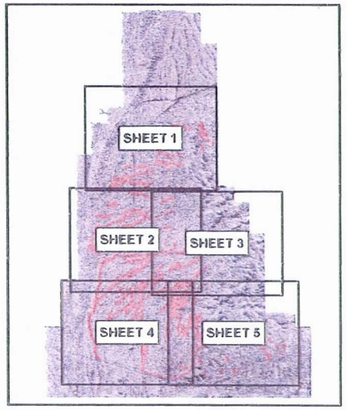
Apex

- Hydrographic
- Topographic

Landform Stability Assessment

- Unstable, Active Alluvial Fan
- Conditionally Unstable

INDEX MAP



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COORDINATE SYSTEM:
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915000 910000 905000 900000 895000 890000 885000

USGS SITE 38

BSV SITE #15

USGS SITE 37

HASSAYAMPA RIVER

BSV SITE #7

WHITE TANKS WASH

WHITE TANK FAN (USGS SITE 36)
Approximate Floodplain Delineation Study (2001)
Wood, Patel & Associates, Inc. and
JE Fuller/Hydrology & Geomorphology, Inc.

FLOOD RETARDING STRUCTURE #1

I-10

DATE OF AERIAL PHOTOGRAPHY: 2003

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BUCKEYE/SUN VALLEY AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD2002C027
TASK 2.6.3

STAGE 2
PIEDMONT LANDFORM STABILITY ASSESSMENT

LEGEND

50ft Contours

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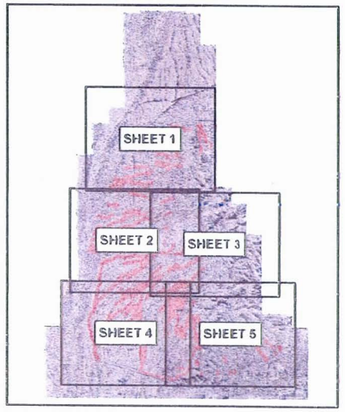

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CHIEF ENGINEER AND GENERAL MANAGER

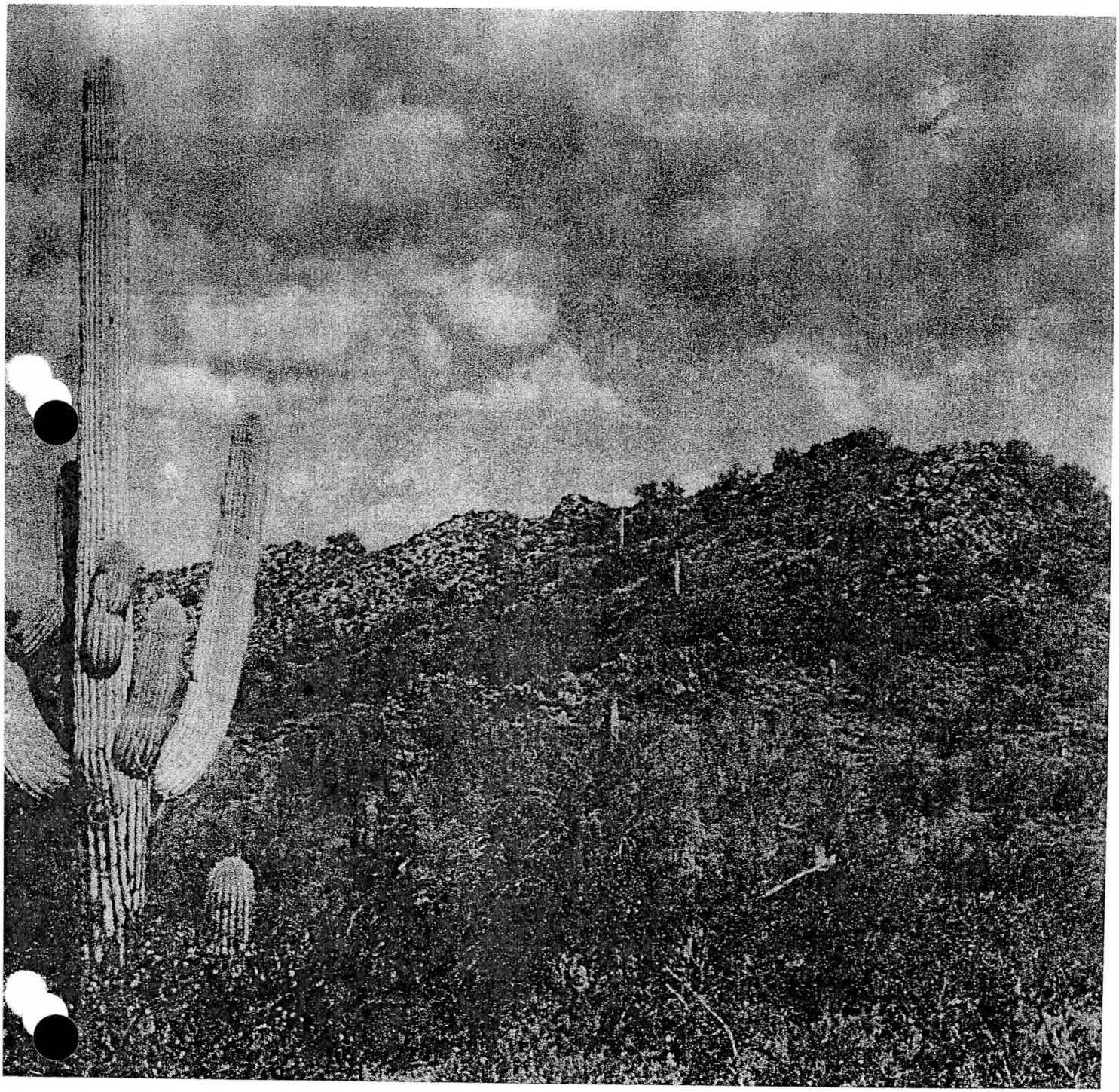
G.4 NRCS Soil Map Unit Descriptions

United States Department of Agriculture

S
C rvation
Ser

In Cooperation with United States Department of the Interior, Bureau of Indian Affairs and Bureau of Land Management, and the Arizona Agricultural Experiment Station

Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona



This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1981. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Indian Affairs and Bureau of Land Management, and the Arizona Agricultural Experiment Station. It is part of the technical assistance furnished to the Agua Fria-New River, Buckeye-Roosevelt, East Maricopa, and Wickenburg Natural Resource Conservation Districts.

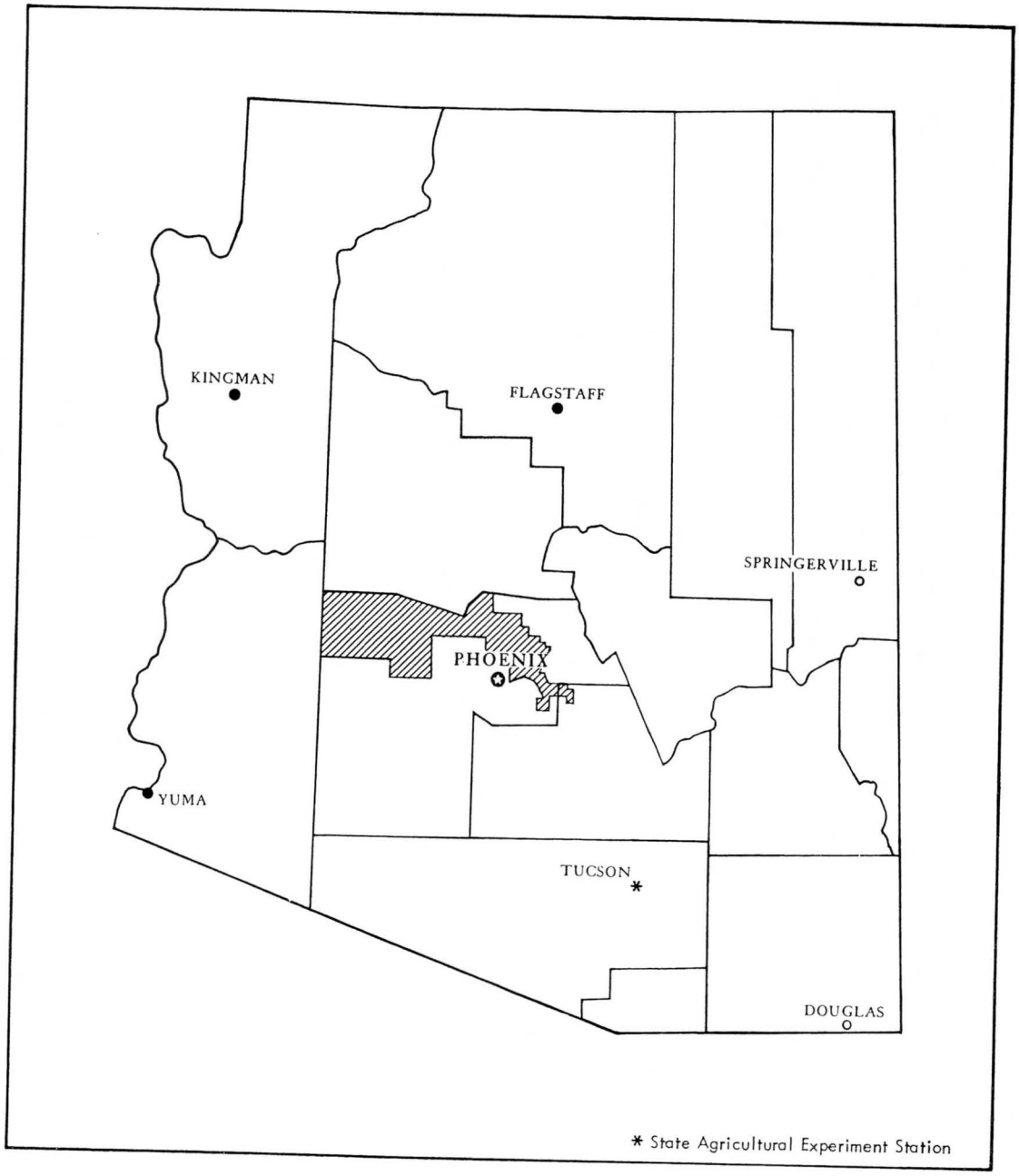
Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Desert plants on Vaiva very gravelly loam, 1 to 20 percent slopes. Dominant plants are saguaro, triangle bursage, and littleleaf paloverde.

Index to Map Units

1—Antho sandy loams 12
2—Antho gravelly sandy loams 12
3—Antho-Carrizo-Maripo complex 13
4—Antho-Carrizo-Maripo complex, low precipitation .. 14
5—Anthony sandy loam 15
6—Anthony-Arizo complex 15
7—Anthony-Arizo complex, low precipitation 16
8—Arizo cobbly sandy loam 16
9—Beeline-Cipriano complex, 3 to 45 percent slopes 17
10—Brios-Carrizo complex, 1 to 5 percent slopes 17
11—Brios-Carrizo complex, low precipitation, 1 to 5 percent slopes 19
12—Carefree cobbly clay loam, 1 to 8 percent slopes 19
13—Carefree-Beardsley complex 20
14—Carrizo very gravelly sand 20
15—Carrizo-Gunsight complex, 1 to 5 percent slopes 21
16—Cellar-Rock outcrop complex, 10 to 70 percent slopes 21
17—Cellar-Rock outcrop complex, low precipitation, 10 to 70 percent slopes 22
18—Cherioni-Rock outcrop complex, 5 to 60 percent slopes 22
19—Chuckawalla-Gunsight complex, 1 to 8 percent slopes 24
20—Chuckawalla-Gunsight complex, low precipitation, 1 to 8 percent slopes 24
21—Cipriano very gravelly loam 26
22—Contine clay loam 26
23—Contine clay 27
24—Continental clay loam, 0 to 3 percent slopes 28
25—Continental clay, 0 to 3 percent slopes 28
26—Continental cobbly clay loam, 1 to 8 percent slopes 29
27—Continental-Mohave complex, 1 to 7 percent slopes 30
28—Continental-Ohaco complex 30
29—Denure-Momoli-Carrizo complex 31
30—Denure-Momoli-Carrizo complex, low precipitation 31
31—Dixaleta-Rock outcrop complex, 25 to 65 percent slopes 32
32—Dixaleta-Rock outcrop complex, low precipitation, 25 to 65 percent slopes 33
33—Eba very gravelly loam, 1 to 8 percent slopes 33
34—Eba very gravelly loam, 8 to 20 percent slopes .. 34
35—Eba very gravelly loam, low precipitation, 8 to 20 percent slopes 34
36—Eba-Continental complex, 1 to 8 percent slopes 34
37—Eba-Continental-Cave association, 3 to 20 percent slopes 35
38—Eba-Continental-Cave association, low precipitation, 3 to 20 percent slopes 36
39—Eba-Nickel-Cave association, 3 to 25 percent slopes 37
40—Eba-Pinaleno complex, 3 to 20 percent slopes .. 38
41—Eba-Pinaleno complex, 20 to 40 percent slopes 39
42—Eba-Pinaleno complex, low precipitation, 3 to 20 percent slopes 39
43—Eba-Pinaleno complex, low precipitation, 20 to 40 percent slopes 40
44—Ebon very gravelly loam, 1 to 8 percent slopes.. 40
45—Ebon very gravelly loam, 8 to 20 percent slopes 41
46—Ebon-Contine complex, 1 to 8 percent slopes 42
47—Ebon-Gunsight-Cipriano association, 3 to 25 percent slopes 42
48—Ebon-Pinamt complex, 3 to 20 percent slopes ... 43
49—Ebon-Pinamt complex, 20 to 40 percent slopes . 44
50—Estrella loams 45
51—Gachado-Lomitas complex, 8 to 25 percent slopes 45
52—Gachado-Lomitas-Rock outcrop complex, 7 to 55 percent slopes 46
53—Gadsden clay 47
54—Gila fine sandy loams 47
55—Gilman loams 48
56—Gilman loams, low precipitation 49
57—Gilman clay loam 50
58—Gilman-Momoli-Denure complex 50
59—Gilman-Momoli-Denure complex, low precipitation 50
60—Glenbar loams 51
61—Gran-Wickenburg complex, 1 to 10 percent slopes 52
62—Gran-Wickenburg complex, low precipitation, 1 to 10 percent slopes 53
63—Gran-Wickenburg-Rock outcrop complex, 10 to 65 percent slopes 53
64—Gran-Wickenburg-Rock outcrop complex, low precipitation, 10 to 65 percent slopes 55
65—Greyeagle-Continental-Nickel association, 1 to 40 percent slopes 56
66—Greyeagle-Suncity Variant complex, 1 to 7 percent slopes 56

67—Guest clay 57
68—Gunsight-Cipriano complex, 1 to 7 percent slopes 58
69—Gunsight-Cipriano complex, low precipitation, 1 to 7 percent slopes 59
70—Gunsight-Rillito complex, 1 to 25 percent slopes 59
71—Gunsight-Rillito complex, low precipitation, 1 to 40 percent slopes 60
72—Lehmans-Rock outcrop complex, 8 to 65 percent slopes 60
73—Lehmans-Rock outcrop complex, low precipitation, 8 to 65 percent slopes 61
74—Luke-Cipriano association, 1 to 15 percent slopes 61
75—Mohall loam 62
76—Mohall loam, calcareous solum 63
77—Mohall clay loam 63
78—Mohall clay loam, calcareous solum 64
79—Mohall clay 65
80—Mohall-Tremant complex, 1 to 8 percent slopes 65
81—Mohall-Tremant complex, low precipitation, 1 to 8 percent slopes 66
82—Mohave sandy loam 66
83—Mohave loam 67
84—Mohave loam, calcareous solum 67
85—Mohave clay loam 68
86—Mohave clay loam, calcareous solum 68
87—Mohave complex 69
88—Mohave-Guest complex 69
89—Mohave-Tres Hermanos complex, 1 to 8 percent slopes 70
90—Momoli gravelly sandy loam, 1 to 5 percent slopes 71
91—Momoli-Carrizo complex 71
92—Momoli-Carrizo complex, low precipitation 71
93—Nickel-Cave complex, 8 to 30 percent slopes 72
94—Nickel-Cave complex, low precipitation, 8 to 30 percent slopes 73
95—Ohaco gravelly loam 74
96—Pinaleno-Tres Hermanos complex, 1 to 10 percent slopes 74
97—Pinaleno-Tres Hermanos complex, low precipitation, 1 to 10 percent slopes 75
98—Pinamt-Tremant complex, 1 to 10 percent slopes 75
99—Pinamt-Tremant complex, low precipitation, 1 to 10 percent slopes 76
100—Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 percent slopes 77
101—Rillito loam, 0 to 3 percent slopes 78
102—Rillito gravelly loam, 1 to 8 percent slopes 78
103—Rock outcrop-Gachado complex, 5 to 55 percent slopes 79
104—Rock outcrop-Lehmans complex, 15 to 65 percent slopes 79
105—Rock outcrop-Lehmans complex, low precipitation, 15 to 65 percent slopes 80
106—Sal-Cipriano complex, 1 to 10 percent slopes .. 80
107—Sal-Cipriano complex, low precipitation, 1 to 10 percent slopes 81
108—Schenco-Rock outcrop complex, 3 to 25 percent slopes 81
109—Schenco-Rock outcrop complex, 25 to 60 percent slopes 82
110—Suncity-Cipriano complex, 1 to 7 percent slopes 83
111—Torriorthents, 15 to 40 percent slopes 85
112—Tremant gravelly sandy loams 85
113—Tremant gravelly loams 86
114—Tremant gravelly loams, low precipitation 86
115—Tremant-Antho complex, 1 to 5 percent slopes 87
116—Tremant-Gunsight-Rillito complex, 1 to 5 percent slopes 88
117—Tremant-Gunsight-Rillito complex, low precipitation, 1 to 5 percent slopes 88
118—Tremant-Rillito complex 89
119—Tremant-Suncity complex, 1 to 8 percent slopes 90
120—Tres Hermanos gravelly sandy loams 90
121—Tres Hermanos-Anthony complex, 1 to 5 percent slopes 91
122—Vado gravelly sandy loam, 1 to 5 percent slopes 92
123—Vaiva very gravelly loam, 1 to 20 percent slopes 92
124—Valencia sandy loam 93
125—Vint loamy fine sand 93



Location of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, in Arizona.

