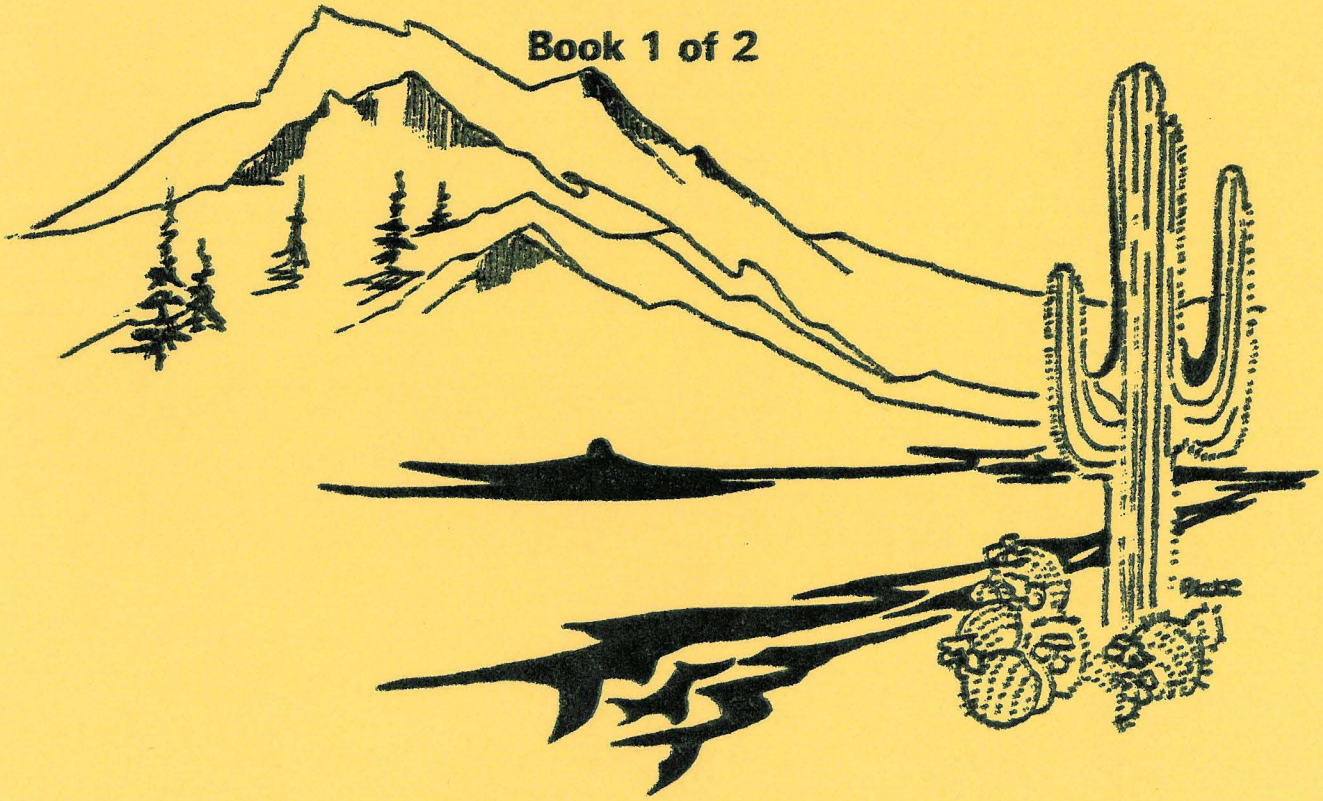
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PHOENIX, ARIZONA

# CAVE CREEK
# ABOVE CAREFREE HIGHWAY
# FLOODPLAIN DELINEATION STUDY
# FCD 95-28

## TECHNICAL DATA NOTEBOOK
## HYDROLOGY
### Existing Condition

Book 1 of 2



*George V. Sabol Consulting Engineers, Inc.*
Scottsdale, Arizona

in association with
McLaughlin Kmetty Engineers, Ltd.

JULY 1997

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## TECHNICAL DATA NOTEBOOK
## HYDROLOGY
**Existing Condition**

**Book 1 of 2**

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ARIZONA, U.S.A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
17928
GEORGE V.
SABOL
Date Signed 31 July
ARIZONA, U.S.A.

*George V. Sabol Consulting Engineers, Inc.*
Scottsdale, Arizona

in association with
McLaughlin Kmetty Engineers, Ltd.

JULY 1997

# PREFACE

The Cave Creek Above Carefree Highway Floodplain Delineation Study (Contract No. FCD 95-28) was performed for:

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009
(602) 506-1501 FAX (602) 506-4601

Engineering, Hydraulics Branch
Branch Manager: Pedro Calzo
Project Manager: Kofi Awumah, PhD, PE

Engineering, Hydrology Branch
Branch Manager: Amir Motamedi
Project Manager: Valerie Swick

By:
George V. Sabol Consulting Engineers, Inc.
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Scottsdale, Arizona 85260
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Project Manager: George V. Sabol, PhD, PE
Project Engineer: W. Scott Ogden, PE

and,

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Project Co-Manager: Geza Kmetty, PE
Project Co-Engineer: Frank Edward Brown, PE

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## INTRODUCTION

The following report is a comprehensive document which contains the results and supporting computations for the hydrology portion of the Cave Creek Above Carefree Highway Floodplain Delineation Study located in Maricopa County, Arizona. Our sincere appreciation is extended to the following agencies for their help and perspective while studying this watershed:

- Arizona Department of Water Resources
- Flood Control District of Maricopa County
- U.S. Forest Service, Tonto National Forest
- U.S. Soil Conservation Service.

The purpose of this study is to provide estimates of peak discharges resulting from a 100-year storm at key locations on the watershed. Those discharges are then used to estimate the horizontal limits of flooding in designated study reaches, and to define floodway limits. The study was ordered by the Flood Control District of Maricopa County (District). The hydraulics portion of this study is contained under separate cover. The hydrology portion of this study is executed using the methodology contained in the Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology, (Design Manual), 1992, Flood Control District of Maricopa County. Hydrologic modeling is accomplished using the US Army Corps of Engineers (COE) HEC-1 computer program, version 4.0.1E. The primary focus of this report is a floodplain delineation re-study for 5.4 miles of Cave Creek, from the Carefree Highway Bridge (river mile 30.2) north to approximately Morning Star Drive (river mile 35.49). Additional revised hydrology is also prepared for the Andora Hills Wash sub-watershed, from the Cave Creek confluence east to the watercourse headwater. Floodplain delineations currently exist for the study area and were estimated by previous flood insurance studies.

The Cave Creek study watershed is approximately 124 square miles in area, and includes the unincorporated communities of Cave Creek and Carefree, the City of Scottsdale, the City of Phoenix, and U.S. Forest Service lands. Flooding consists of roadway flooding at wash crossings and the potential for flooding of homes situated near the major watercourses. The natural watercourses are generally maintained through the

urbanized areas with some encroachment and channelization occurring at scattered locations. Some watercourses are regraded in the form of broad swales through the golf course areas and prismatic channels through developed areas. The typical rainfall cycle consists of short duration, high intensity thunder storms during the summer months, and general storms of longer duration during the winter months. Refer to the hydraulics report for other Community information.

| STUDY DOCUMENTATION ABSTRACT | | | | | | | |
|---|---|---|---|---|---|---|---|
| INITIAL STUDY | | RESTUDY | X | LOMR | | OTHER | |

SECTION 1: GENERAL INFORMATION

| | | |
|---|---|---|
| 1A | COMMUNITY | Cave Creek/Carefree (unincorporated) |
| 1B | COMMUNITY NUMBER | 04013 |
| 1C | COUNTY | Maricopa |
| 1D | STATE | Arizona |
| 1E | DATE STUDY ACCEPTED | 5 August 1997 |
| 1F | STUDY CONTRACTOR | George V. Sabol Consulting Engineers, Inc. |
| | CONTACTS | W. Scott Ogden, PE<br>George V. Sabol, PhD, PE |
| | ADDRESS | C/O: Stantech Consulting, Inc.<br>7776 Pointe Parkway W., Ste 290<br>Phoenix, Arizona 85044 |
| | PHONE | (602)438-2200<br>(602)431-9562 (FAX) |
| | SUBCONSULTANTS | McLaughlin Kmetty Engineers, Ltd.<br>Aerial Mapping Company, Inc.<br>Alcocer Land Surveyors, Inc. |
| 1G | TECH. REVIEWER (FEMA, contractor) | Mike Conaboy (Michael Baker Jr., Inc.) |
| | PHONE | (609) 734-7922 |
| 1H | FEMA REGIONAL REVIEWER | |
| | PHONE | |
| 1I | STATE REVIEWER | N/A |
| | PHONE | |
| 1J | LOCAL REVIEWER | Flood Control District of Maricopa County<br>Kofi Awumah, PhD, PE Valerie Swick<br>Pedro Calza, PE Amir Motamedi |
| | PHONE | (602) 506-1501 |
| 1K | RIVER OR STREAM NAME | Cave Creek |
| 1L | REACH DESCRIPTION | Refer to Exhibit A |
| 1M | STUDY TYPE | Floodplain/Floodway Re-Delineations |

## STUDY DOCUMENTATION ABSTRACT (continued)

SECTION 2: MAPPING INFORMATION

| | | |
|---|---|---|
| 2A | USGS QUAD SHEETS | Cave Creek |
| | | Cooks Mesa |
| | | Wildcat Hill |
| | | New River Mesa |
| | | Humboldt Mountain |
| | | Rover Peak |
| 2B | MAPPING FOR HYDROLOGIC STUDY<br>TYPE/SOURCE | USGS Quad maps per Section 2A of the TDN |
| | SCALE | 1 inch = 2,000 feet |
| | DATE | 1964, 1965 and 1967 |
| 2C | MAPPING FOR HYDRAULIC STUDY<br>TYPE/SOURCE | 2-foot contour interval mapping in digital format<br>Aerial Mapping Company, Inc. |
| | SCALE | 1 inch = 200 feet |
| | DATE | 12 January 1996 |

SECTION 3: HYDROLOGY

| | | |
|---|---|---|
| 3A | MODEL OR METHOD USED<br>(Including vendor and version description) | HEC-1 version 4.0.1E dated May 1991<br>Dodson & Associates, Inc. |
| 3B | STORM DURATION | 6-hour and 24-hour |
| 3C | HYETOGRAPH TYPE | In accordance with Design Manual |
| 3D | FREQUENCIES DETERMINED | 100-year |
| 3E | LIST OF GAGES USED IN FREQUENCY ANALYSIS OR CALIBRATION (Location, Years of Record, Gage Ownership) | None used |
| 3F | RAINFALL AMOUNTS AND REFERENCE | 100-year, 6-hour = 3.58 inches<br>100-year, 24-hour = 4.98 inches<br>NOAA Atlas II |
| 3G | UNIQUE CONDITIONS AND PROBLEMS | None significant |
| 3H | COORDINATION OF Q'S<br>(Agency, date, comments | |

## STUDY DOCUMENTATION ABSTRACT (continued)

SECTION 4: HYDRAULICS

| | | |
|---|---|---|
| 4A | MODEL OR METHOD USED (including vendor and version description) | HEC-2 version 4.6.2 as enhanced by Dodson & Associates's PROHEC-2 |
| 4B | REGIME | Subcritical |
| 4C | FREQUENCIES FOR WHICH PROFILES WERE COMPUTED | 100-year |
| 4D | METHOD OF FLOODWAY CALCULATION | Method 1 |
| 4E | UNIQUE CONDITIONS AND PROBLEMS | none |

| STUDY DOCUMENTATION ABSTRACT | | | | | | | |
|---|---|---|---|---|---|---|---|
| INITIAL STUDY | | RESTUDY | X | LOMR | | OTHER | |

SECTION 1: GENERAL INFORMATION

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| 1D | STATE | Arizona |
| 1E | DATE STUDY ACCEPTED | (pending) |
| 1F | STUDY CONTRACTOR | George V. Sabol Consulting Engineers, Inc. |
| | CONTACTS | W. Scott Ogden, PE<br>George V. Sabol, PhD, PE |
| | ADDRESS | C/O: SFC Engineering Company<br>7776 Pointe Parkway W., Ste 290<br>Phoenix, Arizona 85044 |
| | PHONE | (602)438-2200<br>(602)431-9562 (FAX) |
| | SUBCONSULTANTS | McLaughlin Kmetty Engineers, Ltd.<br>Aerial Mapping Company, Inc.<br>Alcocer Land Surveyors, Inc. |
| 1G | TECH. REVIEWER (FEMA) | (pending) |
| | PHONE | |
| 1H | FEMA REGIONAL REVIEWER | (pending) |
| | PHONE | |
| 1I | STATE REVIEWER | Arizona Department of Water Resources |
| | PHONE | (602) 542-1541 |
| 1J | LOCAL REVIEWER | Flood Control District of Maricopa County<br>Kofi Awumah, PhD, PE Valerie Swick<br>Pedro Calza, PE Amir Motamedi |
| | PHONE | (602) 506-1501 |
| 1K | RIVER OR STREAM NAME | Cave Creek |
| 1L | REACH DESCRIPTION | Refer to Exhibit A |
| 1M | STUDY TYPE | Floodplain/Floodway Re-Delineations |

## STUDY DOCUMENTATION ABSTRACT (continued)

SECTION 2: MAPPING INFORMATION

| | | |
|---|---|---|
| 2A | USGS QUAD SHEETS | Cave Creek |
| | | Cooks Mesa |
| | | Wildcat Hill |
| | | New River Mesa |
| | | Humboldt Mountain |
| | | Rover Peak |
| 2B | MAPPING FOR HYDROLOGIC STUDY<br>TYPE/SOURCE | USGS Quad maps per Section 2A of the TDN |
| | SCALE | 1 inch = 2,000 feet |
| | DATE | 1964, 1965 and 1967 |
| 2C | MAPPING FOR HYDRAULIC STUDY<br>TYPE/SOURCE | 2-foot contour interval mapping in digital format<br>Aerial Mapping Company, Inc. |
| | SCALE | 1 inch = 200 feet |
| | DATE | 12 January 1996 |

SECTION 3: HYDROLOGY

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|---|---|---|
| 3A | MODEL OR METHOD USED<br>(Including vendor and version description) | HEC-1 version 4.0.1E dated May 1991<br>Dodson & Associates, Inc. |
| 3B | STORM DURATION | 6-hour and 24-hour |
| 3C | HYETOGRAPH TYPE | In accordance with Design Manual |
| 3D | FREQUENCIES DETERMINED | 100-year |
| 3E | LIST OF GAGES USED IN FREQUENCY ANALYSIS OR CALIBRATION (Location, Years of Record, Gage Ownership) | None used |
| 3F | RAINFALL AMOUNTS AND REFERENCE | 100-year, 6-hour = 3.58 inches<br>100-year, 24-hour = 4.98 inches<br>NOAA Atlas II |
| 3G | UNIQUE CONDITIONS AND PROBLEMS | None significant |
| 3H | COORDINATION OF Q'S<br>(Agency, date, comments | |

## STUDY DOCUMENTATION ABSTRACT (continued)

SECTION 4: HYDRAULICS

| | | |
|---|---|---|
| 4A | MODEL OR METHOD USED (including vendor and version description) | HEC-2 version 4.6.2 as enhanced by Dodson & Associates's PROHEC-2 |
| 4B | REGIME | Subcritical |
| 4C | FREQUENCIES FOR WHICH PROFILES WERE COMPUTED | 100-year |
| 4D | METHOD OF FLOODWAY CALCULATION | Method 1 |
| 4E | UNIQUE CONDITIONS AND PROBLEMS | none |

# 1.1 CONTACT (TELEPHONE) REPORTS

**MKE** McLaughlin Kmetty Engineers, Ltd.

TELEPHONE COMMUNICATION REPORT

1/1

DATE: 12-26-95 TIME: 11:30 AM JOB NO. C. C&K
TO: F Brown LOCATION: MKE
FROM: Hal Marron LOCATION: Willdan + Assoc

SUBJECT/DISCUSSION:

NDOT not on 29
FCD no like CityPhx control (only 3rd order)

try tie into Cave Buttes Dam - some problems - see improvement area study, which had better ties. (CH2 or Hutt Zollars)

ALS should tie into USGS points to verify datum
is there anything further north
Hal/Val is resting survey on other studies,
we are resting ours on theirs.

Summary - used bed rock
we are on 1929 Datum 83 NAD last points set? Not known
but will tie into bridge. (should be in field notes).
Val has keys to gates

Hal gone San Jose near mid-January

Willdan Kick off

SUMMARY/ACTION ITEMS:

1. Valco survey was tied into Benchmarks @ Cave Buttes Dam, set in bed rock

2. Valco and this project are on 1929 NGVD and 1983 NAD

3. Alcocer to set parcel points along Carefree Hwy if Valco does not set them. Check field notes Recd 12-26-95 from Valco.

4. I told Hal that at the latest, Aerial Mapping Co will fly on 13 January 1996

5. Alcocer should tie into USGS or Forest Service points north of Carefree Hwy, to verify datum and coordinates.

~~COPY TO:~~

6. Val has keys to all gates, for State land/FCD land.

**MKE** McLaughlin Kmetty Engineers, Ltd

TELEPHONE COMMUNICATION REPORT

1/1

DATE: 2 Jan 96 TIME: JOB NO. Cane Creek

TO: Kofi A. LOCATION: Fcn of MC

FROM: Frank B. LOCATION: MKE

SUBJECT/DISCUSSION:

Kofi – ✓ 1. A value work 4 Jan 96 FAX trim schedule.

✓ 2. mylars avail for Harris Taups Study? anything digital / will call

3. Survey notes – total sta printout / annotation ok?

OK // Kofi to do this.

Hal Marcon 3 Jan 95 4:20 PM

George Schedule office Monday in field

for Their out back Fri → 12th

maybe gone Mon + Tues

15 + 16 back 19 18 + 19

Hal @ 1:50PM Fri 5 Jan

says Val has asked to get // ALS on 0.97'

Horz ctrl – has coords @ dam / improvement study Z+H study

+ we tie into coord. – he will check into it.

we may need to pay them for some coords!

Hal is not opposed to cost sharing on GPS points

SUMMARY/ACTION ITEMS:

Hal Marcon

1. Will call me on Monday 8 Jan 96

2. Valco will contact ALS about 0.97' vert difference

3. Coords may come from the dam – Hal to check with Valco

4. Told him we may like it next Wednesday – and Valco knows this and has talked // ALS.

COPY TO:

Hal 8 Jan 96 4:15 P.M. 1/1

Cave Creek

[illegible] of [illegible] road?

Followed 2+4 page [illegible] [illegible]

SIT down, ARS VAL [illegible]

[illegible] Tues. P.M. for [illegible] on VERT bottom.
4:30.

ok [illegible] pg 1675.

[illegible] [illegible] [illegible] [illegible]

*George V. Sabol Consulting Engineers, Inc.*

**TELEPHONE LOG**

**PROJECT:** #84/ Cave Creek FDS **TO/FROM:** Kofi Awumah

**DATE:** 17 January **ORGANIZATION:** FCDMC

**TOPICS:**

**CITY:** **PHONE NO.:** 506-2942

**ITEMS DISCUSSED:** (1) Kofi is getting the cadastral and corporate boundary CAD files made up and will deliver those to us. (2) Kofi spoke w/ Marta Dent concerning HIS conversion of the new land use data. He said that the District would prefer for us to do the conversion if possible because the District is swamped. I agreed to do it. (3) Kofi will set up a mtg sometime on 24 January to meet w/ Besian Khatiblou of Regulatory to discuss lining out the surveying for modeling the Galloway Wash breakout.

W. Scott Ogden

**FURTHER ACTIONS REQUIRED:** None

10 AM 18 Jan 96 Cave Creek

Lori

~~using~~ Special use permit
temporary situation

typical stockpile not to sell to developers.

do not include in model
will call us back to discuss

11:00 AM. a district employee will talk, then
will not stockpile in floodway
we will discuss it later

# George V. Sabol Consulting Engineers, Inc.

## TELEPHONE LOG

**PROJECT:** #84/Cave Creek FDS

**TO/FROM:** Kofi Awumah

**DATE:** 30 January '96

**ORGANIZATION:** FCDMC

**TOPICS:**

**CITY:**

**PHONE NO.:** 506-2742

**ITEMS DISCUSSED:** Kofi called and said that he has the following items ready: (1) cartographic and municipal boundary DXF files (2) ± 50% of the property owner names for the parcels requested. I informed Kofi that ALS was substantially finished w/ their field work and that these letters were just a formality, and that if Kofi agreed, we would send letters to the remaining people he has ID'd. Kofi agreed that that would be satisfactory.

I asked Kofi if the District has made a decision regarding the southern boundary changes. He said Valerie has that info and that He would check and get back to us.

**FURTHER ACTIONS REQUIRED:** Upon receipt of additional names and addresses, send out right of entry letters to those individuals.

*George V. Sabol Consulting Engineers, Inc.*

**TELEPHONE LOG**

**PROJECT:** 84\ Cave Creek FDS **TO/FROM:** Kofi Awumah via Frank Brown

**DATE:** 2/28/96 **ORGANIZATION:** FCDMC

**TOPICS:** Rights-of-entry letters

**CITY:** **PHONE NO.:** 506-2942

**ITEMS DISCUSSED:** Kofi received two phone calls from property owners stating that they did not want survey crews on their properties. Those people are:

Don Marshall 211-59-003K 488-2500
P.O. Box 1783
Cave Creek, AZ
85331

Mrs. McKinstry 211-17-013N

Mr. Marshall did not get a letter because we did not have an address or name. We will send him a letter and follow up with a phone call.

**FURTHER ACTIONS REQUIRED:**

Kofi

Don Marshall

Cave Creek 28 Feb 96
1:30 PM

488-2500 1/1

Survey crew on his land
Call him to discuss permission
Look on list - did he get letter?
Go on list

211-59-003K

PO Box 723 Cave Creek 85331

verify address

Mrs. McKensing "no one on file"
left msg 9 Feb 96 Scott property "
get parcel #
chk list
letter
crew survey

BC # Sys 2m OK.

put into rept for repass rpt

parcel on GIS
211-17-13N

PV Scott X ok

Give survey crew
Street location.