The Antho and Maripo soils have moderate potential for producing forage. They respond well to rangeland management. Where the range is in good or excellent condition, the soils produce forage year round. They are easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Fencing and developing watering facilities help to control grazing. To control erosion, extra care must be taken to maintain a good plant cover. In a few areas these soils are calcareous in the surface layer and are therefore less productive than in most other areas of the unit.

The Carrizo soil is one of the most productive rangeland soils in the survey area. It receives extra moisture from runoff, which increases production. The soil responds well to rangeland management. Extra care in management is needed to protect the soil from gullying and channeling. This soil can produce forage year round, and it is easily traversed by cattle. Because of the availability of water, ease of access, and abundance of feed, some areas of this soil are overgrazed.

The riparian habitat in some areas of the Carrizo soil is extremely important to wildlife.

The soils in this unit are severely limited for urban use because they are in drainageways and on flood plains that are subject to flooding.

This map unit is in capability subclass VIIw, nonirrigated. The Antho and Maripo soils are in the Sandy Loam Upland, 7- to 10-inch p.z., range site, and the Carrizo soil is in the Sandy Bottom, 7- to 10-inch p.z., range site.

4—Antho-Carrizo-Maripo complex, low precipitation. This map unit is on flood plains and in drainageways. Slope is 0 to 3 percent. Elevation is 1,100 to 2,100 feet. The average annual precipitation is 2 to 7 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 35 percent Antho sandy loam, 30 percent Carrizo very gravelly sand, and 20 percent Maripo sandy loam. The Antho and Maripo soils are on flood plains, and the Carrizo soil is in narrow, meandering drainageways. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Brios soils in drainageways, Gilman and Vint soils on flood plains, and Denure, Momoli, and Carrizo soils on stream terraces. The included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Antho soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is brown sandy loam about 3 inches thick. The underlying material to a depth of 60 inches or more is light brown, slightly calcareous sandy loam. In some areas the soil is calcareous throughout.

Permeability of the Antho soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. Where unprotected, this soil is subject to rare periods of flooding.

The Carrizo soil is deep and excessively drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the soil is pinkish gray, calcareous very gravelly sand and very gravelly coarse sand to a depth of 60 inches or more.

Permeability of the Carrizo soil is very rapid. Available water capacity is very low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is severe. Where unprotected, this soil is subject to occasional periods of flooding. Channeling, deposition, and streambank erosion occur during periods of flooding.

The Maripo soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is light brown sandy loam about 18 inches thick. The upper 11 inches of the underlying material is light brown, calcareous sandy loam, and the lower part to a depth of 60 inches or more is light brown, calcareous very gravelly loamy sand. Depth to very gravelly loamy sand ranges from 20 to 36 inches.

Permeability of the Maripo soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. Where unprotected, this soil is subject to rare periods of flooding.

This unit is used as rangeland and wildlife habitat.

The Antho and Maripo soils have low potential for producing forage. They respond well to rangeland management. Where the range is in good or excellent condition, the soils produce forage year round. They are easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Fencing and developing watering facilities help to control grazing. To control erosion, extra care must be taken to maintain a good plant cover. In a few areas these soils are calcareous in the surface layer and are therefore less productive than in most other areas of the unit.

The Carrizo soil is one of the most productive rangeland soils in the survey area. It receives extra moisture from runoff, which increases production. The soil responds well to rangeland management. Extra care in management is needed to protect the soil from gullying and channeling. This soil can produce forage year round, and it is easily traversed by cattle. Because of the availability of water, ease of access, and abundance of feed, some areas of this soil are overgrazed.

The riparian habitat in some areas of the Carrizo soil is extremely important to wildlife.

This map unit is in capability subclass VIIw, nonirrigated. The Antho and Maripo soils are in the Sandy Loam Upland, 2- to 7-inch p.z., range site, and the Carrizo soil is in the Sandy Bottom, 2- to 7-inch p.z., range site.

5—Anthony sandy loam. This deep and well drained soil is on flood plains and alluvial fans. It formed in alluvium derived dominantly from acid and basic igneous rock. Slope is 0 to 3 percent. Most of the areas used as cropland have slopes of less than 1 percent. Elevation is 1,800 to 2,500 feet. The average annual precipitation is 8 to 10 inches, and the average annual air temperature is 66 to 70 degrees F.

Typically, the surface layer is light brown sandy loam about 2 inches thick. The upper 38 inches of the underlying material is light brown and brown, calcareous gravelly sandy loam, and the lower part to a depth of 60 inches or more is light reddish brown, calcareous loam. In some areas this soil is noncalcareous to a depth of 10 inches or more, and in some areas the soil is affected by salts and sodium.

Included in this unit are small areas of Gila and Arizo soils. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Anthony soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. Where unprotected, this soil is subject to rare periods of flooding.

Most areas of this unit are used as rangeland and wildlife habitat. A few areas are used as irrigated cropland.

This unit has moderate potential for producing forage. It responds well to rangeland management. The unit can produce forage year round. It is easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Fencing and developing watering facilities help to control grazing. To control erosion, extra care must be taken to maintain a good plant cover. In some areas of this unit, the soil is calcareous in the surface layer and is therefore less productive than in most other areas of the unit.

If this unit is used as irrigated cropland, the main limitation is the moderate available water capacity. The soil in this unit generally is droughty in areas where it is surrounded by soils that have a higher available water capacity.

If feasible, irrigation systems should be designed to irrigate this soil separately from adjacent soils that have a lower water intake rate. Light and frequent applications of water are necessary. In the more sloping areas, irrigation streams can cause erosion. Erosion can be minimized by irrigating across the slope or by leveling the soil. Generally, leveling cuts can be made to a depth of about 40 inches without exposing unfavorable soil material. An onsite investigation is advisable, however, before irrigation systems are planned and leveling cuts are made.

Lining irrigation ditches with concrete reduces loss of water by seepage. Applying manure or cotton gin trash or plowing under crop residue or green manure crops increases the available water capacity and improves tilth. Fertilizer containing nitrogen should be applied in several light applications because it is readily leached below the root zone.

This map unit is in capability subclasses IIs, irrigated, and VIIs, nonirrigated. It is in the Sandy Loam Upland, 8- to 10-inch p.z., range site.

6—Anthony-Arizo complex. This map unit is on flood plains and in drainageways. Slope is 0 to 3 percent. Elevation is 1,800 to 3,000 feet. The average annual precipitation is 10 to 12 inches, and the average annual air temperature is 66 to 70 degrees F.

This unit is about 40 percent Anthony sandy loam and 40 percent Arizo gravelly sandy loam. The Anthony soil is on flood plains adjacent to drainageways, and the Arizo soil is in drainageways. The components of this unit are so intricately intermingled that it was not pracitical to map them separately at the scale used.

Included in this unit are small areas of sandy soils that are similar to the Arizo soil but are nongravelly. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Anthony soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is light brown sandy loam about 2 inches thick. The upper 38 inches of the underlying material is light brown and brown, calcareous gravelly sandy loam, and the lower part to a depth of 60 inches or more is light reddish brown, calcareous loam. In some areas this soil is noncalcareous to a depth of 10 inches or more.

Permeability of the Anthony soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is moderate. Where unprotected, this soil is subject to rare periods of flooding.

The Arizo soil is deep and excessively drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is pink gravelly sandy loam about 1 inch thick. The upper 7 inches of the underlying material is light brown very gravelly sandy loam, and the lower part to a depth of 60 inches or more is reddish yellow and pink, calcareous very gravelly loamy sand.

Permeability of the Arizo soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is severe. Where unprotected, this soil is

absorption field and by backfilling excavations with gravelly or sandy material. Poorly designed septic tank absorption fields can seriously compound the effects of shrinking and swelling if foundations are close to the absorption fields.

Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Clayey Upland, 7- to 10-inch p.z., range site.

13—Carefree-Beardsley complex. This map unit is on fan terraces. Slope is 0 to 3 percent. Elevation is 1,200 to 2,200 feet. The average annual precipitation is 7 to 10 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 50 percent Carefree cobbly clay and 40 percent Beardsley cobbly clay loam. The Carefree soil is dominantly in slightly concave areas, and the Beardsley soil is in slightly convex areas. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Antho and Carrizo soils on flood plains and Contine, Ebon, and Suncity soils on fan terraces. The included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

The Carefree soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is pink cobbly clay about 1 inch thick. The subsoil is light reddish brown, calcareous clay about 49 inches thick. The substratum to a depth of 60 inches or more is light brown, calcareous very cobbly clay.

Permeability of the Carefree soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Beardsley soil is moderately deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is reddish brown cobbly clay loam about 2 inches thick. The subsoil is reddish brown clay about 34 inches thick. A silica-cemented hardpan is at a depth of 36 inches.

Permeability of the Beardsley soil is slow. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as rangeland or wildlife habitat. A few areas are used for urban development.

This unit has moderate potential for producing forage. It responds well to rangeland management. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Tobosa, the dominant forage species, is unpalatable when cured and should therefore be used during the growing season. Fencing and developing watering facilities help to control grazing.

If the soils in this unit are used as sites for buildings or roads, the main limitations are the shrink-swell potential, and in the Beardsley soil, the depth to hardpan. The effects of shrinking and swelling can be reduced by maintaining a constant moisture content in the soil. Runoff should be diverted away from buildings. Landscaping plants that require little water should be used near building foundations, and overwatering should be avoided. A sealer can be used under roads to prevent shrinking and swelling of the material below. The effects of shrinking and swelling on building foundations can be minimized by using an appropriate engineering design and by backfilling with material that has a low shrink-swell potential. In addition, more reinforcement can be provided. The limited depth to the hardpan interferes with excavation, and ripping the pan may be necessary.

If the soils in this unit are used for septic tank absorption fields, the main limitations are the slow permeability and, in the Beardsley soil, the depth to the hardpan. The limitation of slow permeability can be minimized by increasing the size of the absorption field and by backfilling excavations with gravelly or sandy material. The hardpan restricts the movement of effluent. Where the hardpan is thin and is underlain by more permeable material, the pan can be ripped and the absorption lines placed below it. In some areas the size of the absorption field needed may exceed the lot size. Alternatives include locating absorption fields in more suitable soils in adjacent areas or installing community sewage systems. Poorly designed septic tank absorption fields can seriously compound the effects of shrinking and swelling if foundations are close to the absorption fields.

Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Clayey Upland, 7- to 10-inch p.z., range site.

14—Carrizo very gravelly sand. This deep and excessively drained soil is on flood plains and alluvial fans. It formed in alluvium derived dominantly from acid and basic igneous rock. Slope is 0 to 3 percent. Elevation is 1,200 to 1,400 feet. The average annual precipitation is 2 to 7 inches, and the average annual air temperature is 70 to 73 degrees F.

Typically, the surface layer is pinkish gray, calcareous very gravelly sand about 1 inch thick. The underlying material to a depth of 60 inches or more is pinkish gray, calcareous very gravelly sand and very gravelly coarse sand.

cluded in this unit are small areas of Antho, Brios, Maripo soils in positions similar to those of the rizo soil. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Carrizo soil is very rapid. Available water capacity is very low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. Where unprotected, this soil is subject to rare periods of flooding.

This unit is used as rangeland and wildlife habitat.

The soil in this unit is one of the most productive rangeland soils in the survey area. It responds well to rangeland management. Where the range is in good or excellent condition, it produces forage year round. The soil is easily traversed by livestock. Fencing and developing watering facilities help to control grazing.

A few small areas of this unit outside the Hassayampa Plain area receive more precipitation than is typical for the unit. These areas are somewhat more productive than most other areas of the unit.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Sandy Upland, 2- to 7-inch p.z., range site.

15—Carrizo-Gunsight complex, 1 to 5 percent opes. This map unit is on fan terraces. Elevation is 200 to 2,200 feet. The average annual precipitation is 7 inches, and the average annual air temperature is 73 degrees F.

This unit is about 50 percent Carrizo gravelly sandy loam and 30 percent Gunsight very gravelly sandy loam. The Carrizo soil is on broad fan terraces between areas of the Gunsight soil, and the Gunsight soil is on ridgetops and side slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Brios and Carrizo soils in drainageways and Denure, Cipriano, Chuckawalla, Momoli, Pinamt, and Rillito soils on fan terraces. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Carrizo soil is deep and excessively drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is light yellowish brown gravelly sandy loam about 1 inch thick. The subsurface layer is brown gravelly sandy loam about 4 inches thick. The underlying material to a depth of 60 inches or more is light brown, brown, and strong brown very gravelly sand and very gravelly coarse sand.

Permeability of the Carrizo soil is very rapid. Available water capacity is very low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Gunsight soil is deep and well drained. It formed alluvium derived dominantly from acid and basic igneous rock. Typically, the upper 1 inch of the surface layer is light brown, calcareous very gravelly sandy loam and the lower 9 inches is light brown, calcareous very gravelly sandy loam. The underlying material to a depth of 45 inches is pinkish white, weakly cemented or strongly cemented, calcareous very gravelly sandy loam. Below this to a depth of 60 inches or more is yellowish red gravelly sandy clay loam.

Permeability of the Gunsight soil is moderate. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as rangeland and wildlife habitat.

The Carrizo soil has high potential for producing forage. It responds well to rangeland management. Where the range is in good or excellent condition, it produces forage year round. The soil is easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Fencing and developing watering facilities help to control grazing. In a few areas this soil is calcareous in the surface layer and is therefore less productive than in most other areas of the soil.

The Gunsight soil is among the least productive rangeland soils in the survey area. It responds very slowly to rangeland management. The high content of lime and the low available water capacity contribute to the low productivity of this soil.

This map unit is in capability subclass VIIs, nonirrigated. The Carrizo soil is in the Sandy Loam Upland, 2- to 7-inch p.z., range site, and the Gunsight soil is in the Limy Upland, 2- to 7-inch p.z., range site.

16—Cellar-Rock outcrop, 10 to 70 percent slopes. This map unit is on hill slopes and mountain slopes. Elevation is 3,000 to 5,400 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 63 to 67 degrees F.

This unit is about 65 percent Cellar very gravelly fine sandy loam and 15 percent Rock outcrop. The Cellar soil is on hill slopes and mountain slopes, and the Rock outcrop is scattered throughout the unit. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Nickel and Eba soils on the lower side slopes and Arizo soils in drainageways. Also included are small areas of exposed calcareous volcanic ash and dark colored, medium textured, noncalcareous soils on summits. The annual precipitation in areas of these soils is as much as 16 inches. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Cellar soil is very shallow and shallow and is well drained. It formed in alluvium and colluvium derived dominantly from granite and gneis. Typically, the surface

90—Momoli gravelly sandy loam, 1 to 5 percent slopes. This deep and well drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Elevation is 1,400 to 2,200 feet. The average annual precipitation is 7 to 10 inches, and the average annual air temperature is 70 to 73 degrees F.

Typically, the surface layer is strong brown gravelly sandy loam about 3 inches thick. The subsoil is strong brown very gravelly sandy loam about 23 inches thick. The substratum to a depth of 60 inches or more is brown, calcareous very gravelly sandy loam.

Included in this unit are small areas of Carrizo and Maripo soils on flood plains and Pinamt and Denure soils on fan terraces. The included areas make up about 30 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Momoli soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as rangeland and wildlife habitat. A few areas are used for urban development.

The soil in this unit has moderate potential for producing forage. It responds moderately well to rangeland management. Where the range is in good or excellent condition, it produces forage year round. The unit is easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Fencing and developing watering facilities help to control grazing. To control erosion, extra care must be taken to maintain a good plant cover.

If this unit is used as sites for buildings, roads, or septic tank absorption fields, it has few limitations. Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Sandy Loam Upland, 7- to 10-inch p.z., range site.

91—Momoli-Carrizo complex. This map unit is on fan terraces. Slope is 0 to 3 percent. Elevation is 1,400 to 2,200 feet. The average annual precipitation is 7 to 10 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 45 percent Momoli very gravelly sandy loam and 35 percent Carrizo very gravelly sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Mohall, Tremant, Gunsight, and Chuckawalla soils on slightly higher terraces, Denure soils scattered throughout the unit, and Gilman, Maripo, and Carrizo soils on flood plains and in drainageways. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The soils in some areas of this unit south of Pinnacle Peak and west of the McDowell Mountains are noncalcareous to a depth of 20 inches or more. The soils in these areas typically are extremely cobbly or extremely gravelly.

The Momoli soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is pinkish gray, calcareous very gravelly sandy loam about 1 inch thick. Below this to a depth of 60 inches or more is light brown, calcareous very gravelly sandy loam. In some areas this soil is noncalcareous to a depth of 15 inches or more.