#

*George V. Sabol Consulting Engineers, Inc.*

**TELEPHONE LOG**

**PROJECT:** CAVE CREEK FPD **TO/FROM:** NORM AMBOS

**DATE:** 7 MARCH **ORGANIZATION:** TONTO NATL. FOREST

**TOPICS:** SOIL DEPTHS FOR TONTO NATIONAL FOREST / CARTWRIGHT ALLOTMENT

**CITY:** **PHONE NO.:** 225-5200

**ITEMS DISCUSSED:**

SURFACE HORIZON DEPTHS FOR CARTWRIGHT ALLOTMENT & SURROUNDI NATIONAL FOREST.

- CARTWRIGHT ALLOTMENT:
  - SURFACE HORIZON ("A" ZONE) IS GENERALLY 2-3" DEEP. IT DOES NOT DEPEND ON SLOPE OR VARY GREATELY BETWEEN MAP UNITS. A DEEP SURFACE HORIZON IS ± 6".
  - SUBSOIL DEPTHS ARE TYPICALLY MUCH GREATER THAN 6".
- GENERAL FOREST:
  - SURFACE HORIZON DEPTHS ARE VERY SIMILAR TO CARTWRIGHT ALLOTMENT. HOWEVER THE SOILS HAVE A MORE DIVERSE COMPOSITION AND THEREFOR A GREATER RANGE IN DEPTH. WHEN PINNED DOWN, NORM FELT A 3" A ZONE WOULD BE TYPICAL.
  - SUBSOIL DEPTHS ARE TYPICALLY MUCH GREATER THAN 6".

**FURTHER ACTIONS REQUIRED:**

1/1

**MKE** McLaughlin Kmetty Engineers, Ltd

TELEPHONE COMMUNICATION REPORT

DATE: 18 March 96 TIME: ~ 9 AM JOB NO. Cane Creek

TO: Rob Davies LOCATION: MKE

FROM: Frank Brown LOCATION: AMC

SUBJECT/DISCUSSION:

Cane Creek

will apply today South half Today. Paint pit stick.

mapping done compilation & draw contours. by Friday

(Wilson delayed - Arsenic Rats & delivered

Speed up check sections - FAX to him ASAP

Requested to Scott Gordon: 11:30 AM Mon 18th

Scott no major problem if a Friday - project on Friday

Keep progress going.

Told him check sections leave Friday to Scott.

7 Mar 96 10-12 people there

Scott had calculation mess - got letters to "Professional" [illegible]

told him will [illegible] to fix

[illegible] Kirk [illegible]

SUMMARY/ACTION ITEMS:

Progress Reports - bring summary to mtg

per work plan - written - hand [illegible]

COPY TO:

1/1

**MKE** **McLaughlin Kmetty Engineers, Ltd.**

TELEPHONE COMMUNICATION REPORT

DATE: 27 Mar 96 TIME: JOB NO. Cave Creek
TO: Frank Brown LOCATION:
FROM: Hal Morrow LOCATION:

SUBJECT/DISCUSSION:

Hal called - upset about no GPS point @ dam

per Richard - Richard talked w/ Sandy + says that val tied into Union, not and then ALS told PEC to use Union.
did not tell PEC to use BC @ Cave Butte Dam
also Richard says locked gates + my impression is he did not want to mess w/ getting / keep for PEC timing fuzzy w/ our discussion
my view - will dam in trouble, VALCO no $ for another trip.

per Richard
Union is the State Control pt - 3rd order survey GPS could not use the Dam. (Unless pay per extra point)

4:50PM still waiting for Val + R. Alcocer to talk.
I left msg w/ Hal. We probably need to talk on the phone or maybe have a mtg w/ ALS.

2 April 96 - sent the USGS pages + treated GPS points. Please note the following:

SUMMARY/ACTION ITEMS:

1. Cost + ... Cave Butte Dam GPS might be $3,250.00
2. Union is 5 miles from Dam!
3. CABS is not @ VALCO's point
4. ... what is vertical datum of HVI? (why is GPS alt - 21 different?)

COPY TO: for ALS 1. see 12-26-95 telecom. did ALS use USGS points?

**MKE** McLaughlin Kmetty Engineers, I[illegible].

TELEPHONE COMMUNICATION REPORT 1/1

DATE: 2 April 9 TIME: JOB NO. [illegible]
TO: various LOCATION:
FROM: Frank Brown LOCATION:

SUBJECT/DISCUSSION:
Karl Mortensen 2 April 2:35 PM

Dam - [illegible] it on [illegible] ALS [illegible] A [illegible] not a [illegible] point NGS [illegible] not [illegible] survey was not asked to get coords @ dam.
Drop to last @ on ALS. needs 3 points 2 base + 1 target
Could use CAPE + Rifle 8 bod x 3 = 1800.00

Karl looking for point nearby. 19th Ave + Bell Rd
→ COP or FCD client)
McCain did work in area/Ashtock GPS ; called 800-229-2400 ask who has data
[illegible] GPS has coords COP [illegible] or FCDMC
I-17 Scottsdale / hills to Carefree Highway
all See Cor + 1/4 Cor
[illegible] for operation for McCain for COP/FCDMC job.

Conclusion - best bet is [illegible] FCDMC get list of coordinates nearby then decide if less [illegible] to survey or set GPS points to it. For future 'set to' set all in advance

called Hal 3 April Wed 8:20 AM

Hal [illegible] 900 [illegible] for HV1, 2' clear, off.
~~SUMMARY/ACTION ITEMS:~~ HV1 is not HV1, Val [illegible] not [illegible] NE 1/4
Corner point vs other visual description
What if get Ashtock points - [illegible] PEC? So better to get good coords now
PEC [illegible] [illegible] asked ALS what do I do [illegible]? [illegible] @ dam

Home Carrie call Hal.
Carrie says here mtg to back out decide cost: Hal + Val / ALS / PEC / GVS

George 9:25 AM distracted, Hal called during my call George will call him back + discuss, then call he back.
Carrie 7:45 Hal happy [illegible] at to dam + who pays? mtg - yes
MKE office Thurs 8:30 AM mtg: FB set up PEC - Val + ALS call Hal or late PM 4PM
COPY TO: call to confirm.
~~4PM @ 2:30 M. 35th Avenue [illegible]~~
(Karl) talked [illegible] Larry [illegible] Larry 8:30 AM here

**MKE** McLaughlin Kmetty Engineers, Ltd.

TELEPHONE COMMUNICATION REPORT

1/1

DATE: 3 April 96 TIME: 11:30 AM JOB NO. [illegible]
TO: Frank LOCATION:
FROM: Hal M LOCATION:

SUBJECT/DISCUSSION:

Hal would pay $475

? When pay for balance (will be decided @ mtg) 1000 600

CARE is 900' from OC

We decided VALCO out @ mtg,

+ will GPS missed point

∴ mtg @ 8:30 AM.

I talked with Rick Alcover 3PM 3 April 96

1. Sorry Wildan crew had been out in field to show GPS which points to needed. Rick would not have picked out a [illegible] cap @ dam for us. Rick was in field, why wasn't Wildan?

2. Why wasn't Hal working on coordinate basis long ago before AES was? They started earlier and should've had it all hammered out before we came on scene.

SUMMARY/ACTION ITEMS:

COPY TO:

*George V. Sabol Consulting Engineers, Inc.*

**TELEPHONE LOG**

**PROJECT:** #84 / Cave Creek FDS **TO/FROM:** Kofi Awumah

**DATE:** 22 May 1996 **ORGANIZATION:** FCDMC

**TOPICS:**

**CITY:** **PHONE NO.:**

**ITEMS DISCUSSED:** (1). Kofi confirmed that HEC-RAS submittals are acceptable and welcomed by FEMA. (2) Kofi inquired about status of the hydrology report. Willdan has requested the information. (3) Confirmed our meeting time of 5 June @ 10:00 am to present calibration data to the District.

W. Scott Ogden

**FURTHER ACTIONS REQUIRED:**

**TELEPHONE LOG**

**PROJECT:** #84/Cave Creek FDS **TO/FROM:** Lee Abbott

**DATE:** 8 July 1996 **ORGANIZATION:** Willdan Assoc.

**TOPICS:** Status of their project.

**CITY:** Phx **PHONE NO.:** 870-7600

**ITEMS DISCUSSED:** ① Called to request two items: 1) Their upstream river mile stationing (at the two project's match point), and 2) Their upstream (match point) floodplain and floodway final water surface elevations. Lee (who is the project mgr for Willdan) told me that they just obtained their mapping and were identifying preliminary cross-sections. Lee also stated that the hydrology is not completed and from our conversation, I would estimate 70%-80%. She stated that their contract date was October 1 like ours, but really doubted if they would make that date or even be able to provide the information we require to finish our study.

W. Scott Ogle

**FURTHER ACTIONS REQUIRED:** Because this directly impacts us, need to draft letter to District explaining the situation.

# TELEPHONE LOG

**PROJECT:** Cave Creek FDS / #84 **TO/FROM:** Kofi Awumah

**DATE:** 26 August 1996 **ORGANIZATION:** FCDMC

**TOPICS:** Channel geometry at Carefree Highway Bridge

**CITY:** Phx **PHONE NO.:** 506-2942

**ITEMS DISCUSSED:** Kofi informed me that as of 8/26/96, Willdan has not obtained the surveyed information for the bridge. Kofi directed us to go ahead and pull our starting cross section geometry at the upstream edge of the bridge from our topography mapping.

W. Scott Ogle

**FURTHER ACTIONS REQUIRED:** Inform MKE and continue w/ hydraulic modeling.

# TELEPHONE LOG

PROJECT: #84/Cave Creek FDS

(TO) FROM: Frank Brown

DATE: 10/14/96

ORGANIZATION: MKE

TOPICS: comments regarding FAX memo dated 10/14/96 by MKE

CITY:

PHONE NO.: 248-770Z

ITEMS DISCUSSED: 1) Discussed sealing issue and decided to have AMC, GVSCE, + MKE seal every sheet. RLS will only seal Cover sheet. statements were OK, w/ exception of ALS charge. 2) Recommended to Frank that the FDD plots remain un-sealed and stamped "Preliminary" until Willdan finishes its study and gives us a match section. 3) Let the District coordinate w/ Willdan regarding similarity of maps between studies.

(Memo + statement attached hereto)

W. Scott Ogden

FURTHER ACTIONS REQUIRED:

~~George V. Sabol Consulting Engineers, Inc.~~
SFC Engineering Company

**TELEPHONE LOG**

PROJECT: # 1204102 TO/FROM: Kofi Awumah

DATE: 11/5/96 ORGANIZATION: FCDMC

TOPICS: Floodway location

CITY: PHONE NO.: 506-2942

ITEMS DISCUSSED: ① Called Kofi to inquire about the District's policy on setting floodways. I suggested that he and Frank Brown (MKE) sit down and review the floodway cross section plots together and consider moving the floodway to more logical locations as opposed to setting it solely based on equal conveyance encroachment. I informed Kofi that I will forward a list of the sections I feel warrant further analysis, and will then have Frank call to set up a review meeting.
② Requested that Kofi coordinate w/ Ning Mao on the exchange of information w/ Willdan. He said he would do that.

W. Scott Ogle

FURTHER ACTIONS REQUIRED:

George V. Sabol Consulting Engineers, Inc.

CLIENT FCDMC
PROJECT Cave Creek FDS FCD 95-28
SUBJECT Phone Log

SHEET ___ OF ___
DATE 4/30/97
BY
PROJECT NO.

Call to: Bob Parks, Aerial Mapping Co.
Subject: H.I.S. Conversions

Talked to Bob to get status on conversions and projected completion date. Bob stated that he would not be able to meet the 16 May deadline but anticipated a submittal by 1 June. Bob said that the District is calling for all outstanding H.I.S. submittals to be in by 30 June for some governmental funding reason, and therefore, AMCI is very busy. I told Bob that I will call MKE to inform them that coordination will be taking place.

I also asked Bob about the ITM and he said he would check into the comments and respond to me.

Action Items: Call MKE to coordinate the delivery of data for the HIS conversions.

# 1.2 MEETING MINUTES AND REPORTS

# *George V. Sabol Consulting Engineers, Inc.*

**Cave Creek Floodplain Delineation Study, FCD 95-28**

Minutes of Meeting No. 1
14 December 1995, 2:00 pm

**Attendees:** Kofi Awumah, PhD, Flood Control District of Maricopa County (FCDMC)
Pedro Calza, PE, (FCDMC)
Valerie Swick, (FCDMC)
George V. Sabol, PhD, PE, George V. Sabol Consulting Engineers, Inc., (GVSCE)
Geza E. Kmetty, PE, McLaughlin Kmetty Engineers, Ltd., (MKE)
W. Scott Ogden, PE, (GVSCE)

The meeting commenced at 2:00 p.m. and was held at FCDMC's office in Phoenix, Arizona. The meeting was held to address issues regarding the scope of work and to establish project information exchange formats and protocol.

These notes are our understanding of the major items of interest discussed at this meeting. Please inform GVSCE if corrections or additions are appropriate. The following is a list of the items discussed:

1. Kofi Awumah opened the meeting by welcoming everyone and congratulating the consultants on a successful procurement of a contract. Kofi then introduced himself as the District's Project Manager and also introduced Valerie Swick. Valerie will provide the hydrology review for the project.

2. Kofi Awumah asked for questions regarding the scope of work. No major questions were raised.

3. Kofi Awumah asked if GVSCE has prepared the quarterly billing estimation. George Sabol responded that the estimate will be submitted during the following week. Pedro Calza requested that GVSCE perform (and subsequently bill) as much work as possible during this fiscal year. The fiscal year ends 30 June 1996.

4. George Sabol asked if the MicroSoft Project software would be required to track the project. The District responded that that is not a project requirement.

5. Pedro Calza informed the consultants that FCDMC currently has CAD specs and would like them used if it does not create an undo burden. Pedro stressed that usage of the CAD specs is purely voluntary and that no change orders would be issued. GVSCE obtained a copy of the CAD specs and will endeavor to utilize them for this project.

6. Kofi Awumah asked GVSCE about the level of involvement they anticipated in the first public meeting. George Sabol responded that GVSCE would be represented at the public meetings to answer questions if needed, per the scope of work Task 1.8.

7. GVSCE agreed to provide a mounted blackline print of the base 1" = 2000' mapping for use as an exhibit at the first public meeting.

8. It was generally agreed that the first public meeting will be scheduled after the first of the year.

9. Kofi Awumah asked GVSCE about advertising the study. George Sabol responded that the legal announcement would be executed per the scope of work Task 1.5. A Phoenix and a local newspaper will be used.

10. George Sabol brought up the subject of field trips and asked Kofi Awumah and Valerie Swick for input on coordination of trips that will include them. It was agreed that Frank Brown of MKE would coordinate with Kofi when Frank begins the Manning's n investigations. GVSCE will keep Kofi and Valerie apprised regarding hydrology related field trips.

11. Pedro Calza requested that the consultants use HEC-RAS instead of HEC-2 for floodplain and floodway modeling. This would be voluntary with no change orders, but would be greatly appreciated by the District. Pedro also pointed out that as of January 1996, HEC-2 would no longer be made available by the Corps for distribution. It was also discussed that AFMA is offering a 3-day short course on HEC-RAS on 28-30 March 1996. Instruction on HEC-RAS usage and a copy of the program will be provided as part of the course fee.

The following notes are per discussions held regarding the District's review of the preliminary subbasin delineations submitted on 7 December 1995.

12. Valerie Swick stated that the southern-most subbasin is too long and narrow and suggested that the subbasin be divided into 2 or 3 subbasins. GVSCE agreed and will make that change. Due to the distributive flow pattern, it was agreed to use "lines" of concentration at the divisions instead of "points."

13. Valerie Swick noted that there are concentration points that have been placed at confluence locations where large tributary drainage branches enter Cave Creek from the east, and that some of those concentration points do not include delineation of the corresponding area that would drain to Cave Creek from the west. Valerie questioned the lack of delineation and asked if it will affect the

hydraulics. George Sabol responded by explaining that the corresponding west side area is typically very small, steep hillsides and if analyzed as a subbasin, would peak very quickly and therefore have little to no hydrologic effect on the main Cave Creek flood hydrograph passing at a much later time. It is, therefore, hydrologically unnecessary to model those small subbasins separately and that those areas are accounted for at the downstream concentration point.

14. George Sabol pointed out that due to the distributive flow patterns occurring within the southern-most subbasins, it is likely that flow splitting occurs, with possible breakouts of flow from the study watershed. It was agreed by all that for the purpose of this study, the flow splits and breakouts are not effective and are not to be analyzed.

15. The meeting was adjourned at 3:00 p.m.

Distribution: Attendees
Frank Brown, PE, (MKE)

**Cave Creek Floodplain Delineation Study, FCD 95-28**
**GVSCE Job No. 84**

Minutes of Hydrology Meeting No. 1
12 January 1996, 9:00 am

**Attendees:** Kofi Awumah, PhD, PE, Flood Control District of Maricopa County (FCDMC)
Valerie Swick (FCDMC)
George V. Sabol, PhD, PE, George V. Sabol Consulting Engineers, Inc. (GVSCE)
W. Scott Ogden, PE (GVSCE) W. Scott Ogden

The meeting commenced at 9:00 a.m. at GVSCE's office in Scottsdale, Arizona. The meeting was held per GVSCE Work Plan Tasks 5.1.c, 5.1.d, and 5.4.

These notes are our understanding of the major items of interest discussed at this meeting. Please inform GVSCE if corrections or additions are appropriate. The following is a list of the items discussed:

1. **Project Schedule** - George Sabol opened the meeting and copies of the project schedule were distributed, reviewed, and discussed.

2. **Watershed Subbasin Delineations** - The following items were discussed with regard to the preliminary subbasin delineation map and observations made during a 10 January 1996 detailed field reconnaissance of the southern watershed boundary and Cave Creek and Carefree Town areas.

    a. Scott Ogden summarized the existing drainage patterns of the Terravita Master Planned Community and Cave Creek Road, as they relate to the flow splits indicated on the base 1" = 2000' USGS mapping. In both cases, the observed dominant flow pattern is to the south, which changes the southern limits of the GVSCE study watershed. Kofi Awumah and/or Valerie Swick will discuss the changes with the District team for the WillDan study, decide on a final watershed boundary between the two studies, and inform GVSCE of the decision.

    b. Scott Ogden summarized and discussed revised subbasin delineations at several locations within the Cave Creek and Carefree Town areas (mostly tributary areas of Andora Wash).

    c. Scott Ogden summarized the addition of a concentration point on Cave Creek at the upstream limit of floodplain delineation and the resulting subbasin boundary changes.

    d. A revised subbasin map will be prepared by GVSCE and submitted to the District after the subbasin changes previously discussed and in Item 3 below, have been finalized.

3. **Galloway Wash Breakout** - Scott Ogden communicated that on 11 January 1996, Pedro Calza, Dave Johnson, and Besian Khatiblou of the District called Scott to discuss a drainage problem regarding eyewitness accounts of flows that breakout from Galloway Wash near the Horny Toad Restaurant along Cave Creek Road, and the possibility of having GVSCE analyze and hydrologically model the diversion. Scott Ogden pointed out that the breakout flows drain to Andora Wash and that a flow split analysis is necessary to properly estimate the breakout impact on peak flows in Andora Wash. Scott Ogden recommended that the diversion rating curve be generated using the split flow option of HEC-2 and surveyed existing condition cross sections and the side flow weir profile data. Scott Ogden communicated that Pedro Calza said the District was getting physical data and that it would be made available to GVSCE. Kofi Awumah will follow up with Pedro Calza to determine whether or not the District will supply the surveying. GVSCE will provide direction for the survey needs. Scott Ogden presented an estimate of the breakout impact on Andora Wash hydrology.

4. **Local Drainage Problem** - Scott Ogden presented a drainage problem located in the Town of Carefree at the southeast corner of Tom Darlington Drive (Scottsdale Road alignment) and Cave Creek Road that was observed during the 10 January 1996 field reconnaissance. Kofi Awumah noted the problem and will discuss it with Dave Johnson at the District.

5. **Property Ownership and Rights of Entry** - Kofi Awumah provided the property ownership list per GVSCE Work Plan Task 1.6 and the sending of right of entry letters was discussed. Scott Ogden will coordinate with Frank Brown of McLaughlin Kmetty Engineers, Ltd., to make sure appropriate property owners are notified.

6. **Public Meeting #1** - Kofi Awumah stated that the first public meeting will be scheduled sometime in February, with the actual date to be set later.

7. **Legal Advertising** - Kofi Awumah asked if the legal advertising had been done yet. George Sabol responded that ads are currently being run per GVSCE Work Plan Task 1.5 in the local newspaper (considered to be Scottsdale Progress) and a general newspaper. Upon their receipt, GVSCE will send original affidavits of advertisement from both papers to the District.

8. **Land Use Data** - Scott Ogden identified existing development in the region north of Cave Creek Road and east of what is shown on USGS maps as the Tonto Nation Forest boundary. That developed area is not included in the land use polygon DXF file received from the District. It was agreed that GVSCE will identify land use polygons from recent aerial photography of this area and indicate those areas on the land use hydrology exhibit. GVSCE will also supply that data in AutoCAD DWG or DXF format to the District for the District to convert to HIS format. Kofi Awumah will discuss this with Marta Dent. GVSCE offered to do the HIS conversion, if necessary, but noted that no land use HIS conversions are provided for in the contract per GVSCE Work Plan Task 5.5.

9. **Base Mapping and Hydrology Exhibits** - The following items were presented and discussed regarding base mapping and the hydrology exhibits for the TDN.

    a. Scott Ogden provided an example of the watershed hydrology exhibit map symbol conventions proposed for use in project maps.

    b. Four exhibit maps are proposed for the TDN, they are:

        1. Exhibit "A" is a 1" = 2000' scale map showing watershed subbasin boundaries and ID's, concentration points, flow splits, Tc or Lag flowpaths, normal depth routing reaches, and subbasin centroids.

        2. Exhibit "B" is a 1" = 3000' scale map showing the tributary watershed to the Cave Buttes Dam and information relating to model calibration.

        3. Exhibit "C" is a 1" = 2000' scale map showing NRCS and USFS TES soil unit boundaries with subbasins shown for reference (similar to Fountain Hills (North) FDS and Rio Verde (South) FDS soil maps).