Permeability of the Momoli soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Carrizo soil is deep and excessively drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is pinkish gray, calcareous very gravelly sandy loam about 2 inches thick. The upper 9 inches of the underlying material is light brown, calcareous very gravelly sandy loam, and the lower part to a depth of 60 inches or more is brown, calcareous extremely gravelly loamy sand. In some areas this soil is noncalcareous to a depth of 15 inches or more.

Permeability of the Carrizo soil is very rapid. Available water capacity is very low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as rangeland and wildlife habitat.

The soils in this unit have moderate potential for producing forage. They respond slowly to rangeland management. Most of the vegetation is produced following rainfall in winter and spring. In favorable winters, the production of annual grasses and forbs can support grazing for about 2 to 3 months. Little forage is available during the rest of the year. In some areas of this unit, west of the McDowell Mountains and south of the Vulture Mountains, the soils are noncalcareous in the surface layer and are therefore more productive than they are in most other areas of the unit.

This map unit is in capability subclass VIIs, nonirrigated. It is in Limy Fan, 7- to 10-inch p.z., range site.

92—Momoli-Carrizo complex, low precipitation. This map unit is on fan terraces. Slope is 0 to 3 percent. Elevation is 1,400 to 2,200 feet. The average annual precipitation is 2 to 7 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 45 percent Momoli very gravelly sandy loam and 35 percent Carrizo very gravelly sandy loam. The components of this unit are so intricately

me are as the size of the absorption field needed may ceed the lot size. Alternatives include locating absorption fields in more suitable adjacent areas or installing community sewage systems. Steepness of slope makes it difficult to control the distribution of effluent. Effluent distributed into the soil on the steeper slopes can seep to the surface downslope. Absorption lines should be placed on the contour to slow the flow of effluent and produce more uniform distribution. To achieve the deepest possible infiltration and minimize downslope seepage, absorption lines should be placed at a greater depth in the steeper areas than in the more nearly level areas.

Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIs, nonirrigated. The Nickel soil is in the Limy Slopes, 8- to 10-inch p.z., range site, and the Cave soil is in the Limy Upland, 8- to 10-inch p.z., range site.

95—Ohaco gravelly loam. This moderately deep and well drained soil is on stream terraces and fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Slope is 0 to 3 percent. Elevation is 1,800 to 2,500 feet. The average annual precipitation is 10 to 12 inches, and the average annual air temperature 66 to 70 degrees F.

ypically, the surface layer is brown gravelly loam out 2 inches thick. The upper 9 inches of the subsoil is yellowish red clay loam, and the lower 16 inches is yellowish red clay loam and clay. The substratum is pink gravelly sandy loam about 4 inches thick over a silica- and lime-cemented hardpan at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Continental and Suncity Variant soils on fan terraces. The included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Ohaco soil is slow. Available water capacity is high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as rangeland and wildlife habitat.

This unit has moderate potential for producing forage. It responds well to rangeland management. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Tobosa, the dominant forage species, is unpalatable when cured and should therefore be used during the growing season. Fencing and developing watering facilities help to control grazing.

A few small areas of this unit, in the northwestern part of the survey area, receive less precipitation than is ical for the unit. These areas are somewhat less ductive than are most other areas of the unit.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Clayey Upland, 10- to 12-inch p.z., range site.

96—Pinaleno-Tres Hermanos complex, 1 to 10 percent slopes. This map unit is on fan terraces. Elevation is 2,000 to 2,500 feet. The average annual precipitation is 10 to 12 inches, and the average annual air temperature is 66 to 70 degrees F.

This unit is about 45 percent Pinaleno very gravelly clay loam and 40 percent Tres Hermanos gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Arizo soils in drainageways; Mohave, Greyeagle, Eba, Vado, and Nickel soils on fan terraces; and soils that have less gravel throughout the profile. Also included are small areas of soils that are stratified sandy loam, are in and adjacent to drainageways, and receive runoff from surrounding areas. The included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Pinaleno soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is yellowish red very gravelly clay loam about 1 inch thick. The upper 11 inches of the subsoil is yellowish red, calcareous gravelly clay loam and very gravelly clay loam, and the lower 12 inches is light brown, calcareous gravelly loam. The substratum to a depth of 60 inches or more is light brown, calcareous loam. In some areas the surface layer is gravelly sandy loam. In some areas a buried soil is below the substratum.

Permeability of the Pinaleno soil is moderately slow. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Tres Hermanos soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is reddish yellow gravelly loam about 2 inches thick. The upper 4 inches of the subsoil is reddish yellow, calcareous clay loam, and the lower 16 inches is yellowish red, calcareous gravelly and very gravelly clay loam. The substratum to a depth of 60 inches or more is white, weakly lime-cemented or strongly lime-cemented very gravelly loam. In some areas the surface layer is gravelly sandy loam. In some areas this soil is noncalcareous to a depth of 10 inches or more.

Permeability of the Tres Hermanos soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as rangeland and wildlife habitat. A few areas are used for urban development.

that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Carrizo soils in drainageways and Chuckawalla, Ebon, Gunsight, and Rillito soils on fan terraces. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Pinamt soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the upper 1 inch of the surface layer is brown, calcareous extremely gravelly sandy loam and the lower 2 inches is light brown, calcareous very gravelly loam. The upper 12 inches of the subsoil is yellowish red, calcareous very gravelly sandy clay loam, and the lower 13 inches is light brown, calcareous extremely gravelly sandy clay loam. The substratum to a depth of 60 inches or more is light brown, calcareous extremely gravelly sandy loam. In some areas this soil is noncalcareous to a depth of 60 inches or more.

Permeability of the Pinamt soil is moderately slow. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Tremant soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is reddish yellow gravelly loam 5 inches thick. The subsoil is reddish yellow and yellowish red, calcareous sandy clay loam and gravelly clay loam about 24 inches thick. The substratum to a depth of 60 inches or more is white, calcareous gravelly sand. In some areas this soil is noncalcareous to a depth of 60 inches or more, and in some areas it is calcareous throughout.

Permeability of the Tremant soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as rangeland and wildlife habitat. A few areas are used for urban development.

The Pinamt soil has low potential for producing forage. It responds slowly to rangeland management. Most of the vegetation is produced following rainfall in winter and spring. In favorable winters, the production of annual grasses and forbs can support grazing for about 2 to 3 months. Little forage is available during the rest of the year. In some areas this soil is noncalcareous in the surface layer and is therefore more productive than in most other areas of the soil.

The Tremant soil has moderate potential for producing forage. It responds moderately well to rangeland management. Where the range is in good or excellent condition, it produces forage year round. It is easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Fencing and developing watering facilities help to control grazing. In some areas this soil is calcareous in the surface layer and is therefore less productive than in most other areas of the soil.

If the Pinamt soil is used as sites for buildings or roads, it has few limitations. If the Tremant soil is used as sites for buildings or roads, the main limitation is the shrink-swell potential. The effects of shrinking and swelling can be reduced by maintaining a constant moisture content in the soil. Runoff should be diverted away from buildings. Landscaping plants that require little water should be used near building foundations, and overwatering should be avoided. A sealer can be used under roads to prevent shrinking and swelling of the material below. The Pinamt soil is better suited to use as sites for buildings and roads than is the Tremant soil; therefore, buildings and roads should be located in areas of the Pinamt soil if feasible.

If the soils in this unit are used for septic tank absorption fields, they have few limitations. In a few areas the substratum is somewhat finer in texture than is typical for the soils, and in other areas the substratum is weakly cemented. The reduced permeability in these areas may require the use of larger absorption fields.

Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIs, nonirrigated. The Pinamt soil is in the Limy Fan, 7- to 10-inch p.z., range site, and the Tremant soil is in the Loamy Upland, 7- to 10-inch p.z., range site.

99—Pinamt-Tremant complex, low precipitation, 1 to 10 percent slopes. This map unit is on fan terraces. Elevation is 1,200 to 2,200 feet. The average annual precipitation is 2 to 7 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 45 percent Pinamt extremely gravelly sandy loam and 35 percent Tremant gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Carrizo soils in drainageways and Chuckawalla, Ebon, Gunsight, and Rillito soils on fan terraces. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

The Pinamt soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the upper 1 inch of the surface layer is brown, calcareous extremely gravelly sandy loam and the lower 2 inches is light brown, calcareous very gravelly loam. The upper 12 inches of the subsoil is yellowish red, calcareous very gravelly sandy clay loam, and the lower 13 inches is light brown, calcareous extremely gravelly sandy clay loam. The substratum to a depth of 60 inches or more is light brown, calcareous extremely gravelly sandy loam. In some areas this soil is noncalcareous to a depth of 20 inches or more.

The soils in this unit have moderate potential for producing forage. They respond well to rangeland management. The unit can produce forage year round. It is easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Proper placement of fences and watering facilities helps to control the distribution of grazing. In some areas of this unit, the soils are calcareous in the surface layer and are therefore less productive than in most other areas of the unit.

If the Pinaleno soil is used as sites for buildings or roads, it has few limitations. If the Tres Hermanos soil is used as sites for buildings or roads, the main limitation is the shrink-swell potential. The effects of shrinking and swelling can be reduced by maintaining a constant moisture content in the soil. Runoff should be diverted away from buildings. Landscaping plants that require little water should be used near building foundations, and overwatering should be avoided. A sealer can be used under roads to prevent shrinking and swelling of the material below. The Pinaleno soil is better suited to use as sites for buildings and roads than is the Tres Hermanos soil; therefore, buildings and roads should be located in areas of the Pinaleno soil if feasible.

If the soils in this unit are used for septic tank absorption fields, they have few limitations. In a few areas the substratum is somewhat finer in texture than is typical, and in other areas the substratum is weakly cemented. The reduced permeability in these areas may require the use of larger absorption fields.

Onsite investigation is needed to determine the most suitable alternatives and th e best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIs, nonirrigated. The Pinaleno soil is in the Loamy Upland, 10- to 12-inch p.z., range site, and the Tres Hermanos soil is in the Sandy Loam Upland, 10- to 12-inch p.z., range site.

97—Pinaleno-Tres Hermanos complex, low precipitation, 1 to 10 percent slopes. This map unit is on fan terraces. Elevation is 2,000 to 2,500 feet. The average annual precipitation is 8 to 10 inches, and the average annual air temperature is 66 to 70 degrees F.

This unit is about 45 percent Pinaleno very gravelly clay loam and 40 percent Tres Hermanos gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Arizo soils in drainageways; Mohave, Greyeagle, Eba, Vado, and Nickel soils on fan terraces; and soils that have less gravel throughout the profile. Also included are small areas of soils that are stratified sandy loam, are in and adjacent to drainageways, and receive runoff from surrounding areas. The included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

The Pinaleno soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is yellowish red very gravelly clay loam about 1 inch thick. The upper 11 inches of the subsoil is yellowish red, calcareous gravelly clay loam and very gravelly clay loam, and the lower 12 inches is light brown, calcareous gravelly loam. The substratum to a depth of 60 inches or more is light brown, calcareous loam. In some areas the surface layer is gravelly sandy loam. In some areas a buried soil is below the substratum.

Permeability of the Pinaleno soil is moderately slow. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

The Tres Hermanos soil is deep and well drained. It formed in alluvium derived dominantly from acid and basic igneous rock. Typically, the surface layer is reddish yellow gravelly loam about 2 inches thick. The upper 2 inches of the subsoil is reddish yellow, calcareous clay loam, and the lower 16 inches is yellowish red and pink, calcareous gravelly clay loam and very gravelly clay loam. The substratum to a depth of 60 inches or more is white, weakly lime-cemented or strongly lime-cemented very gravelly loam. In some areas the surface layer is gravelly sandy loam.

Permeability of the Tres Hermanos soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as rangeland and wildlife habitat.

This unit has moderate potential for producing forage. It responds well to rangeland management. The unit can produce forage year round. It is easily traversed by livestock. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation. Proper placement of fences and watering facilities helps to control the distribution of grazing. In some areas of this unit, the soil is calcareous in the surface layer and is therefore less productive than in most other areas of the unit.

This map unit is in capability subclass VIIs, nonirrigated. The Pinaleno soil is in the Loamy Upland, 8- to 10-inch p.z., range site, and the Tres Hermanos soil is in the Sandy Loam Upland, 8- to 10-inch p.z., range site.

98—Pinamt-Tremant complex, 1 to 10 percent slopes. This map unit is on fan terraces. Elevation is 1,200 to 2,200 feet. The average annual precipitation is 7 to 10 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 45 percent Pinamt extremely gravelly sandy loam and 35 percent Tremant gravelly loam. The components of this unit are so intricately intermingled

cuts and fills are highly susceptible to erosion. The risk of erosion can be reduced by using diversions or terraces to reduce the length of slopes or by revegetating to slow runoff.

If the soils in this unit are used for septic tank absorption fields, the main limitations are the depth to rock and slope. Septic tank absorption fields may not operate properly in some areas of this unit.The limited depth to bedrock restricts the movement of effluent. Effluent is likely to flow through cracks in the rock, resulting in little filtration. Steepness of slope makes it difficult to control the distribution of effluent. Effluent can move along the surface of the bedrock and seep to the surface in downslope areas, creating a hazard to health. Alternatives include locating absorption fields in more suitable soils in adjacent areas and transporting the effluent to them by pipeline or installing community sewage systems. The use of septic tank absorption fields can create serious hazards in areas of the Vaiva soil. If the soil becomes saturated with water, slippage can occur in downslope areas.

Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclass VIIe, nonirrigated. It is in the Granitic Hills, 7- to 10-inch p.z., range site.

101—Rillito loam, 0 to 3 percent slopes. This deep and well drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Most of the areas used as cropland have slopes of less than 1 percent. Elevation is 1,200 to 1,600 feet. The average annual precipitation is 7 to 10 inches, and the average annual air temperature is 70 to 73 degrees F.

Typically, the upper layer is light brown, calcareous loam about 11 inches thick. The next 13 inches is light brown, calcareous loam. The next 15 inches is light brown, calcareous, weakly lime- and silica-cemented gravelly loam. Below this to a depth of 60 inches or more is light brown, calcareous, weakly cemented extremely gravelly loam. In some areas the surface layer is gravelly loam. In a few areas the profile has slightly less gravel than is typical for this soil. Depth to the weakly cemented substratum ranges from 20 to 40 inches. Many of the pebbles in the soil are lime- and silica-cemented.

Included in this unit are small areas of Cipriano, Gunsight, Mohall, and Tremant soils on fan terraces and Gilman soils on flood plains. The included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Rillito soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as irrigated cropland, as wildlife habitat, as rangeland, and for urban development.

If this unit is used as irrigated cropland, the main limitation is the depth to the weakly lime- and silica-cemented, gravelly substratum. Leveling cuts of 20 to 40 inches generally will expose the substratum. Applications of manure or cotton gin trash are beneficial in leveled areas where cuts have exposed concentrations of lime. Phosphorus should be applied in split applications in such areas because it is readily tied up in the soil. Citrus trees, sorghum, and sudangrass in these limy areas are subject to chlorosis. Lining irrigation ditches with concrete reduces loss of water by seepage. Applying manure or cotton gin trash or plowing under crop residue or green manure crops improves tilth and increases the water intake rate. Keeping tillage to a minimum also helps to maintain soil tilth.

The Rillito soil is one of the poorest forage-producing soils in the survey area. It responds very slowly to rangeland management. The high content of lime and the low available water capacity contribute to the low productivity of this soil. The included Gilman soils on flood plains are much more productive than are the other soils in the unit. Management of the soils in this unit should therefore be concentrated on these included soils, because they produce nearly all the available forage.

If the soil in this unit is used as sites for buildings, roads, or septic tank absorption fields, it has few limitations. In a few areas the substratum is more strongly cemented than is typical for the soil. In these areas excavations may be limited and permeability may be a concern.

Onsite investigation is needed to determine the most suitable alternatives and the best design of buildings, roads, and septic tank absorption fields.

This map unit is in capability subclasses IIs, irrigated, and VIIs, nonirrigated. It is in the Limy Upland, 7- to 10-inch p.z., range site.

102—Rillito gravelly loam, 1 to 8 percent slopes. This deep and well drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Elevation is 1,100 to 1,800 feet. The average annual precipitation is 2 to 7 inches, and the average annual air temperature is 70 to 73 degrees F.

Typically, the upper layer of this soil is pinkish gray, calcareous gravelly loam about 14 inches thick. Below this to a depth of 60 inches or more is pinkish white, calcareous gravelly loam. In some areas the upper layer is loam or very gravelly loam. In a few areas the profile has slightly less gravel than is typical for this soil.

Included in this unit are small areas of Mohall, Pinamt, and Tremant soils on the tops of terraces; Gunsight and Cipriano soils scattered throughout the unit; Gilman, Antho, and Maripo soils on flood plains; and Carrizo soils in drainageways. The included areas make up about 30

ercent of the total acreage. The percentage varies from ne area to another.

Permeability of this Rillito soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as rangeland and wildlife habitat.

The Rillito soil is one of the poorest forage-producing soils in the survey area. It responds very slowly to rangeland management. The high content of lime and the low available water capacity contribute to the low productivity of this soil. The included soils in drainageways are much more productive than the other soils in the unit. Management of the soils in this unit therefore should be concentrated on these included soils, because they produce nearly all the available forage.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Limy Upland, 2- to 7-inch p.z., range site.