        4. Exhibit "D" is a 1" = 2000' scale map showing land use polygons and ID's with subbasin boundaries shown for reference (similar to Fountain Hills (North) FDS and Rio Verde (South) FDS land use maps).

    c. Subbasin naming conventions were discussed and it was agreed that GVSCE will attempt to use logical descriptors.

    d. Concentration point numbering will begin with 110 and proceed in increments of 10 to allow for the addition of intervening points as necessary. A logical numbering scheme that progressively increases with movement downstream will be maintained.

    e. Scott Ogden discussed the overlay production process for Exhibits "A" and "B" and the potential slippage problems that may occur due to the size of the maps. Everyone agreed that this would not be a problem.

10. **HEC-1 Model Nomenclature** - Scott Ogden stated that the HEC-1 model nomenclature will be essentially the same as that used in the Fountain Hills (North) FDS and Rio Verde (South) FDS.

11. **Parameter Calculations and Forms** - Scott Ogden summarized the spreadsheet forms that will be used to calculate rainfall loss parameters and unit hydrograph characteristics for each subbasin. Scott Ogden noted that the spreadsheets are essentially the same forms as those used in the Fountain Hills (North) FDS and Rio Verde (South) FDS. Spreadsheet form printouts from Rio Verde (South) FDS were used to illustrate the GVSCE procedures. Scott Ogden also proposed putting the detailed calculation step summaries

in appendices separate from the main report. Digital files of the spreadsheets will be supplied to the District in MS Accel or D-Base compatible format.

12. **Package Submittals** - Scott Ogden informed Kofi Awumah and Valerie Swick that it was his intent to submit preliminary review packages at various steps in the parameter generation process to keep the reviews simple and to facilitate a smooth development of the HEC-1 model.

13. The meeting was adjourned at 11:20 am.

Distribution: Attendees

# *George V. Sabol Consulting Engineers, Inc.*

**Cave Creek Floodplain Delineation Study, FCD 95-28**
**GVSCE Job No. 84**

Minutes of Hydraulics Meeting No. 1
22 May 1996, 2:00 pm

**Attendees:** Kofi Awumah, PhD, PE, Flood Control District of Maricopa County (FCDMC)
Pedro Calza, (FCDMC)
Valerie Swick, (FCDMC)
Frank Brown, PE, McLauglin Kmetty Engineers, Ltd
W. Scott Ogden, PE, (GVSCE)

The meeting commenced at 2:00 p.m. and was held at the District. The meeting was held per GVSCE Work Plan Task 6.4 and to update the District on the status of the hydrologic analysis.

These notes are our understanding of the major items of interest discussed at this meeting. Please inform GVSCE if corrections or additions are appropriate. The following is a list of the items discussed:

HYDROLOGY

1. **Status:** Scott Ogden opened the meeting and briefly discussed the status of the hydrology analysis and calibration effort. In summary, the calibration analysis is considered inconclusive and not useful for a detailed calibration effort. The calibration results do not, however, provide a basis of suspicion to reject the HEC-1 model either. A meeting was scheduled to be held at the District on 5 June 1996 at 10:00 am, to present the calibration data and results to the District. That meeting will be open to anyone desiring to attend. Submittal of the final HEC-1 parameters and models will be made to the District the week of 27 May 1996.

HYDRAULICS

1. **Check Section Plots:** The preliminary check section plots were reviewed. The check sections were derived from field surveys and from photogrammetric methods. It was agreed that a comparison of the surveyed versus photogrammetric cross sections look good from a visual perspective.

2. **RMSE Criteria:** The criterion for application of check section RMSE calculations performed using the January 1995 FEMA 37 publication, was discussed. Pedro Calza mentioned that it was his belief that the current Skunk Creek FDS, is also required to use January 1995 FEMA 37, and that he would check with Mr. Hasan Mushtaq (FCDMC) to ascertain how that criteria is being applied.

3. **Check Section Limits:** It was agreed that the check section limits could extend only to the edge of the 100-year floodplain. The contour maps should meet the criteria within these limits.

4. **Check Section Revisions:** It was agreed that the preliminary check sections should be reread by photogrammetric methods at the same X, Y coordinate location as the field survey. Those results will be reevaluated for RMSE criteria and submitted to the District.

5. **HEC-2 Cross Section Locations:** Kofi Awumah has completed his review of the HEC-2 cross section locations and found them to be acceptable to the District. That acceptance is subject to the preliminary HEC-2 analysis, which may require some cross sections to be rotated normal to the floodplain and the addition of cross sections at locations where houses or other significant structures exist within the floodplain. The District also commented that the lake berm projecting into the floodplain at Cross Section 18 (about 3600 feet north of New River Road) should be analyzed for two conditions; present and washed out.

6. **Channel Centerline Location:** The letter of transmittal for the cross section locations also requested approval of the proposed channel centerline location. This approval is requested in accordance with Tasks 6.6.b and 6.8.1 of the Scope of Work. Although not specifically discussed at the meeting, it is presumed that the centerline as contained on the submitted maps is acceptable to the District.

7. **Floodplain Models:** Discussion occurred on the use of HEC-2 vs. HEC-RAS. The District desires that HEC-RAS be used, even though this item is not in the approved Scope of Work. MKE desires to use HEC-2 so that the BOSS-HEC2 program could be used to map the floodplain. GVSCE and MKE will discuss the advantages and disadvantages of each and make a decision. Version 1.2 of HEC-RAS should be used if HEC-RAS is chosen for floodplain modeling. Pedro Calza will check with Baker Engineers to see if they are ready to begin receiving HEC-RAS models with FEMA submittals.

8. **Supercritical Floodplains:** If supercritical floodplains are encountered, the mapped floodplain should be based upon the energy grade line elevations.

9. **GR Record Data:** It is acceptable to the District for elevation/station pair data (GR records in the HEC-2 model) to be derived using BOSS-HEC2 applied to the contour maps. Photodigitized cross sections are not required for this project.

Distribution: Attendees

# *George V. Sabol Consulting Engineers, Inc.*

**Cave Creek Floodplain Delineation Study, FCD 95-28**
**GVSCE Job No. 84**

**22 August 1996 Meeting Minutes**

**Attendees:** Kofi Awumah, PhD, PE, Flood Control District of Maricopa County (FCDMC)
Pedro Calza, PE (FCDMC)
Valerie Swick (FCDMC)
George V. Sabol, PhD, PE, George V. Sabol Consulting Engineers, Inc. (GVSCE)
W. Scott Ogden, PE ~~(GVSCE)~~ W. Scott Ogden

The meeting commenced at 2:00 p.m. at the District's office in Phoenix, Arizona. The meeting was held to discuss the issues outlined in a letter from GVSCE dated 9 August 1996 regarding coordination between the GVSCE study and the Willdan study and the present status of the Willdan study.

These notes are our understanding of the major items of interest discussed at this meeting. Please inform GVSCE if corrections or additions are appropriate. The following is a list of the items discussed:

1. Kofi Awumah opened the meeting and handed out copies of a 19 August 1996 letter (attached) documenting the District's written response to the 9 August 1996 GVSCE letter. The letter was mailed, but as of the date of the meeting, was not yet received by GVSCE.

2. Kofi Awumah and Pedro Calza presented the District's recommendations addressing the issues raised in the GVSCE letter. The items presented and discussed were:

    a. **Starting floodplain and floodway water surface elevation at the contractual match point between GVSCE and Willdan studies** - The District directed GVSCE to obtain the survey data of the cross section geometry at the Carefree Highway bridge and code that information into the GVSCE HEC-2 model as the downstream cross section. The cross section survey data is to be provided by the District. Critical depth is to be assumed at that cross section as a boundary condition for the natural floodplain. The floodway model boundary condition shall also be set to critical depth with the starting floodway limits equaling the floodplain. The GVSCE HEC-2 modeling would then proceed upstream to the normal contractual limit. It was noted that only the Cave Creek geometry is to be used at the bridge, and that GVSCE is not responsible for modeling the bridge itself. The District will require Willdan to extend its contractual modeling effort upstream of the Carefree Highway bridge until its model results match those determined by GVSCE. This solution was discussed and it was agreed that this will allow GVSCE to continue modeling efforts without dependence on Willdan for starting data. It was noted, however, that finalization of the models, TDN and FEMA forms will not occur until Willdan completes its hydraulic analysis.

b. **River mile stationing at the contractual match point between the two studies** - Pedro Calza requested that GVSCE set the stationing at the bridge location cross section to 0.000 river miles, although it was agreed that any numbering or stationing scheme could be used. This was discussed and it was agreed that use of 0.000 as a starting station for the Carefree Highway bridge section is acceptable.

c. **Project status with regard to GVSCE competing for future projects with the Flood Control District** - Pedro Calza and Kofi Awumah clearly indicated that no negative points will be assessed against GVSCE for any delays caused by this situation. George Sabol stated that he believed the negative point assessment was assigned by the contracting department and asked if they (contracting department) would honor this agreement. Pedro Calza responded that the contracting department typically solicits the District's project manager to evaluate the project status and make a recommendation regarding negative point assignment.

d. **Contractual change order for a time extension** - The District will grant a time extension change order once it is necessary. This was agreed to by all present.

3. Kofi Awumah and Pedro Calza stated that the District desires to submit both projects to FEMA at the same time. This will eventually place the GVSCE project on hold until the Willdan project is completed. At that time, GVSCE can then finalize its modeling and documentation for a final submittal to FEMA.

4. The meeting was adjourned at 3:00 p.m.

Distribution: Attendees
Mr. Geza E. Kmetty (MKE)

**Cave Creek above Carefree Highway Floodplain Delineation Study, FCD 95-28**
**GVSCE Job No. 84**

Minutes of Hydrology Meeting No. 2
Summary of HEC-1 Calibration Presentation

5 June 1996, 10:00 a.m.

**Attendees:** Kofi Awumah, PhD, PE, Flood Control District of Maricopa County (FCDMC)
Valerie Swick, (FCDMC)
Besian Khatiblou, (FCDMC)
Amir Motamedi, (FCDMC)
Magnus Jolayemi, (FCDMC)
Bing Zhao, (FCDMC)
Maximo DeVera, (FCDMC)
Kumar Hanumaiah, (FCDMC)
Steven Tucker, PE, (FCDMC)
Lisa Young, (FCDMC)
Ning Mao, (FCDMC)
Steve Waters, (FCDMC)
Ted Lehman, (FCDMC)
Richard Harris, (FCDMC)
Tom Loomis, PE, ASL Sierra Consulting Engineers
Frank Brown, PE, McLauglin Kmetty Engineers, Ltd., (MKE)
Charles Joy, (MKE)
John Henz, Henz Meteorological Services
George V. Sabol, PhD, PE, George V. Sabol Consulting Engineers, Inc., (GVSCE)
Scott Ogden, PE, (GVSCE)
Mike Gerlach, (GVSCE)

The meeting commenced at 10:00 a.m. and was held at FCDMC's office in Phoenix, Arizona. The purpose of the meeting was to present the results of the Cave Creek above Carefree Highway HEC-1 model calibration efforts performed by George V. Sabol Consulting Engineers, Inc.