103—Rock outcrop-Gachado complex, 5 to 55 percent slopes. This map unit is on mountain slopes. Elevation is 1,200 to 3,000 feet. The average annual precipitation is 7 to 10 inches, and the average annual air temperature is 70 to 73 degrees F.

This unit is about 65 percent Rock outcrop and 25 ercent Gachado very gravelly loam. The Rock outcrop on exposed dikes, ledges, and escarpments, and the chado soil is on mountain slopes. The components of unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Lomitas soils on mountain slopes. The included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Rock outcrop consists of exposed areas of andesite, rhyolite, and tuff.

The Gachado soil is very shallow and shallow and is well drained. It formed in alluvium and colluvium derived dominantly from andesite, rhyolite, and tuff. Typically, the surface layer is light brown very gravelly loam about 1 inch thick. The subsoil is brown very gravelly clay loam about 6 inches thick. Bedrock is at a depth of 7 inches.

Permeability of the Gachado soil is moderately slow. Available water capacity is very low. Effective rooting depth is less than 20 inches. Runoff is rapid, and the hazard of water erosion is moderate.

This unit is used as rangeland and wildlife habitat.

The Gachado soil has moderate potential for producing forage. It responds moderately well to rangeland management. It can produce forage year round. Steepness of slope, the areas of Rock outcrop, and cobbles and stones on the surface limit use. Fencing and developing watering facilities help to prove distribution of livestock. Permitting a large ber of livestock to graze for short periods of time promotes an efficient distribution of livestock and use of available forage. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Volcanic Hills, 7- to 10-inch p.z., range site.

104—Rock outcrop-Lehmans complex, 15 to 65 percent slopes. This map unit is on hill slopes and mountain slopes. Elevation is 1,800 to 4,000 feet. The average annual precipitation is 10 to 12 inches, and the average annual air temperature is 66 to 70 degrees F.

This unit is about 60 percent Rock outcrop and 20 percent Lehmans very gravelly clay loam. The Rock outcrop generally is on mountaintops and the upper part of mountain slopes, and in some areas vertical exposures are common. The Lehmans soil is on the lower part of mountain slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Arizo soils in drainageways and Eba and Pinaleno soils on foot slopes. Also included are small areas of exposed volcanic ash deposits and soils that have more rock fragments or lime than is typical for the Lehmans soil. The included areas make up about 20 percent of the total acreage. The percentage varies from one area to another.

Rock outcrop consists of exposed areas of basalt, andesite, rhyolite, tuff, and agglomerate.

The Lehmans soil is very shallow and shallow and is well drained. It formed in alluvium and colluvium derived dominantly from basalt, andesite, rhyolite, tuff, and agglomerate. The surface layer is reddish brown very gravelly clay loam about 2 inches thick. The subsoil is reddish brown clay and clay loam about 13 inches thick. The substratum is reddish brown very gravelly clay loam 5 inches thick over bedrock.

Permeability of the Lehmans soil is slow. Available water capacity is very low. Effective rooting depth is less than 20 inches. Runoff is rapid, and the hazard of water erosion is moderate.

This unit is used as rangeland and wildlife habitat.

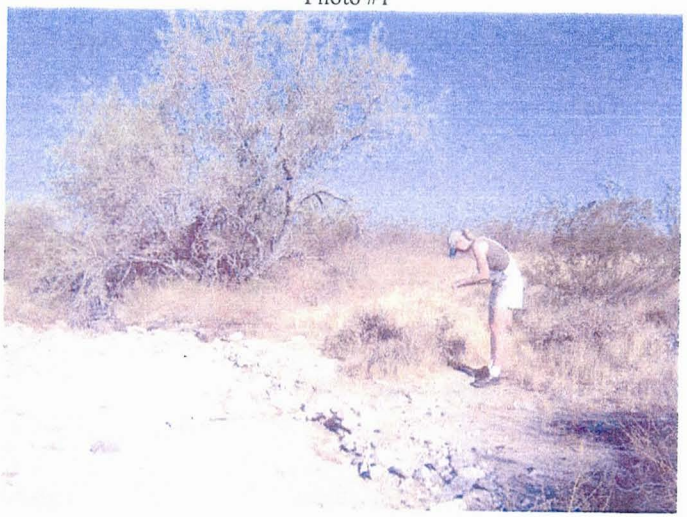
The Lehmans soil has moderate to high potential for producing forage. It responds well to rangeland management. It can produce forage year round. Steepness of slope, the areas of Rock outcrop, and cobbles and stones on the surface limit use. Fencing and developing watering facilities help to improve distribution of livestock. Permitting a large number of livestock to graze for short periods of time promotes an efficient distribution of livestock and use of available forage. Resting pastures during alternate growing seasons helps to maintain or improve the vegetation.

This map unit is in capability subclass VIIs, nonirrigated. It is in the Volcanic Hills, 10- to 12-inch p.z., range site.

G.5 Other Documentation

APPENDIX H
GROUND PHOTOS

Photo #1



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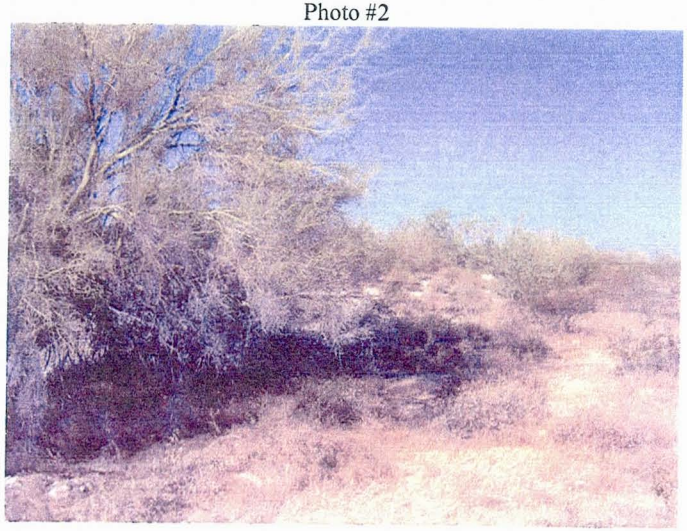

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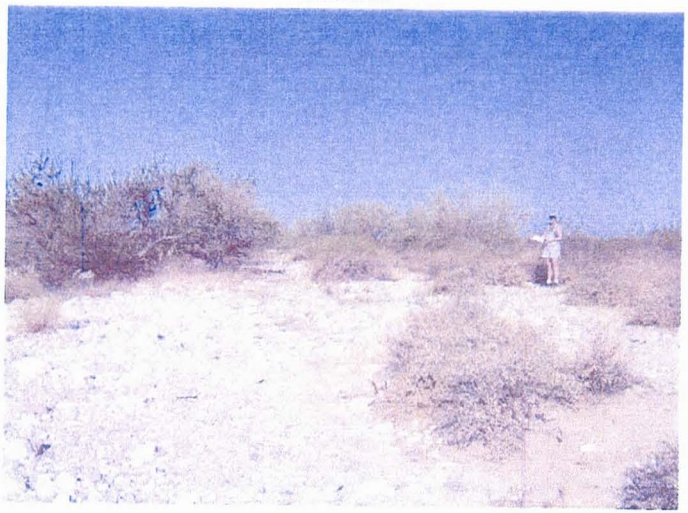

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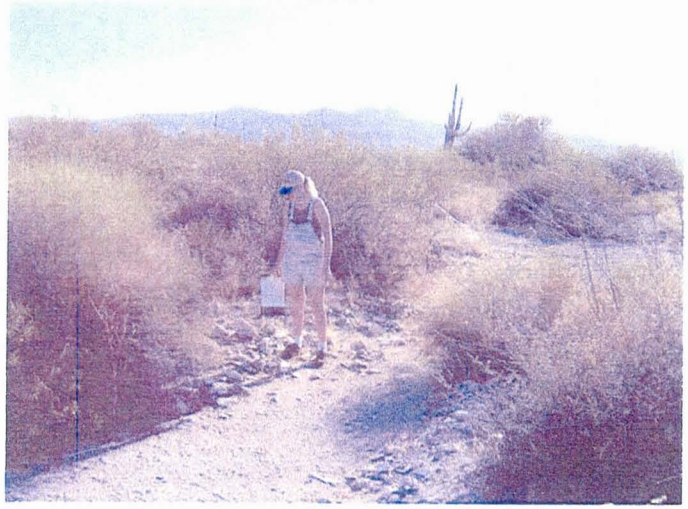

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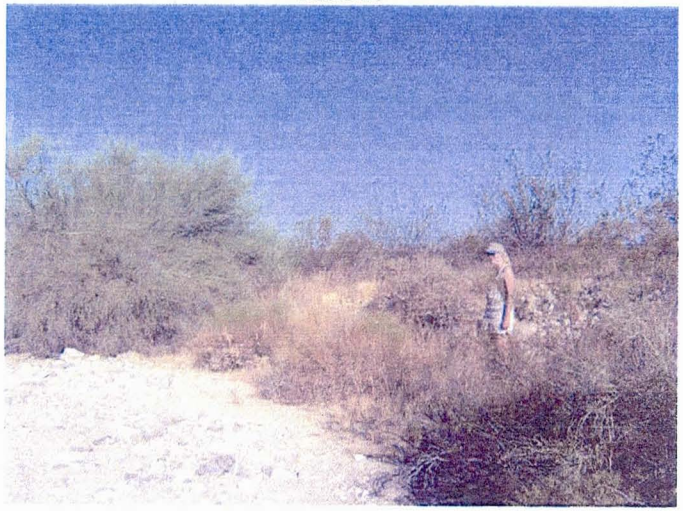

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Photo #9

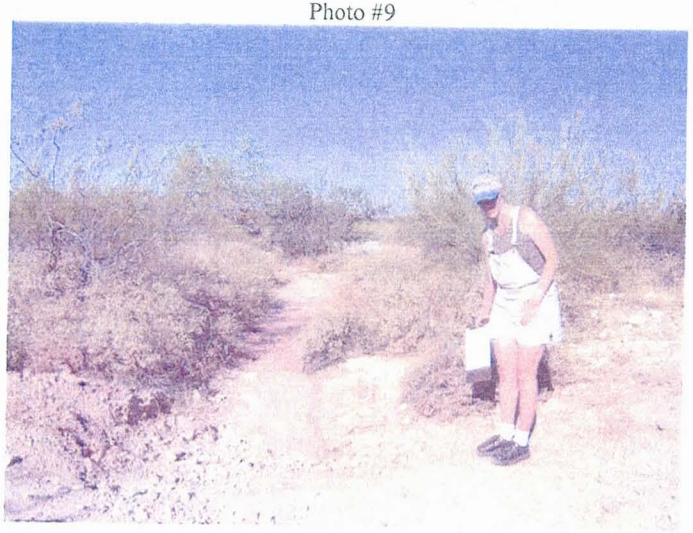

Photo #10

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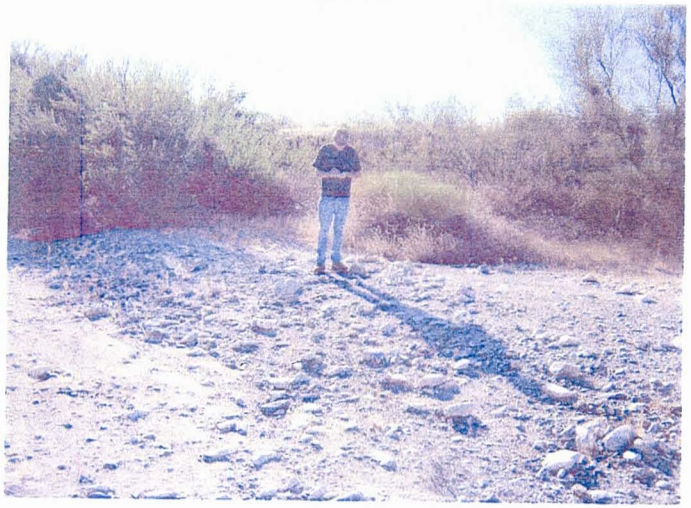
Photo #13



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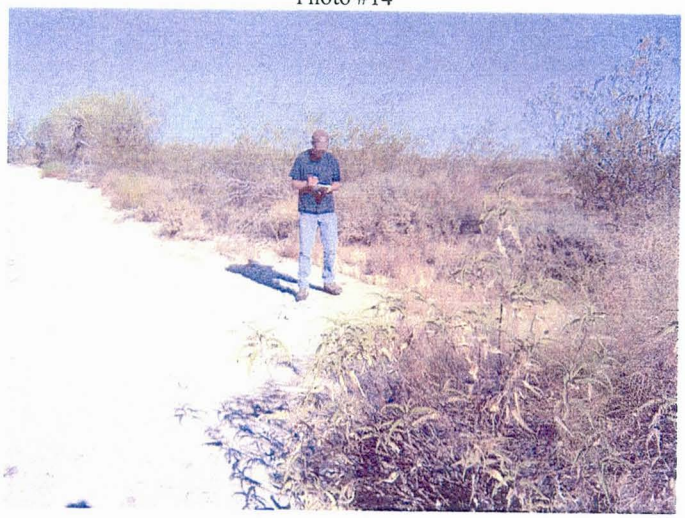

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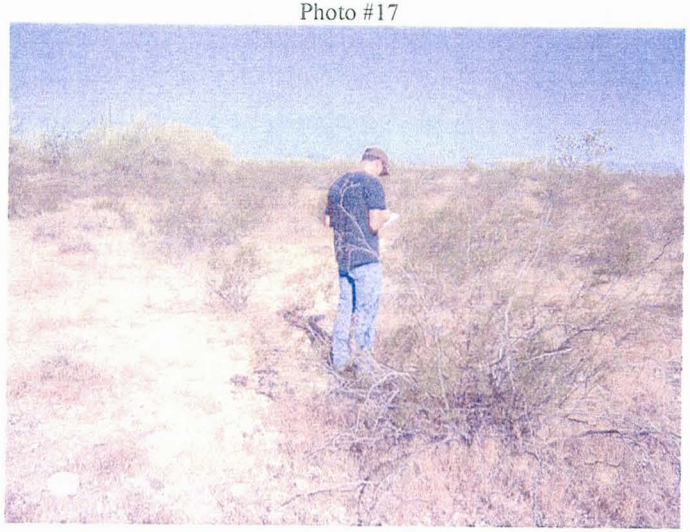
Photo #17



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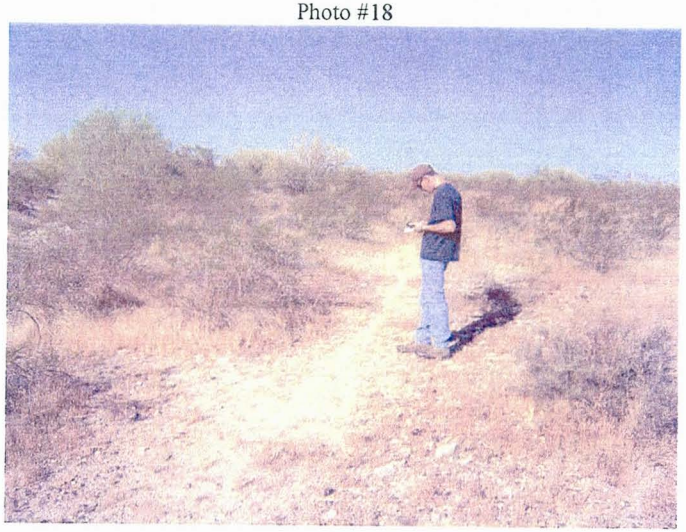

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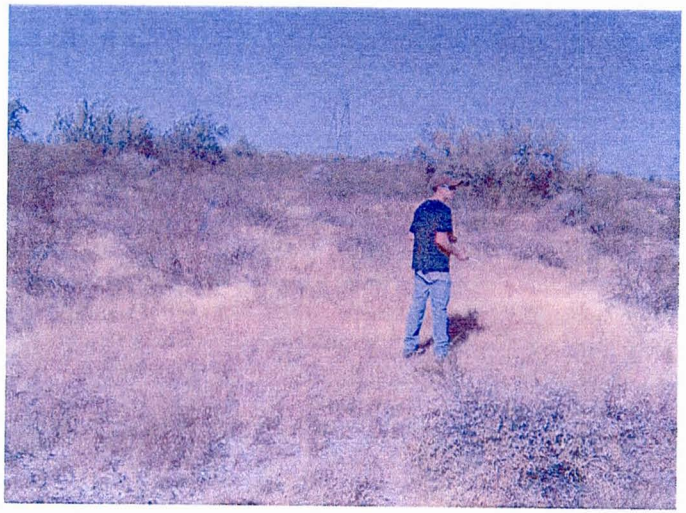

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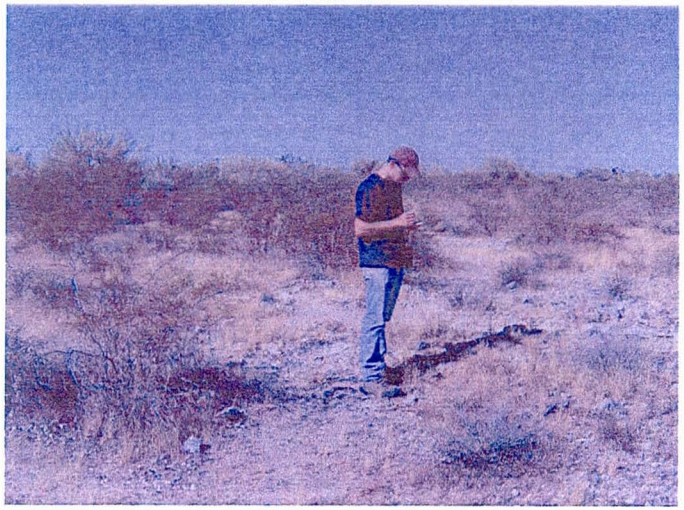

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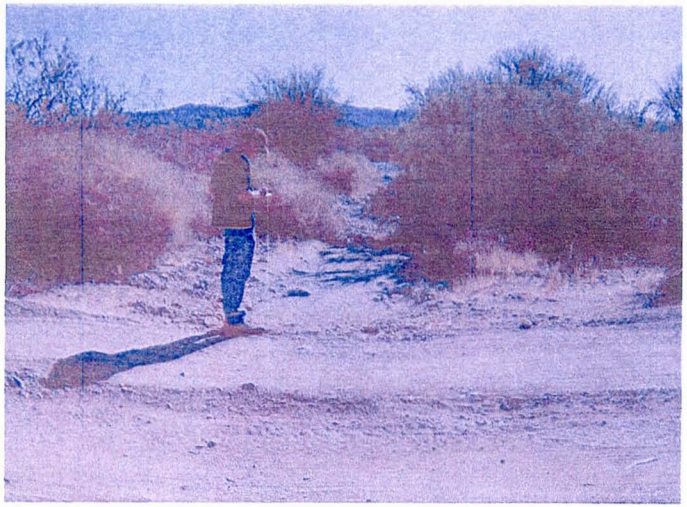

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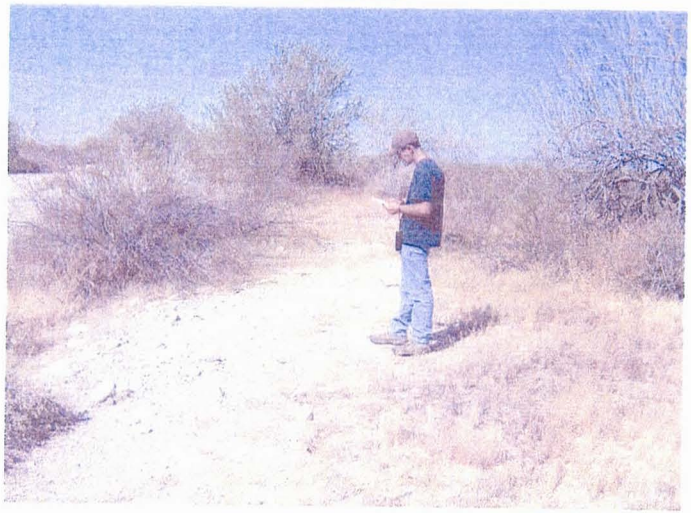
Photo #25

Photo #27

Photo #28



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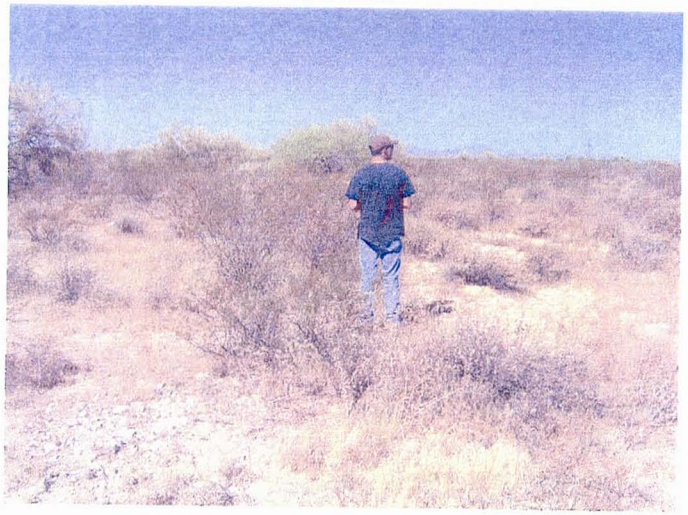

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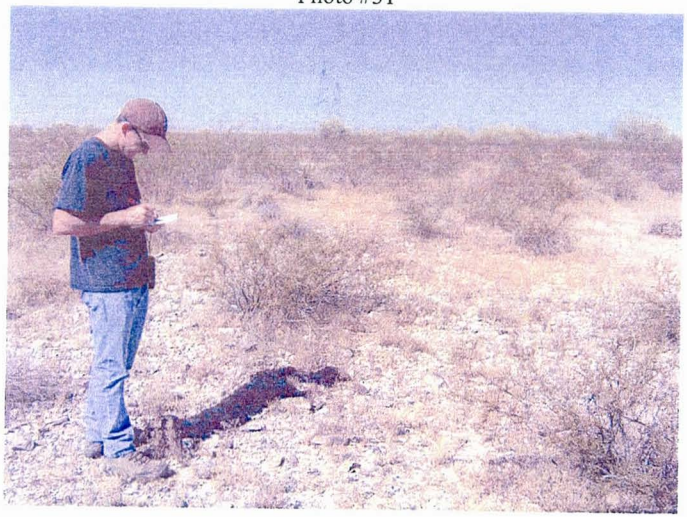

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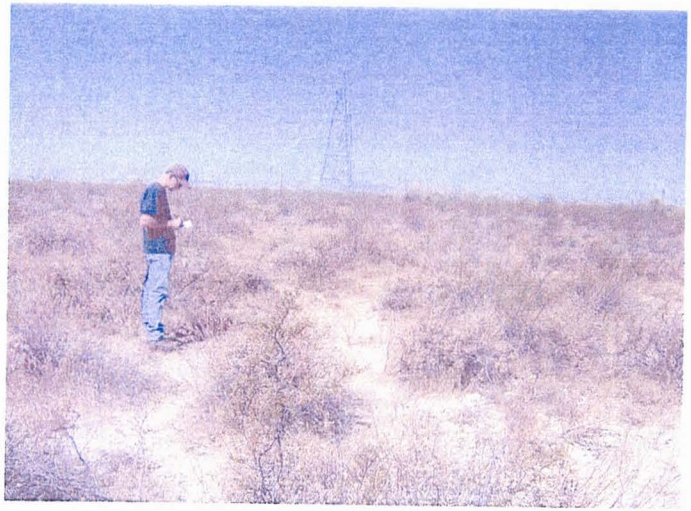

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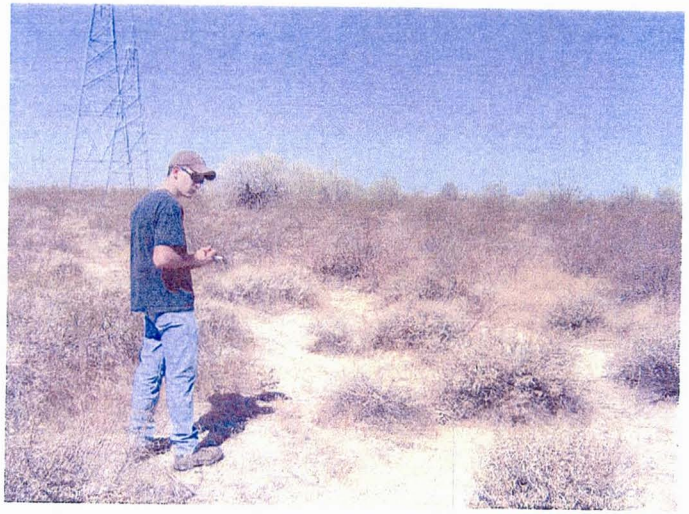

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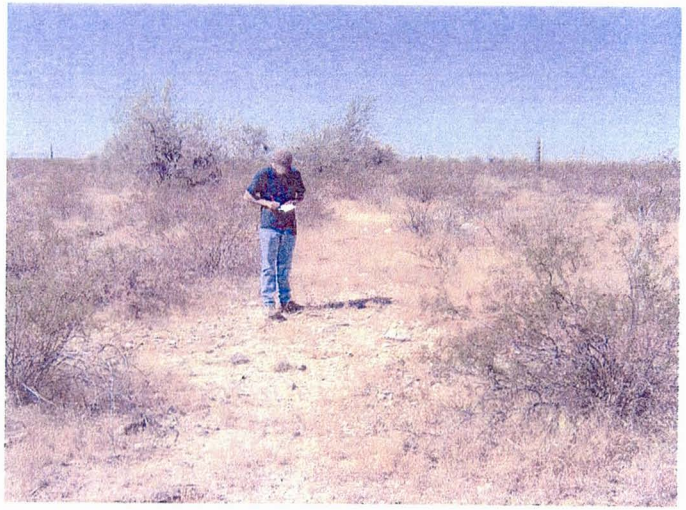
Photo #35

Photo #36

Photo #37



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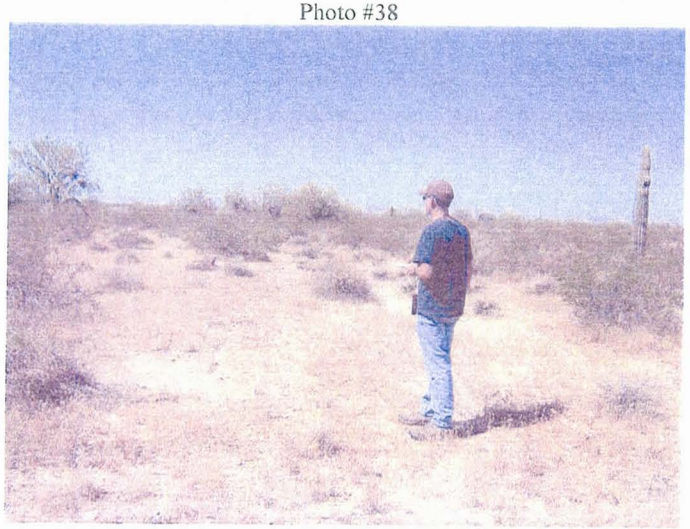

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Photo #40

Photo #41

Photo #42

Photo #43

Photo #44

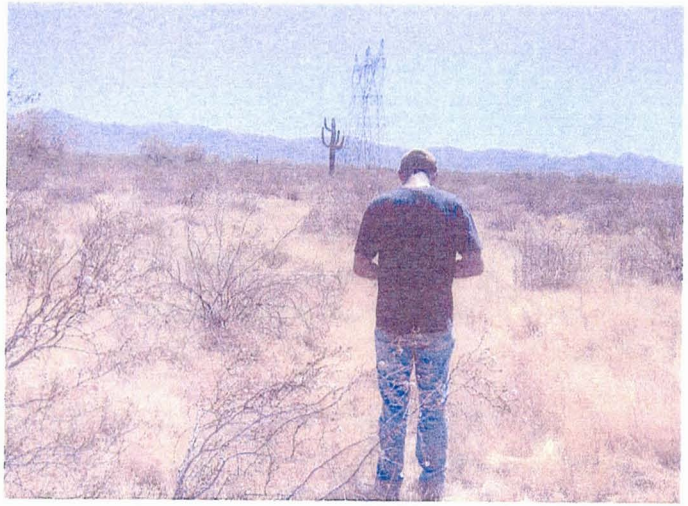

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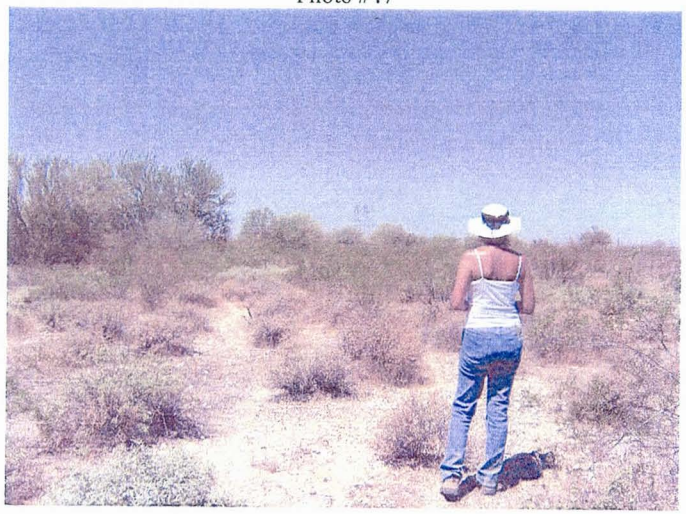
Photo #46

Photo #47



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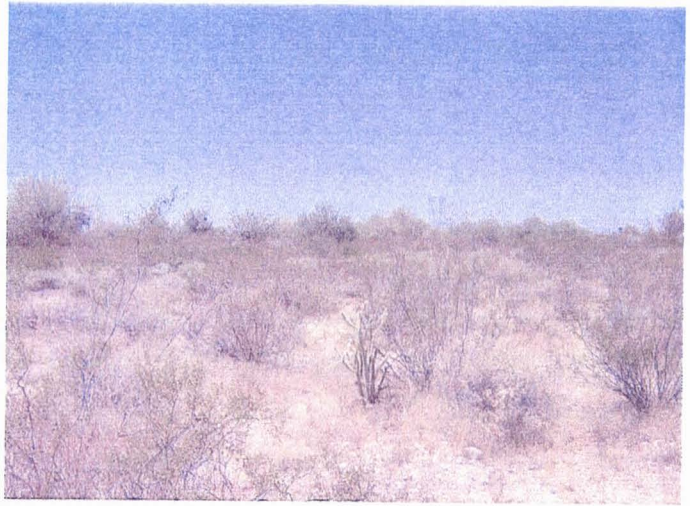
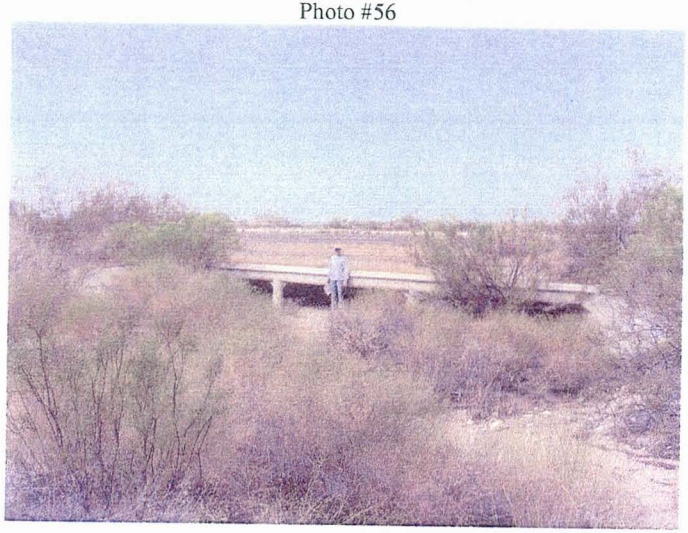


Photo #50

Photo #55

Photo #56



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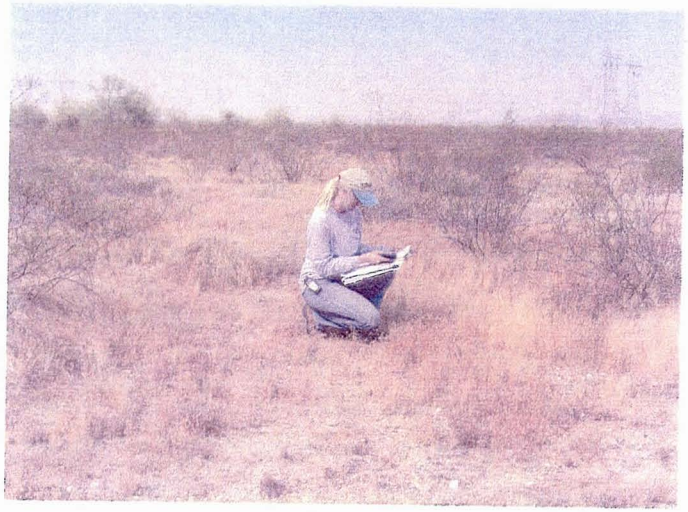

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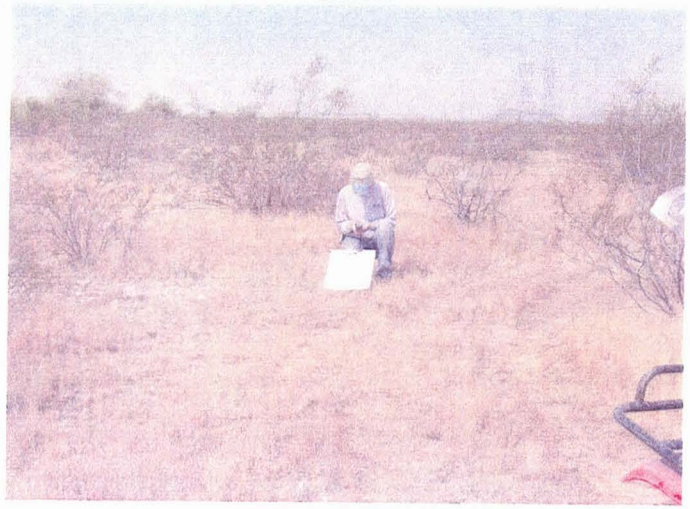