The following is a summary of the presentation:

1. Kofi Awumah began by introducing the topic and the principal speaker, George Sabol.

2. George Sabol introduced the individual speakers; John Henz, Scott Ogden and Mike Gerlach. George continued by discussing the importance of HEC-1 model calibration, a previous successful calibration effort for a watershed model of Lynx Lake near Prescott, Arizona, and the general difficulties encountered during the Cave Creek HEC-1 model calibration.

3. Scott Ogden spoke about the various sources of hydraulic data that were used in the calibration effort. Scott also discussed the assumptions and procedures used for the reconstitution of the inflow hydrograph to the Cave Buttes Dam System. Each discussion also included comments regarding the uncertainty of data and calculations.

4. John Henz spoke about the various sources of the meteorologic data as well as the uncertainty of the data and procedures used in the reconstitution of the precipitation. John also discussed the procedures used to develop the temporal distribution of precipitation values and the subbasin groupings for the five storms used in the calibration.

5. Mike Gerlach provided a general overview of the HEC-1 models used in the calibration effort. Mike also compared the HEC-1 model results to the reconstituted inflow hydrograph to the Cave Buttes Dam System.

6. A question and answer forum of discussion was held following the last presentation. George Sabol provided closing remarks and Kofi Awumah adjourned the meeting at 1:00.

Attached is a copy of the meeting agenda and handouts that were distributed for the ta[illegible]ns.

ution: Kofi Awumah
file

ures

# HYDRAULICS DATA

**2.0 Cave Buttes Dam Gage Data**

a. Stage Data (Measured)
- Source: FCDMC.
- Conversion and plotting.

b. Discharge Data (Measured)
- Source: FCDMC.
- Conversion and plotting.
- Discrepancies and conclusion.

c. Discharge Data (Rating Curve)
- Source: USACOE.
- Discharge from curve using CBD stage.

**2.1 Stage Versus Storage Relations**

a. Cave Buttes Dam (Total)
- Source: USACOE.
- Use of gross capacity curve.

b. Cave Buttes Dam Below Cave Creek Dam (Incremental)
- Mapping Source: USACOE.
- Planimetered surface areas and corresponding volumes.

c. Cave Creek Dam
- Subtract 2.b from 2.a.

**2.2 Cave Creek Dam Stage Versus Discharge Relations**

a. Principal Spillway Rating Curve
- Source: FCDMC files.
- Use "fully open" curve and multiply by 3 (3 openings).
- Curve is based on orifice flow equation. $C_d$*A = +/- 11.6.

b. Bypass Channel Spillway
- Measurements by hand-level and 300 foot tape.
- Hydraulics approximated by Uneven Weir program for weir flow.
- HEC-RAS model used to check for possible backwater conditions.

**2.3 Summary of Data**

a. Table A-1

b. Table A-2

# INFLOW HYDROGRAPH RECONSTITUTION

## 3.0 Basic Assumptions of the Calculations

a. The relation of inflow, outflow and storage for the two dams follows the continuity equation, where:

Avg. Inflow = Avg. Outflow + Storage volume difference/Time difference

b. Inflow hydrograph is linear between time ordinates.

c. The estimated stage vs storage volume curves are representative of conditions at the time of the storms.

d. Stage elevations are level across entire ponding surface (no wave action).

e. Flows are instantaneous and there are no time delays associated with travel time (i.e. impounded runoff draining to main outlet of CBD from the storage created by CBD Dike No. 2 (to the northeast of main dam, near Cave Creek Road)).

## 3.1 General Spreadsheet Calculation Procedures

a. Tabulate Cave Buttes Dam (CBD) stage elevations in 6 hour increments. Tabulate 1 hour incremental data in areas that require that definition.

b. Look up data from database that correspond to the CBD stage. Those data are CBD's outlet discharge, intemediate storage volume, and total storage volume.

c. From the data compiled in 2.a and 2.b, calculate the average inflow to CBD. This is the same as the average outflow of Cave Creek Dam (CCD).

d. Convert average outflows of 2.c to time specific outflows by averaging the average outlfow values.

e. Using the stage vs discharge relations derived for CCD, calculate corresponding CCD stage elevations for the outlfows of 2.d.

f. Look up storage volume corresponding to stage value of 2.e.

g. Calculate average inflow to CCD using the volumes of 2.f and the discharges of 2.d(2.c).

h. Convert the average inflows of 2.g to time specific inflows by averaging the average inflow values.

i. Example of the general condition process.

**3.2 Evaluation Process for Determining CCD Stage Elevation (SEE PLATE 1)**

a. Standard qualifier and filtering checks by spreadsheet.

b. Hand calculations.
   * Case 1
   * Case 2
   * Case 3

c. Final plot of CCD stage elevation versus measured CBD elevations (SEE PLATE 2).

**3.3 Final Averge Inflow Adjustments**

a. Negative values.

**3.4 Final Inflow Hydrograph Results**

a. Volumetric check calculations of Inflow vs Outflow volumes as follows:

   * Outflow Volume based on CBD gage information = 29,656 acre-feet
   * Reconstituted inflow hydrograph volume = 33,566 acre-feet
   * Difference of 11.6%

b. Final plots of hydographs (SEE PLATES 3 - 6).

## HEC-1 MODELING RESULTS USING RECONSTITUTED PRECIPITATION

### 5.0 General Model Overview

a. Cave Creek watershed modeled is the area tributary to a point just downstream of the Carefree Highway bridge (124 square miles).

b. Majority of unit hydrographs by S-Graph method. A few modeled with Clark Unit Hydrograph method.

c. Rainfall losses by Green & Ampt equation with additional consideration for surface retention. DTHETA set to "normal" value for all storms except Storm 1, to account for atecedent conditions by preceding storms.

d. Reach routes by Modified Puls channel storage method. Routing includes a component for losses due to percolation through the stream bed.

e. Areally and temporally distributed rainfall coded into model using PI records and values provided by HMS.

f. Five (5) minute modeling time step used.

### 5.1 HEC-1 Model Results

a. Graphical comparison to reconstituted hydrograph (SEE PLATES 5 and 6).

b. Volumetric comparison of HEC-1 model to reconstituted hydrograph by Storm.

| Storm | HEC-1 Volume, in ac-ft (124 sq.mile watershed) | Reconstituted Hydrograph Volume, in ac-ft (191 sq. mile watershed) |
|---|---|---|
| (1) | (2) | (3) |
| 1 | 1,040 | 952 |
| 2 | 12,971 | 16,545 |
| 3 | 5,522 | 6,094 |
| 4 | 922 | 1,464 |
| 5 | 1,538 | 3,505 |
| Totals | 22,063 | 28,560 |

## CONCLUSIONS AND RECOMMENDATIONS

### 6.0 Conclusions

a. Reconstituted hydrograph and HEC-1 modeling results are considered inconclusive and not usable for a detailed calibration of the study watershed model.

b. Volumetric results from calibration effort do support the modeling rainfall loss parameter estimations as being conservative.

### 6.1 Recommendations

It is recommended that the following things be done to improve the potential for reconstitution of future inflow hydrographs to the Cave Buttes/Cave Creek Dams:

a. Install a continuously recording stage gage at Cave Creek Dam, similar to the existing gage at Cave Buttes Dam. This will eliminate the need for attempting to define the hydraulic characteristics of the principal spillway and bypass channel for Cave Creek Dam.

b. Obtain more detailed and current topographical mapping of the entire Cave Buttes/Cave Creek Dam impoundment areas in order to better define the stage versus storage volume relations. This should provide an ability to estimate inflows at a smaller time increment.

Cave Buttes Dam
Device ID: 4897 Type: Stream Gage Float

| Date | Time | feet | acre-feet |
|---|---|---|---|
| 02/19/93 | 12:25:32 | 2.06 | 0 |
| 02/19/93 | 12:23:55 | 2.09 | 0 |
| 02/19/93 | 12:23:41 | 2.16 | 0 |
| 02/19/93 | 12:23:12 | 2.20 | 0 |
| 02/19/93 | 12:22:58 | 2.33 | 0 |
| 02/19/93 | 12:22:45 | 2.75 | 0 |
| 02/19/93 | 12:22:31 | 2.58 | 0 |
| 02/19/93 | 12:22:17 | 2.58 | 0 |
| 02/19/93 | 12:22:04 | 2.58 | 0 |
| 02/19/93 | 12:16:50 | 2.54 | 0 |
| 02/19/93 | 12:16:36 | 2.58 | 0 |
| 02/19/93 | 12:14:02 | 2.61 | 0 |
| 02/19/93 | 12:13:36 | 2.65 | 0 |
| 02/19/93 | 12:12:26 | 2.68 | 0 |
| 02/19/93 | 12:12:13 | 2.75 | 0 |
| 02/19/93 | 08:41:31 | 2.78 | 0 |
| 02/19/93 | 03:21:05 | 2.82 | 0 |
| 02/18/93 | 18:15:35 | 2.82 | 0 |
| 02/18/93 | 18:07:37 | 2.85 | 0 |

---

Cave Buttes Dam
Stage Data
Date,Military Time,Accumulated hour,Stage (feet)

| | | | |
|---|---|---|---|
| 12/27/92, | 1:12:51, | 1.21, | 1.99 |
| 12/27/92, | 13:24:44, | 13.41, | 1.99 |
| 12/28/92, | 13:48:29, | 37.81, | 1.99 |
| 12/28/92, | 15:16:38, | 39.28, | 2.02 |
| 12/28/92, | 15:17:29, | 39.29, | 2.06 |
| 12/28/92, | 15:17:45, | 39.30, | 2.09 |
| 12/28/92, | 15:17:59, | 39.30, | 2.13 |
| 12/28/92, | 15:18:50, | 39.31, | 2.16 |
| 12/28/92, | 15:19: 4, | 39.32, | 2.23 |
| 12/28/92, | 15:19:44, | 39.33, | 2.27 |
| 12/28/92, | 15:19:58, | 39.33, | 2.30 |
| 12/28/92, | 15:20:12, | 39.34, | 2.33 |
| 12/28/92, | 15:20:41, | 39.34, | 2.37 |
| 12/28/92, | 15:21: 4, | 39.35, | 2.40 |
| 12/28/92, | 15:21:17, | 39.35, | 2.54 |
| 12/28/92, | 15:22: 4, | 39.37, | 2.58 |
| 12/28/92, | 15:22:47, | 39.38, | 2.61 |
| 12/28/92, | 15:23: 1, | 39.38, | 2.65 |
| 12/28/92, | 15:23:15, | 39.39, | 2.68 |
| 12/28/92, | 15:23:43, | 39.40, | 2.71 |
| 12/28/92, | 15:23:59, | 39.40, | 2.75 |
| 12/28/92, | 15:24:40, | 39.41, | 2.78 |