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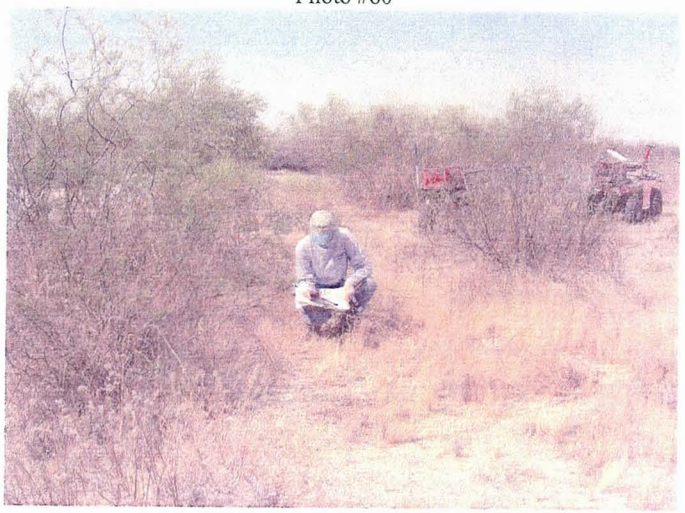

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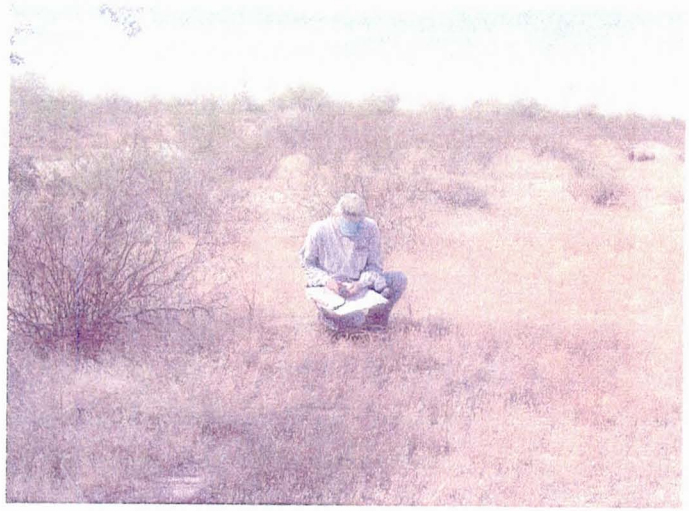

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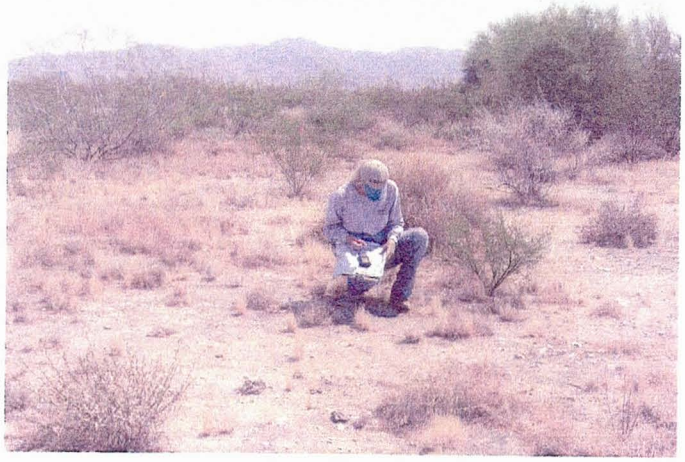

Photo #63 S.W.

Photo #63 W.

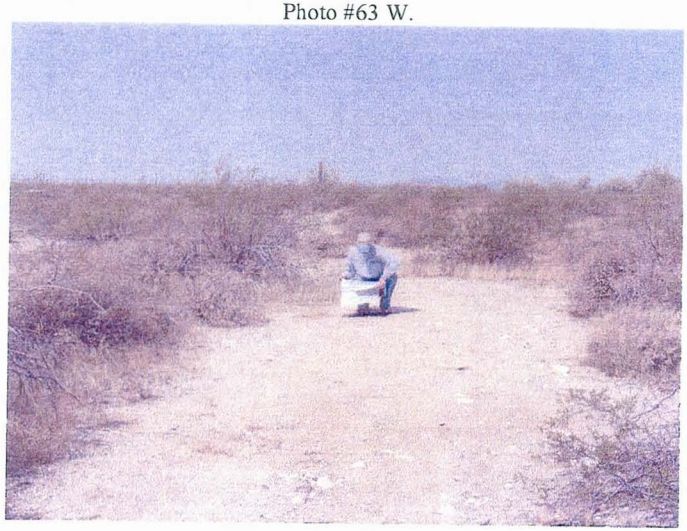

Photo #64

Photo #65

Photo #66

Photo #67

Photo #68

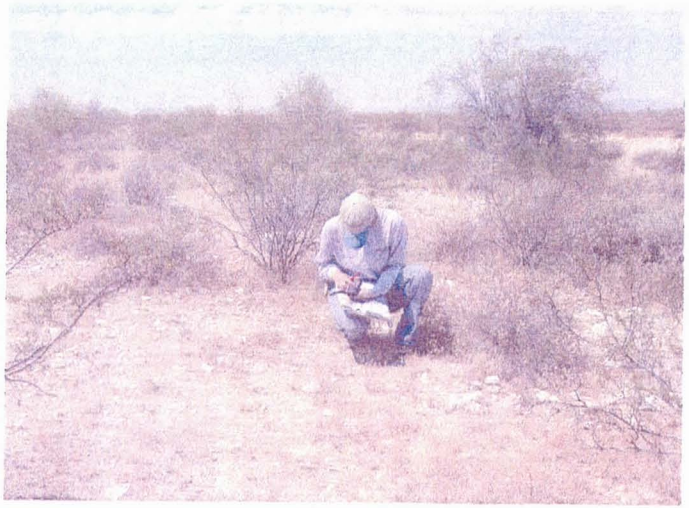

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Photo #70

Photo #71

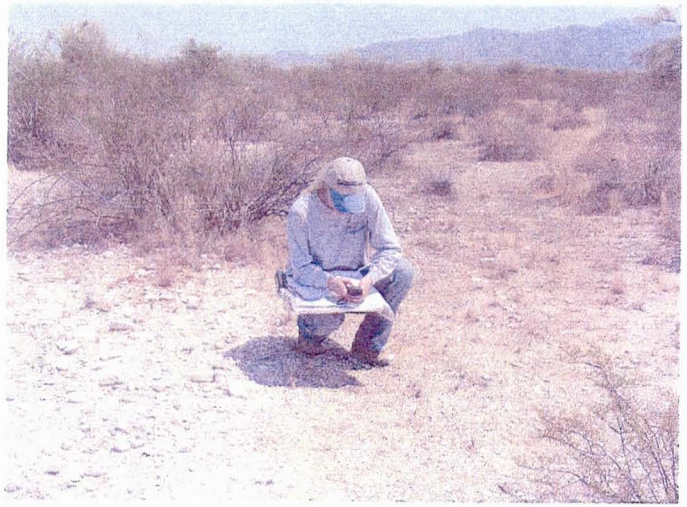

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Photo #73

Photo #74

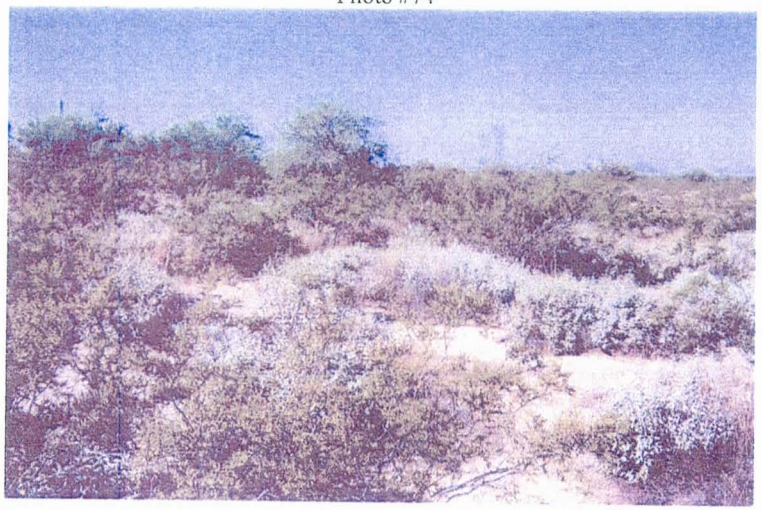
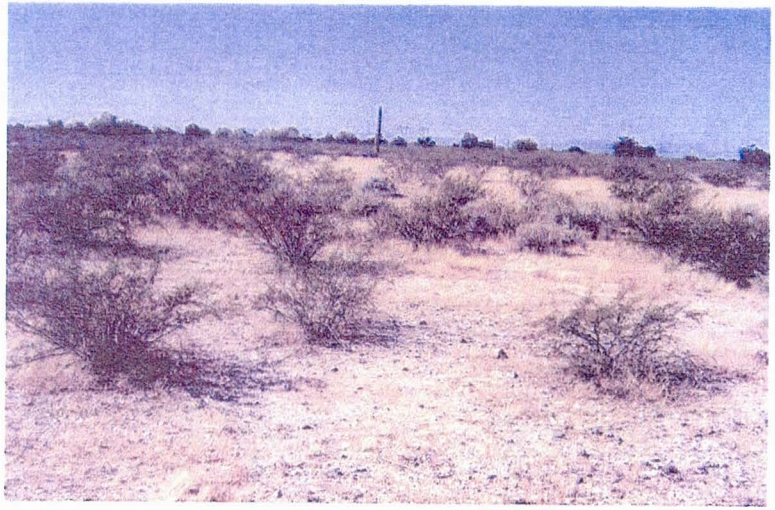


Photo #75

Photo #76

Photo #77



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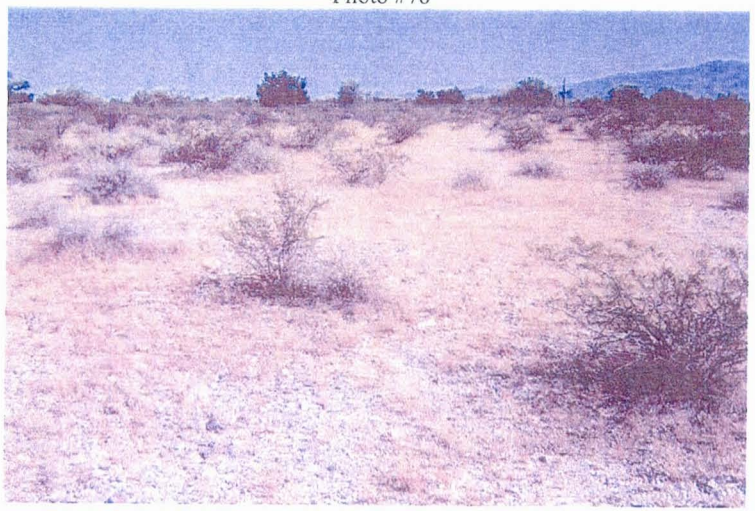

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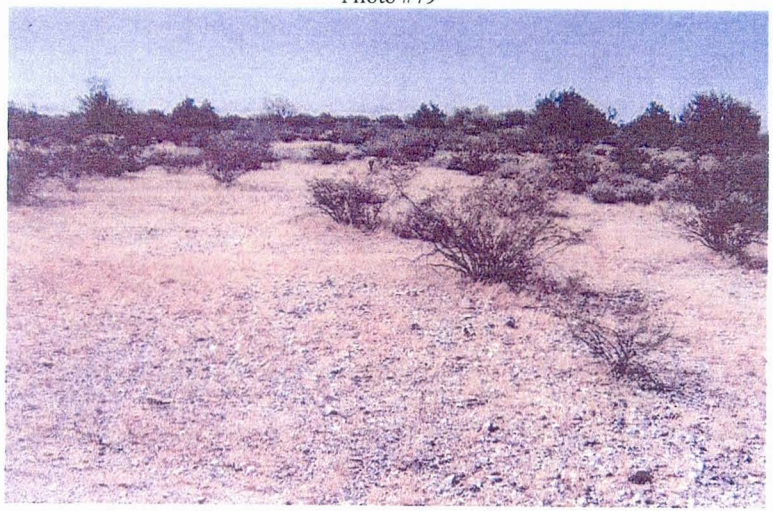

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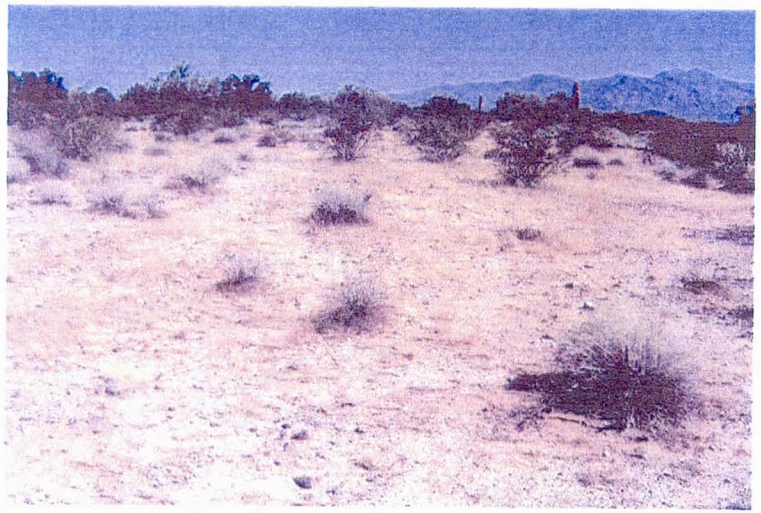

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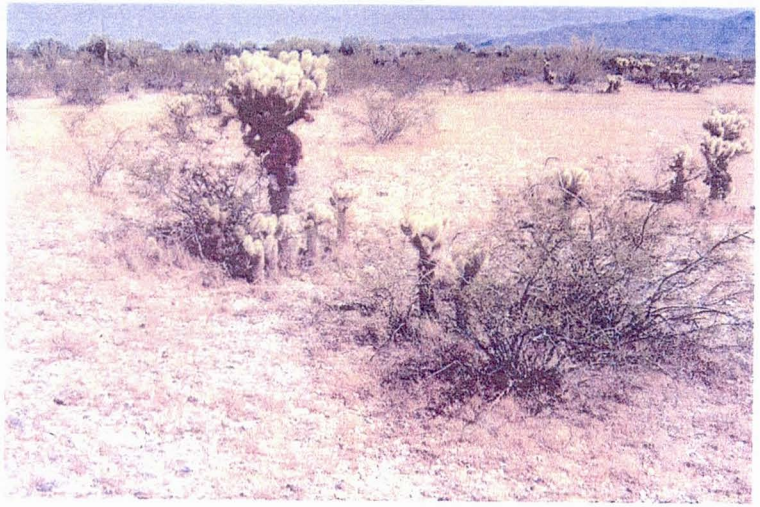


Photo #84

Photo #85

Photo #86

Photo #87

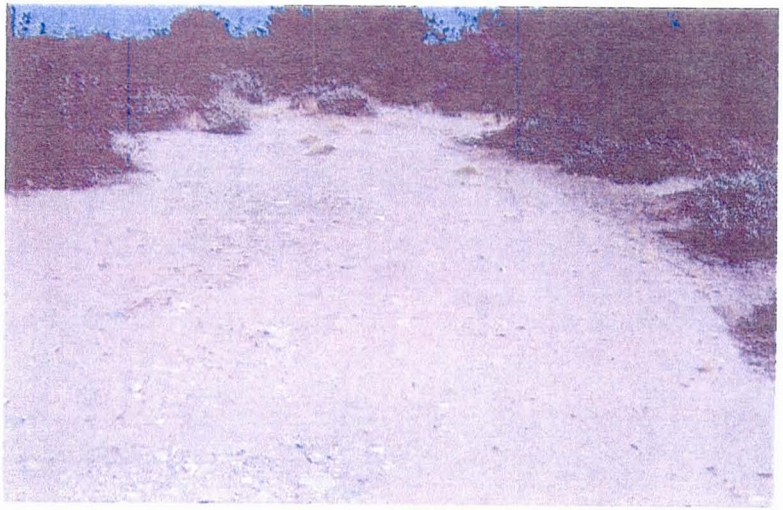
Photo #88

Photo #89

Photo #90

Photo #91

Photo #92



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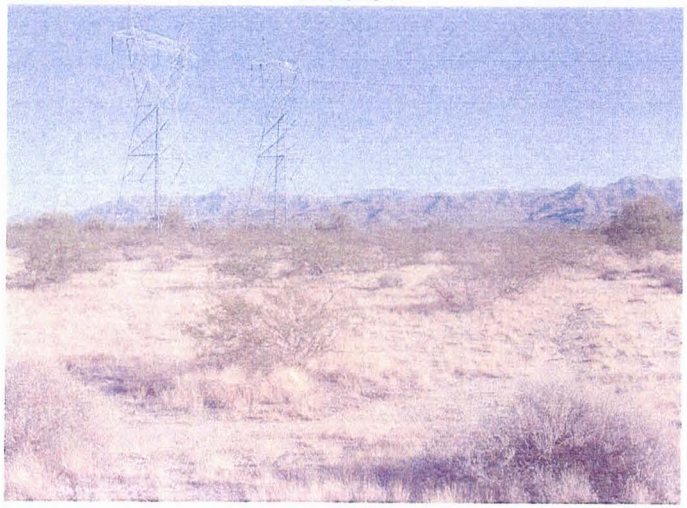