Cave Buttes Outlet

Device ID: 4903 Type: Pressure Transducer

| Date | Time | feet | cfs |
|---|---|---|---|
| 02/18/93 | 17:23:56 | 1.43 | 16 |
| 02/18/93 | 15:01:56 | 1.53 | 18 |
| 02/18/93 | 14:58:18 | 1.63 | 23 |
| 02/18/93 | 14:54:39 | 1.73 | 26 |
| 02/18/93 | 14:51:01 | 1.83 | 29 |
| 02/18/93 | 14:47:22 | 1.93 | 32 |
| 02/18/93 | 14:43:44 | 2.03 | 36 |
| 02/18/93 | 14:40:06 | 2.13 | 41 |
| 02/18/93 | 14:32:48 | 2.23 | 47 |
| 02/18/93 | 14:29:10 | 2.33 | 52 |
| 02/18/93 | 14:18:14 | 2.43 | 58 |
| 02/18/93 | 14:03:41 | 2.53 | 63 |
| 02/18/93 | 13:05:25 | 2.73 | 75 |
| 02/18/93 | 13:03:14 | 2.63 | 69 |
| 02/18/93 | 12:29:00 | 3.13 | 101 |
| 02/18/93 | 11:56:14 | 3.23 | 111 |
| 02/18/93 | 11:30:45 | 3.33 | 120 |

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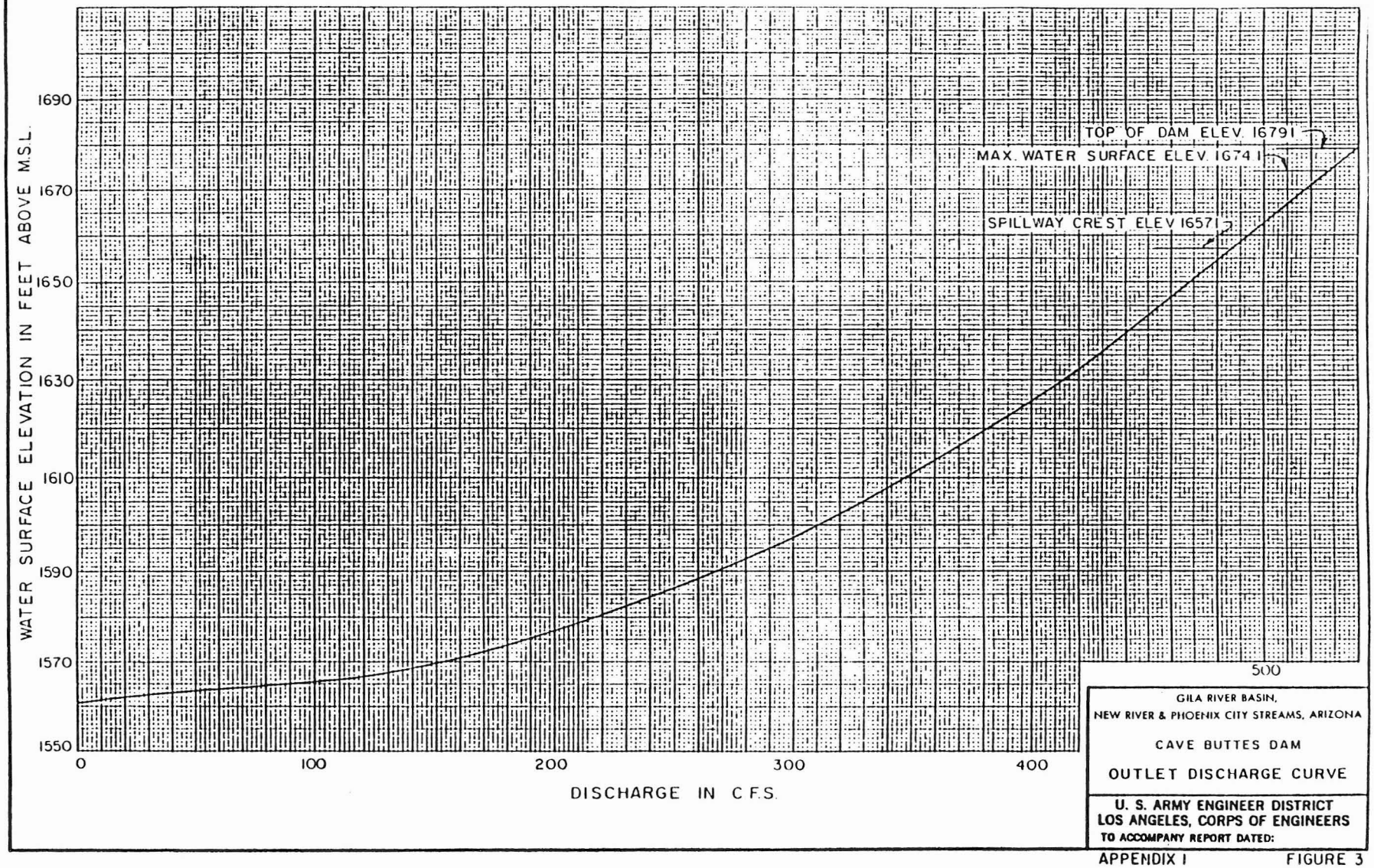
Cave Buttes Dam

Outlet Data

Date,Military Time,Accumulated hour,Discharge (cfs)

| | | | |
|---|---|---|---|
| 12/28/92, | 15:19:31, | 15.33, | 58 |
| 12/28/92, | 15:23:15, | 15.39, | 69 |
| 12/28/92, | 15:26:47, | 15.45, | 80 |
| 12/28/92, | 15:30:26, | 15.51, | 86 |
| 12/28/92, | 15:34:12, | 15.57, | 93 |
| 12/28/92, | 15:37:43, | 15.63, | 101 |
| 12/28/92, | 15:41:34, | 15.69, | 111 |
| 12/28/92, | 15:56: 9, | 15.94, | 120 |
| 12/28/92, | 16:10:36, | 16.18, | 130 |
| 12/28/92, | 16:17:46, | 16.30, | 140 |
| 12/28/92, | 16:28:42, | 16.48, | 150 |
| 12/28/92, | 16:43:15, | 16.72, | 160 |
| 12/28/92, | 17: 1:28, | 17.02, | 171 |
| 12/28/92, | 17:26:58, | 17.45, | 182 |
| 12/28/92, | 18:10:39, | 18.18, | 194 |
| 12/28/92, | 19:12:33, | 19.21, | 207 |
| 12/28/92, | 20:21:44, | 20.36, | 221 |
| 12/28/92, | 22:43:44, | 22.73, | 235 |
| 12/29/92, | 12:15:43, | 36.26, | 207 |
| 12/29/92, | 12:19:21, | 36.32, | 221 |
| 12/29/92, | 22:31: 4, | 46.52, | 194 |
| 12/29/92, | 22:34:43, | 46.58, | 207 |
| 12/30/92, | 6:38:59, | 54.65, | 182 |
| 12/30/92, | 6:42:38, | 54.71, | 194 |




GILA RIVER BASIN,
NEW RIVER & PHOENIX CITY STREAMS, ARIZONA

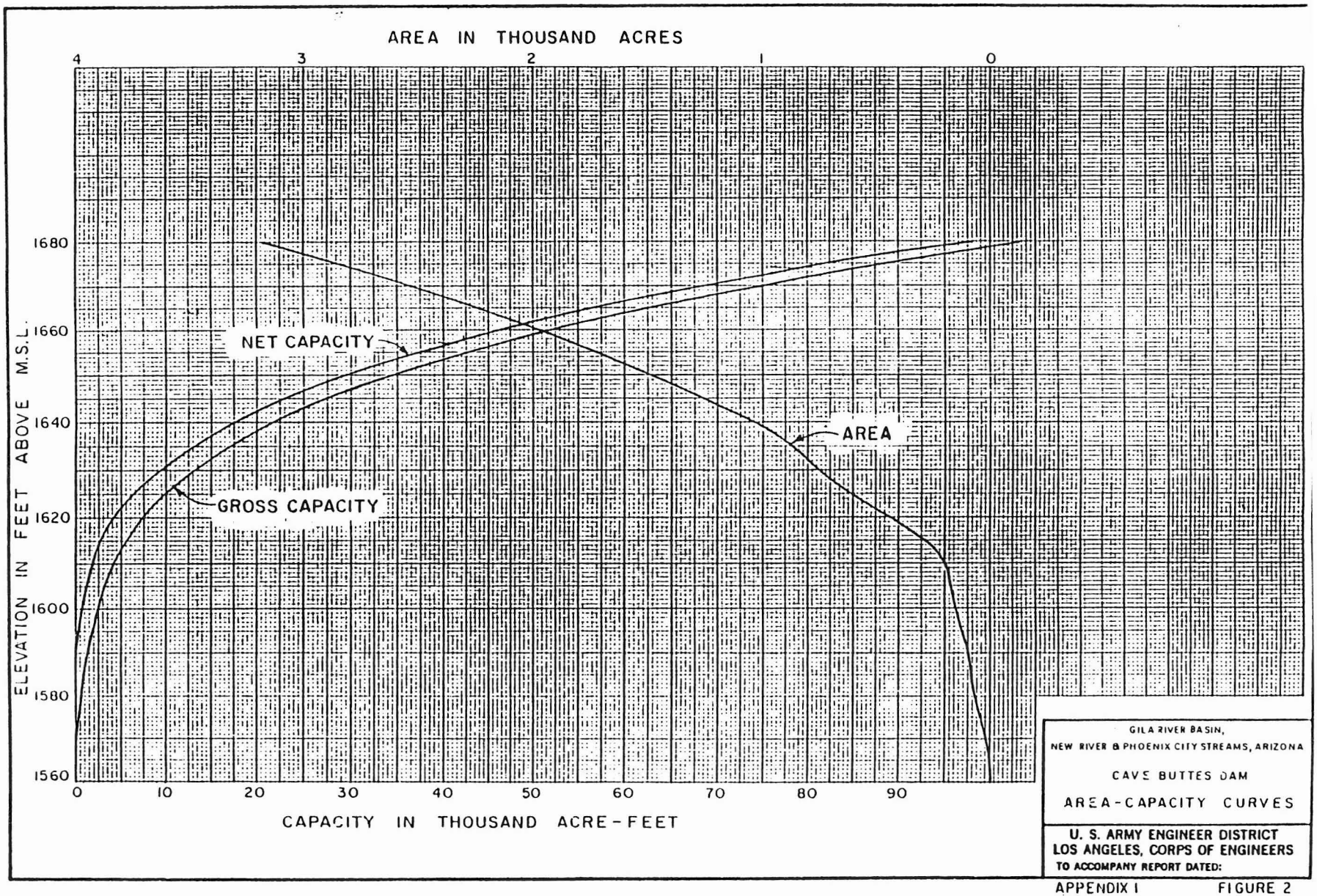
CAVE BUTTES DAM

OUTLET DISCHARGE CURVE

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

APPENDIX I FIGURE 3

(3)