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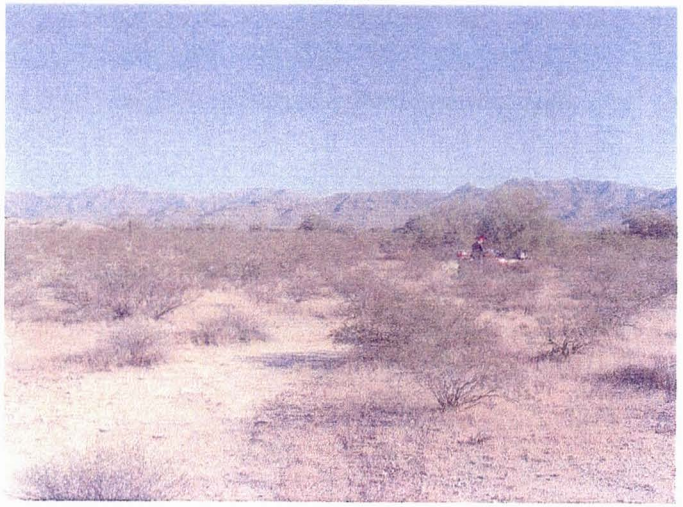

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Photo #97

Photo #98

Photo #99

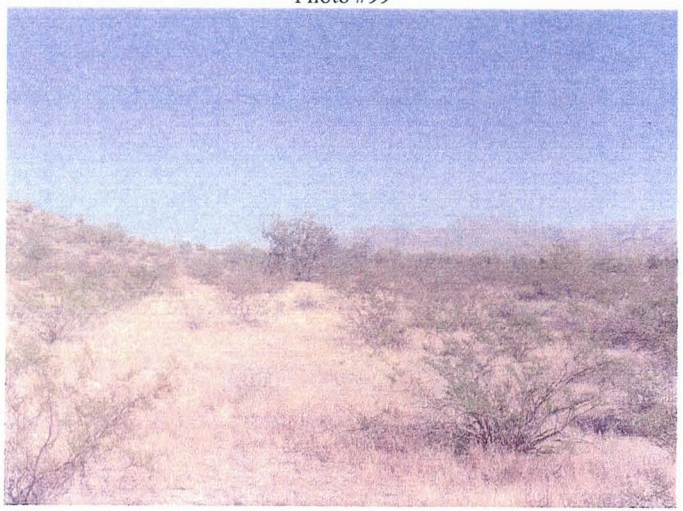
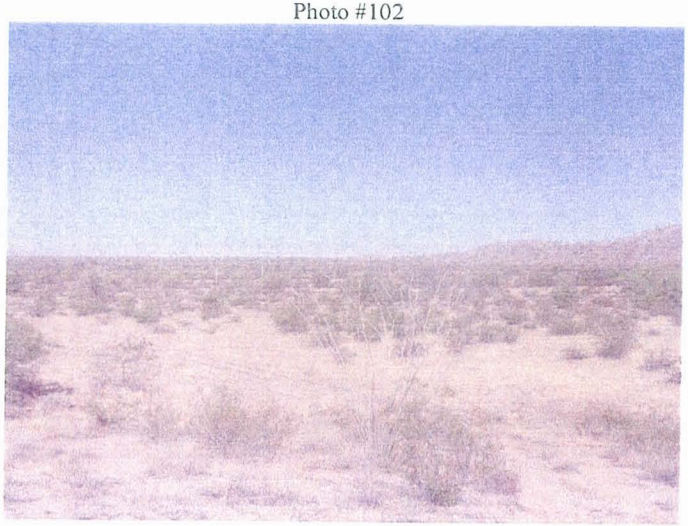


Photo #100

Photo #101

Photo #102



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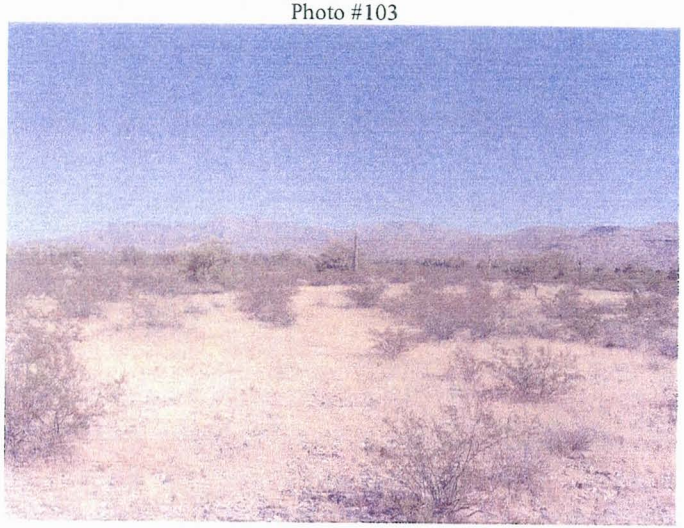

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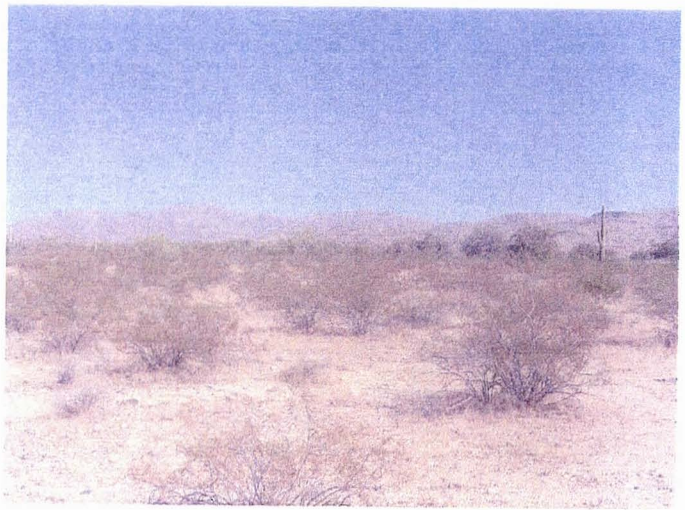


Photo #106

Photo #107

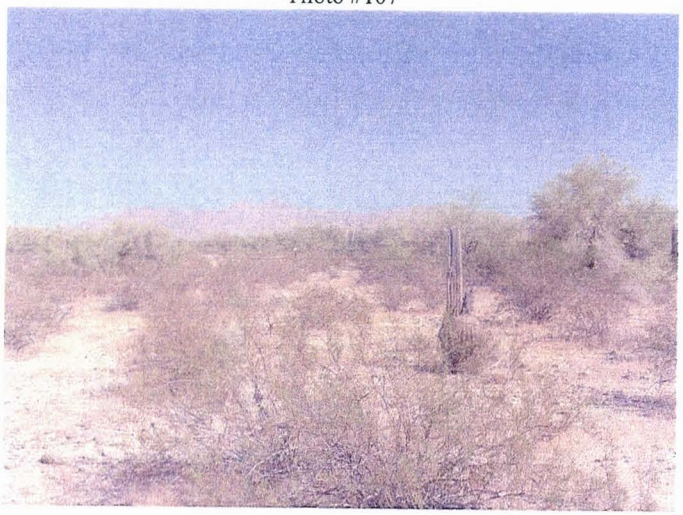


Photo #108

Photo #109

Photo #110

Photo #111

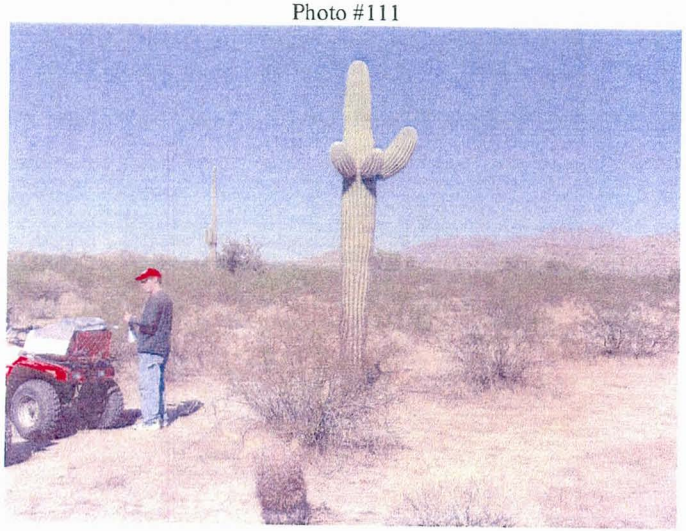
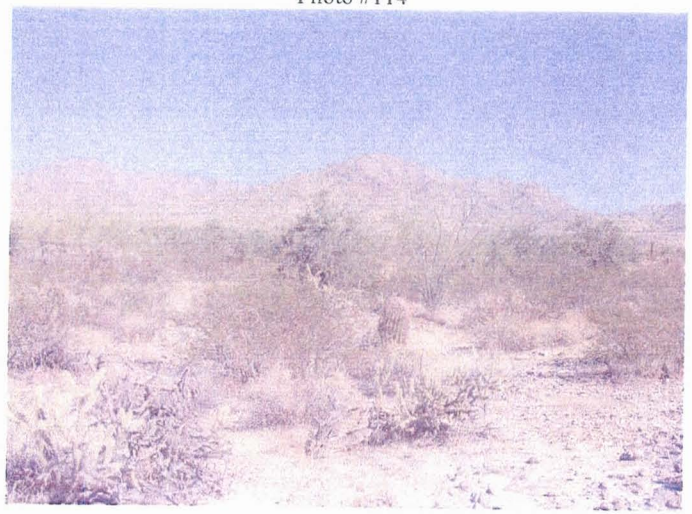


Photo #112

Photo #113

Photo #114



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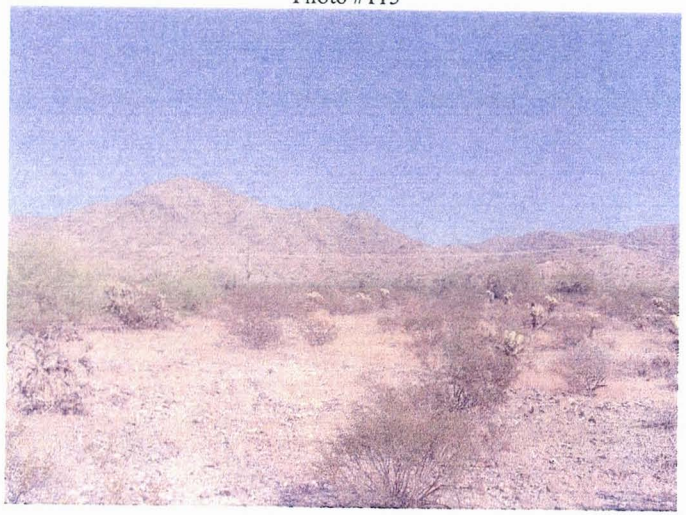

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Photo #117

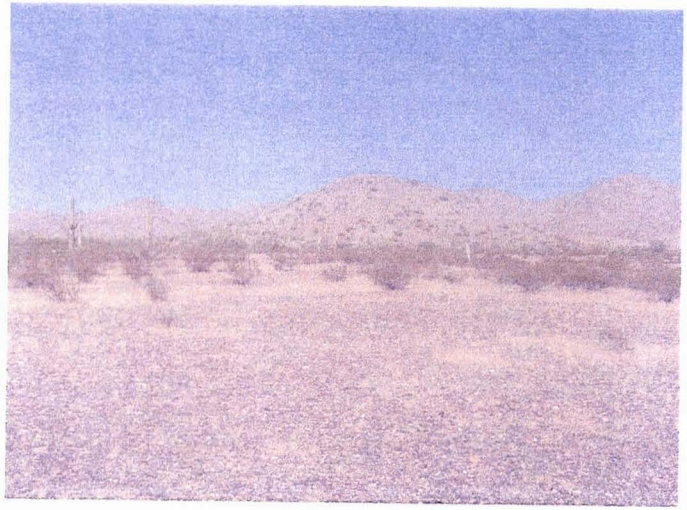

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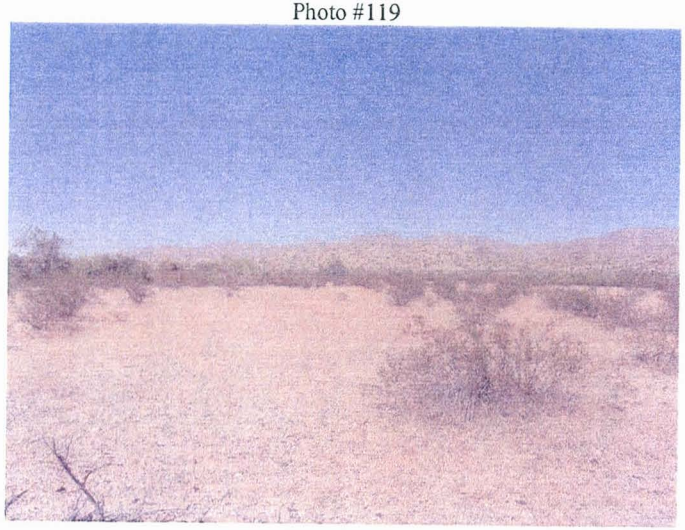
Photo #119



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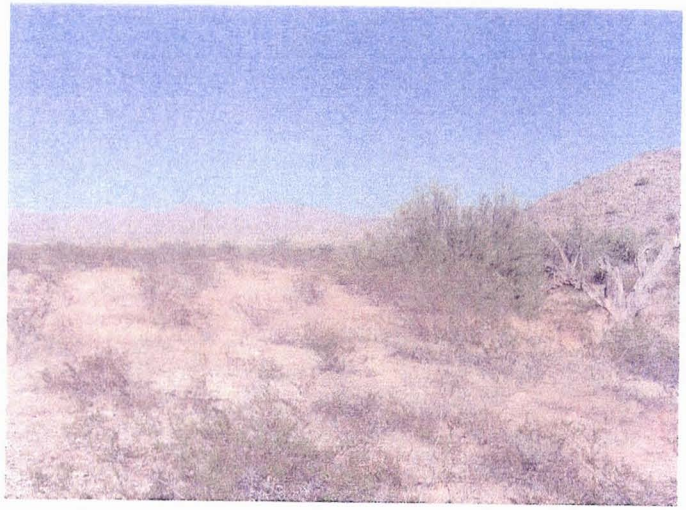

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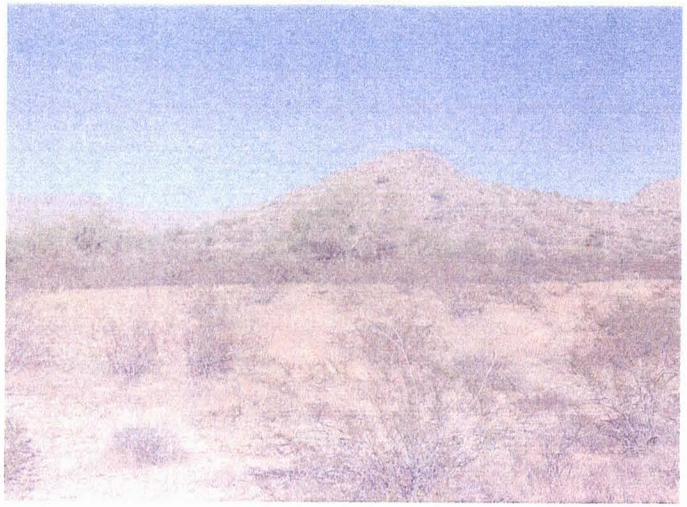

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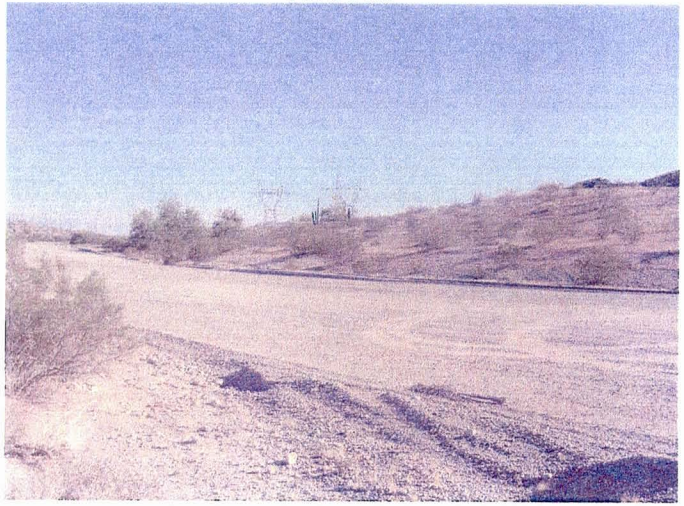
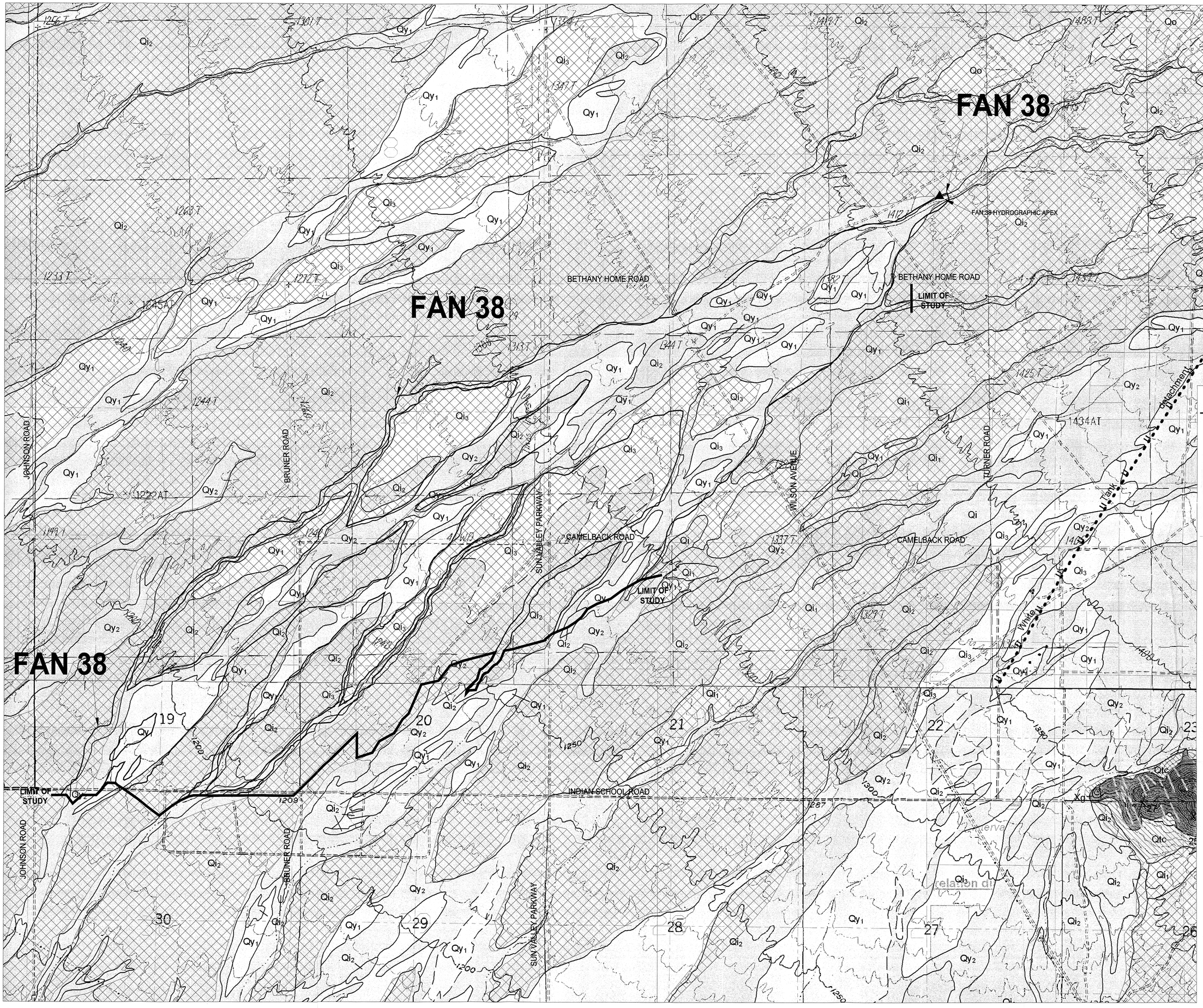


FAN 38
FAN 38
FAN 38
LIMIT OF STUDY
LIMIT OF STUDY
LIMIT OF STUDY
LIMIT OF STUDY
ZONE A
ZONE A
ZONE A
709
Q=1858
FAN 38 HYDROGRAPHIC APEX
710
711
712
713
714
BETHANY HOME ROAD
BETHANY HOME ROAD
CAMELBACK ROAD
CAMELBACK ROAD
INDIAN SCHOOL ROAD
JOHNSON ROAD
JOHNSON ROAD
BRUNER ROAD
BRUNER ROAD
SUN VALLEY PARKWAY
SUN VALLEY PARKWAY
WILSON AVENUE
TURNER ROAD
AFHH
AFUFD
AAFF
AFZA
SHX
LEGEND
Flood Hazard Boundary
Fan 38 Thalwegs
Q=500 Flow Values
714 HEC-RAS Cross Section Location and ID
15 Section Lines and Numbers
AFHH Alluvial Fan High Hazard
AFUFD Alluvial Fan Uncertain Flow Distribution
AAFF Approximate Alluvial Fan Floodway
AFZA Alluvial Fan Zone A Flooding
SHX Shaded Zone X
0 300' 600' 1,200'
SCALE: 1"=600'
DATE REVISION BY
DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151
EXHIBIT 1
HEC-RAS
CROSS SECTION LOCATIONS
FAN 38
SECTION: Varies TWNSHP: 2N RANGE: 4W
DESIGN BY: RTLI DATE: 07/06
CHECKED BY: TSG DRAWN BY: NAGU
JOB NO.: STAR00000131 SHEET 1 OF 1

FAN 38
FAN 38
FAN 38
LIMIT OF STUDY
LIMIT OF STUDY
LIMIT OF STUDY
LIMIT OF STUDY
FAN 38 HYDROGRAPHIC APEX
BETHANY HOME ROAD
BETHANY HOME ROAD
CAMELBACK ROAD
CAMELBACK ROAD
INDIAN SCHOOL ROAD
JOHNSON ROAD
JOHNSON ROAD
BRUNER ROAD
BRUNER ROAD
SUN VALLEY PARKWAY
SUN VALLEY PARKWAY
WILSON AVENUE
TURNER ROAD
LEGEND
Fan 38 Flood Hazard Boundary
Section Lines and Numbers
40 SCS Soils Map Unit
Alluvial Fan
Pediment
Bedrock
Relict Fan
0 300' 600' 1,200'
SCALE: 1"=600'
DATE
REVISION
BY
DAVID EVANS AND ASSOCIATES INC.
2141 East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151
EXHIBIT 2
SOIL CONSERVATION SERVICE
SOILS MAP
FAN 38
SECTION: VARIES
TWNSHP: 2N
RANGE: 4W
DESIGN BY: SXWI
DATE: 11/07
CHECKED BY: MIW
DRAWN BY: SXWI
JOB NO.: STAR00000131
SHEET 1 OF 1



LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- 15 — Section Lines and Numbers

Y2	Late Holocene Alluvial Fans
Y1	Late To Early Holocene Alluvial Fans & Terraces
Y	Undifferentiated Holocene Alluvial Surfaces
M2	Latest To Late Pleistocene Alluvial Fans
M1b	Middle To Late Pleistocene Alluvial Fans
M12	Middle Or Late Pleistocene Distal Alluvial Fans
M1a	Middle To Early Pleistocence Alluvial Fans

0 300' 600' 1,200'

SCALE: 1"=600'

DATE	REVISION	BY

DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151

EXHIBIT 3
SURFICIAL GEOLOGY MAP FROM AZGS

FAN 38

SECTION: VARIES	TWNSHP: 2N	RANGE: 4W	
DESIGN BY: SXWI	DATE: 11/07		
CHECKED BY: MIW	DRAWN BY: SXWI		
JOB NO.: STAR00000131	SHEET 1 OF 1		

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FAN 38

LIMIT OF STUDY

FAN 38 HYDROGRAPHIC APEX

BETHANY HOME ROAD

LIMIT OF STUDY

FAN 38

CAMELBACK ROAD

LIMIT OF STUDY

FAN 38

LIMIT OF STUDY

INDIAN SCHOOL ROAD

JOHNSON ROAD

BRUNER ROAD

SUN VALLEY PARKWAY

WILSON AVENUE

TURNER ROAD

LEGEND

- Fan 38 Flood Hazard Boundary
- Alluvial Fan
- Pediment
- Bedrock
- Relict Fan
- 15 — Section Lines and Numbers
- H1 Very High Flood Potential
- H2 High Flood Potential
- I Intermediate Flood Potential
- L1 Relatively Low Flood Potential
- L2 Very Low Flood Potential

0 300' 600' 1,200'

SCALE: 1"= 600'

DATE	REVISION	BY

DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151

EXHIBIT 4
GEOLOGIC MAPPING FLOOD HAZARDS FROM AZGS

FAN 38

SECTION: VARIES	TWNSHP: 2N	RANGE: 4W	
DESIGN BY: SXWI	DATE: 11/07		
CHECKED BY: MIW	DRAWN BY: SXWI		
JOB NO.: STAR00000131	SHEET 1 OF 1		

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FAN 38

FAN 38

FAN 38

BETHANY HOME ROAD

BETHANY HOME ROAD

CAMELBACK ROAD

CAMELBACK ROAD

INDIAN SCHOOL ROAD

LIMIT OF STUDY

LIMIT OF STUDY

LIMIT OF STUDY

ZONE A

ZONE A

TANNER PROSTHETIC ARM

JOHNSON ROAD

JOHNSON ROAD

BRUNER ROAD

BRUNER ROAD

SUN VALLEY PARKWAY

SUN VALLEY PARKWAY

WILSON AVENUE

AFHH

AFUFD

AAFF

AFZA

SHX

LEGEND

- Fan 38 Flood Hazard Boundary
- Fan 38 Thalweg
- 15 — Section Lines and Numbers
- Photo Locations
- **AFHH** Alluvial Fan High Hazard
- **AFUFD** Alluvial Fan Uncertain Flow Distribution
- **AAFF** Approximate Alluvial Fan Floodway
- **AFZA** Alluvial Fan Zone A Flooding
- **SHX** Shaded Zone X

0 300' 600' 1,200'

SCALE: 1"=600'

DATE	REVISION	BY

DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151

EXHIBIT 5
STAGE 3 RESULTS
AERIAL PHOTOGRPAHY

FAN 38

SECTION: VARIES	TWNSHP: 2N	RANGE: 4W	
DESIGN BY: SXWI	DATE: 07/06		
CHECKED BY: MIW	DRAWN BY: SXWI		
JOB NO.: STAR00000131	SHEET 1 OF 1		

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FAN 38

FAN 38

FAN 38

BETHANY HOME ROAD

BETHANY HOME ROAD

CAMELBACK ROAD

CAMELBACK ROAD

INDIAN SCHOOL ROAD

JOHNSON ROAD

JOHNSON ROAD

BRUNER ROAD

BRUNER ROAD

SUN VALLEY PARKWAY

SUN VALLEY PARKWAY

WILSON AVENUE

TURNER ROAD

ZONE A

ZONE A

LIMIT OF STUDY

LIMIT OF STUDY

LIMIT OF STUDY

FAN 38 HYDROGRAPHIC APEX

AAFF

AFHH

AFUFD

AFZA

SHX

LEGEND

Fan 38 Flood Hazard Boundary

Highly Unstable Active Alluvial Fan

15 Section Lines and Numbers

0 300' 600' 1,200'

SCALE: 1"= 600'

DATE	REVISION	BY

DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151

EXHIBIT 6
STAGE 2 RESULTS
STABLE AND UNSTABLE BOUNDARIES

FAN 38

SECTION: VARIES	TWNSHP: 2N	RANGE: 4W	
DESIGN BY: SXWI	DATE: 11/07		
CHECKED BY: MIW	DRAWN BY: SXWI		
JOB NO.: STAR00000131	SHEET 1 OF 1		

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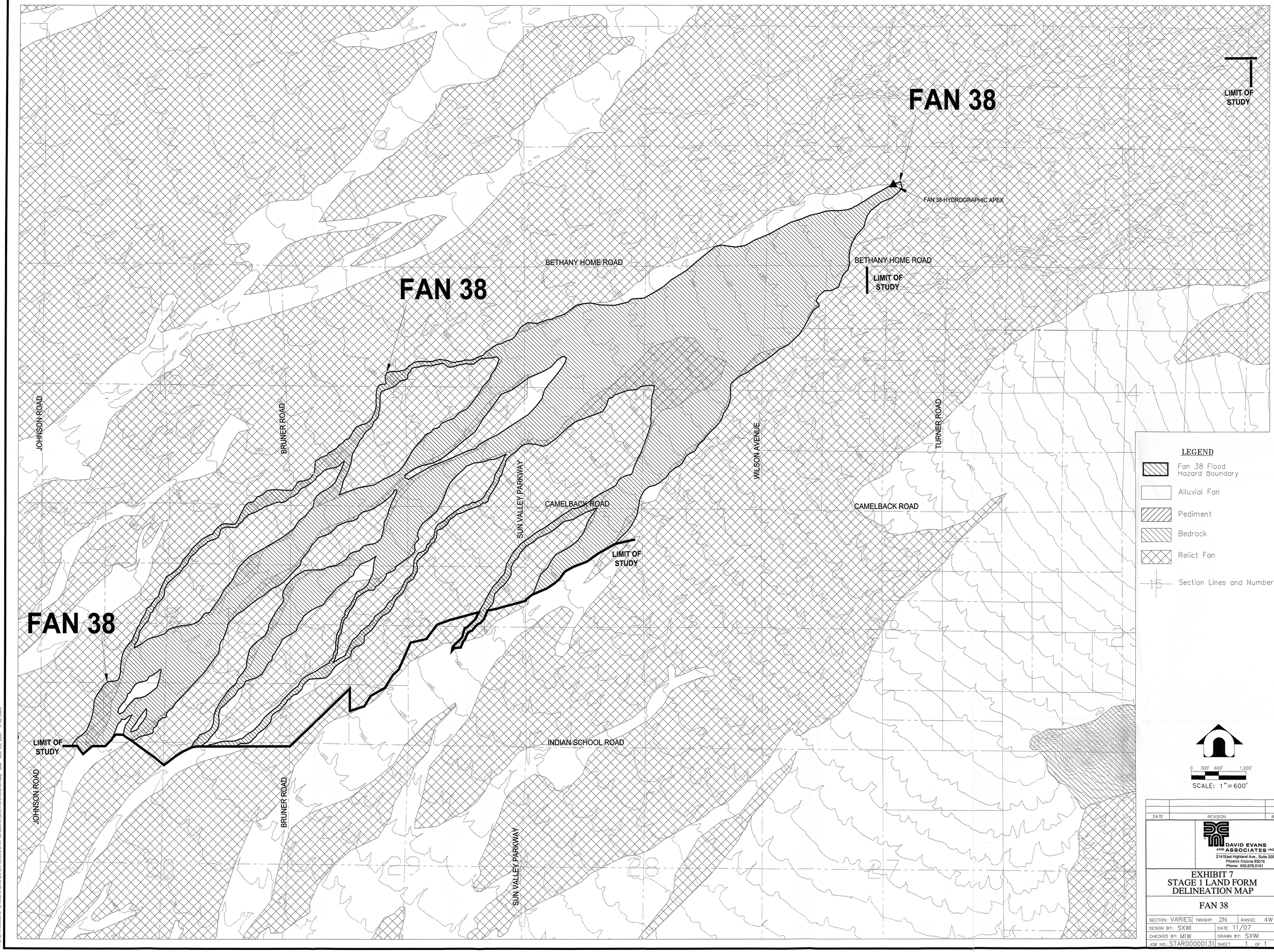

DATE	REVISION	BY

DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151

EXHIBIT 7
STAGE 1 LAND FORM DELINEATION MAP

FAN 38

SECTION: VARIES	TWNSHP: 2N	RANGE: 4W	
DESIGN BY: SXWI	DATE: 11/07		
CHECKED BY: MIW	DRAWN BY: SXWI		
JOB NO.: STAR00000131	SHEET 1 OF 1		

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FAN 38

LIMIT OF STUDY

ZONE A

K2A

1838cfs 13.25hrs
1858cfs 5.25hrs
FAN 38 HYDROGRAPHIC APEX

J1

633cfs 13.08hrs
626cfs 5.08hrs

BETHANY HOME ROAD

K2B

ZONE A

LIMIT OF STUDY

692cfs 12.83hrs
754cfs 4.83hrs

L2C

J1

BETHANY HOME ROAD

626cfs 5.08hrs
633cfs 13.08hrs

FAN 38

K2B

217cfs 12.58hrs
309cfs 4.58hrs

1718cfs 13.67hrs
1744cfs 5.67hrs

L2D

704cfs 4.75hrs
655cfs 12.75hrs

WILSON AVENUE

TURNER ROAD

JOHNSON ROAD

J2

1093cfs 5.33hrs
1212cfs 13.33hrs

BRUNER ROAD

SUN VALLEY PARKWAY

CAMELBACK ROAD

CAMELBACK ROAD

LIMIT OF STUDY

K3

FAN 38

LIMIT OF STUDY

INDIAN SCHOOL ROAD

JOHNSON ROAD

BRUNER ROAD

SUN VALLEY PARKWAY

LEGEND

- Fan 38 Flood Hazard Boundary
- Q=500 — Flow Values
- 1858cfs — 100 Yr, 24-Hr Peak Flows w/Time Of Peak from Buckeye/Sun Valley ADMS
- 1858cfs — 100 Yr, 6-Hr Peak Flows W/Time Of Peak From Buckeye/Sun Valley ADMS
- Concentration Point
- HEC-1 Sub-Basin Boundary
- LC1 — HEC-1 Sub-Basin Boundary
- 15 — Section Lines and Numbers

0 300' 600' 1,200'

SCALE: 1"=600'

DATE	REVISION	BY

DAVID EVANS AND ASSOCIATES INC.
2141East Highland Ave., Suite 200
Phoenix Arizona 85016
Phone: 602.678.5151

EXHIBIT 8
HYDROLOGY EXHIBIT

FAN 38

SECTION: VARIES	TWNSHP: 2N	RANGE: 4W	
DESIGN BY: SXWI	DATE: 11/07		
CHECKED BY: MIW	DRAWN BY: SXWI		
JOB NO.: STAR00000131	SHEET 1 OF 1		

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