GILA RIVER BASIN,
NEW RIVER & PHOENIX CITY STREAMS, ARIZONA

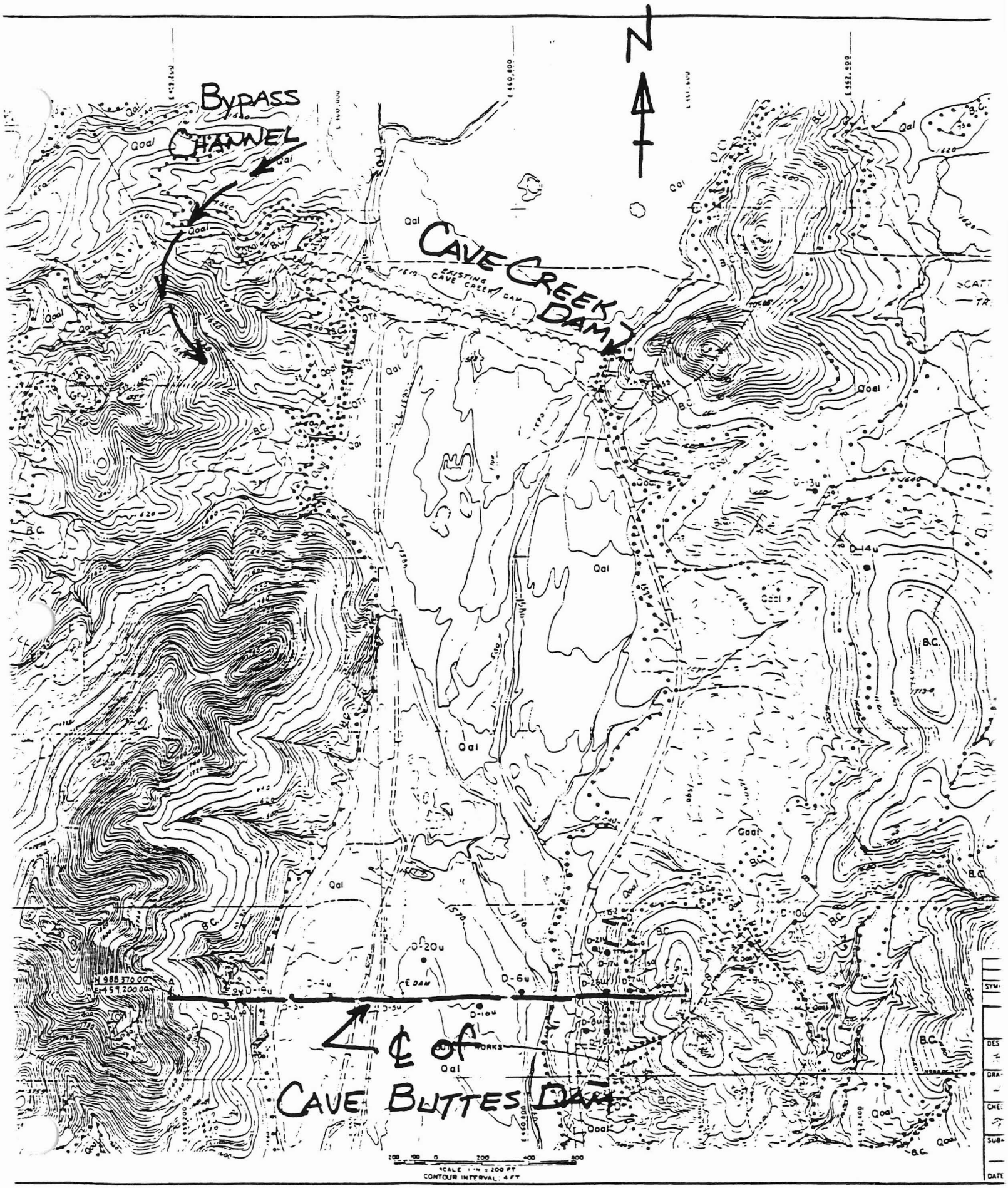
CAVE BUTTES DAM

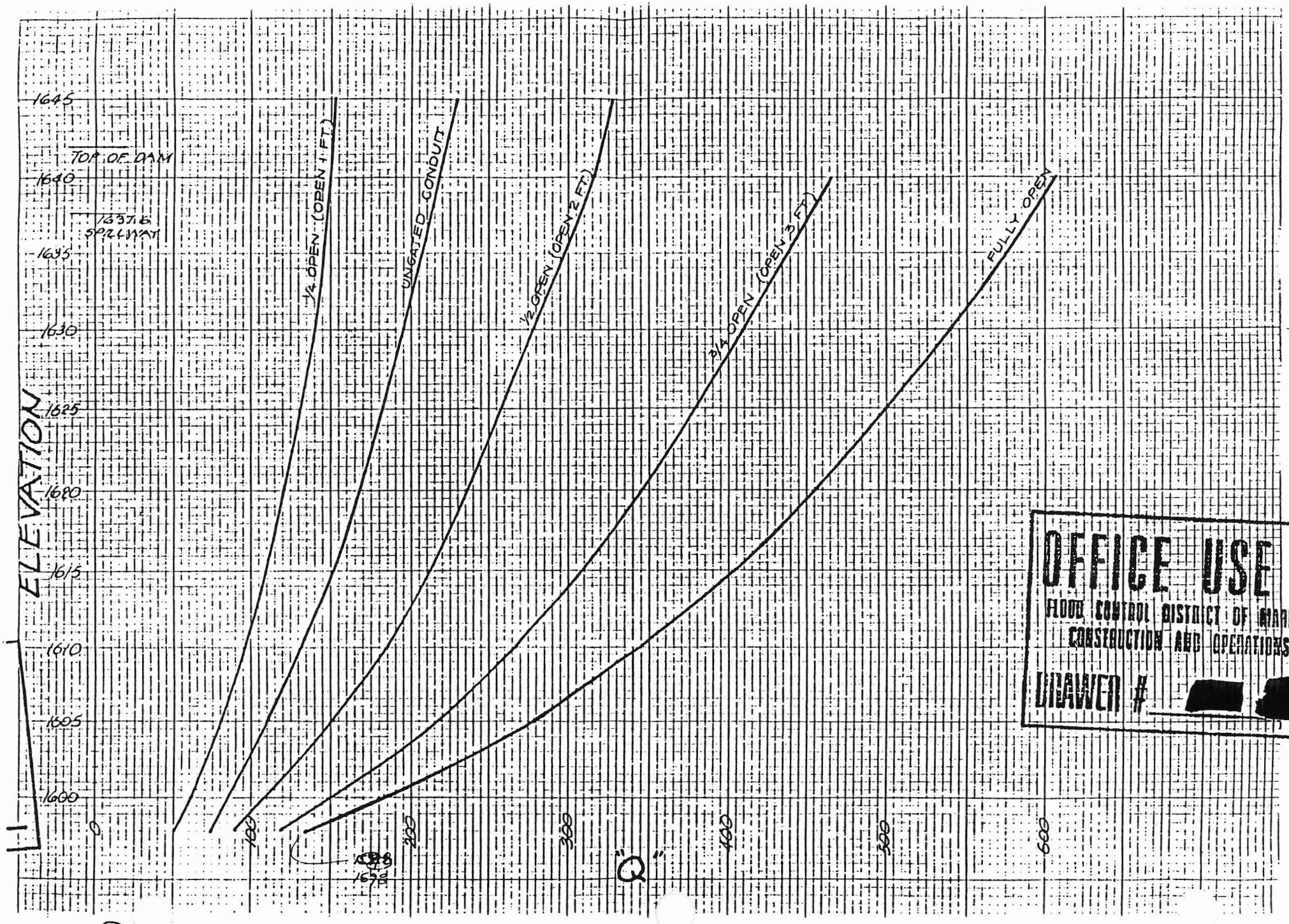
AREA-CAPACITY CURVES

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

APPENDIX I FIGURE 2

4


N
BYPASS CHANNEL
CAVE CREEK DAM
EXISTING CAVE CREEK DAM
℄ of CAVE BUTTES DAM
Qal
Qoal
B.C.
D-3u
D-14u
D-20u
D-6u
D-10u
D-19u
D-21u
D-17u
D-26u
D-7u
D-8u
D-12u
D-5u
D-4u
D-9u
D-1u
℄ DAM
N 988,370.00
E 459,200.00
SCALE 1 IN = 200 FT
CONTOUR INTERVAL: 4 FT




OFFICE USE O
FLOOD CONTROL DISTRICT OF MARICOPA
CONSTRUCTION AND OPERATIONS DIVI
DRAWER # [redacted]

6

## Table A-1

### Inflow calibration lookup data for Cave Buttes Dam and Cave Creek Dam

| Cave Buttes Dam Only | | | | | Total Storage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Planimetered Volumes | | Storage Lookup Table (Interpolated values) | | | | | | | | Q from Army COE Q vs Stage Rating Curve | Storage Lookup Table Interpolated values | | | Outlet Discharge Rat. Curve |
| Stage feet (1) | Volume acre-feet (2) | Depth feet (3) | Stage feet (4) | Volume acre-feet (5) | Stage feet (6) | AREA Acres (7) | Calculated Volume Acre-feet (8) | GROSS Capacity Acre-feet (9) | Total Volume Acre-feet (10) | cfs (11) | Depth feet (12) | Stage feet (13) | Volume Acre-feet (14) | cfs (15) |
| 1560.7 | 0 | 0.0 | 1560.7 | 0.0 | 1560.7 | 0.0 | 0.00 | --- | 0 | 0 | 0.0 | 1560.7 | 0 | 0 |
| 1570 | 133 | 0.1 | 1560.8 | 1.4 | 1570.0 | 40.0 | 124.00 | --- | 124 | 132 | 0.1 | 1560.8 | 1 | 1 |
| 1580 | 500 | 0.2 | 1560.9 | 2.9 | 1580.0 | --- | --- | 500 | 500 | 227 | 0.2 | 1560.9 | 3 | 3 |
| 1590 | 1300 | 0.3 | 1561.0 | 4.3 | 1585.0 | --- | --- | 900 | 900 | 243 | 0.3 | 1561.0 | 4 | 4 |
| 1600 | 2540 | 0.4 | 1561.1 | 5.7 | 1590.0 | --- | --- | 1300 | 1300 | 268 | 0.4 | 1561.1 | 5 | 6 |
| 1610 | 4050 | 0.5 | 1561.2 | 7.2 | 1595.0 | --- | --- | 1800 | 1800 | 290 | 0.5 | 1561.2 | 7 | 7 |
| 1620 | 5500 | 0.6 | 1561.3 | 8.6 | 1600.0 | --- | --- | 2500 | 2500 | 311 | 0.6 | 1561.3 | 8 | 9 |
| 1630 | 7300 | 0.7 | 1561.4 | 10.0 | 1605.0 | --- | --- | 3100 | 3100 | 330 | 0.7 | 1561.4 | 9 | 10 |
| 1640 | 9100 | 0.8 | 1561.5 | 11.4 | 1610.0 | --- | --- | 4100 | 4100 | 347 | 0.8 | 1561.5 | 11 | 11 |
| 1650 | 11200 | 0.9 | 1561.6 | 12.9 | 1615.0 | --- | --- | 5500 | 5500 | 365 | 0.9 | 1561.6 | 12 | 13 |
| | | 1.0 | 1561.7 | 14.3 | 1620.0 | --- | --- | 7200 | 7200 | 381 | 1.0 | 1561.7 | 13 | 14 |
| | | 1.1 | 1561.8 | 15.7 | 1625.0 | --- | --- | 10000 | 10000 | 398 | 1.1 | 1561.8 | 15 | 16 |
| | | 1.2 | 1561.9 | 17.2 | 1630.0 | --- | --- | 13100 | 13100 | 413 | 1.2 | 1561.9 | 16 | 17 |
| | | 1.3 | 1562.0 | 18.6 | 1635.0 | --- | --- | 17000 | 17000 | 428 | 1.3 | 1562.0 | 17 | 18 |
| | | 1.4 | 1562.1 | 20.0 | 1640.0 | --- | --- | 21500 | 21500 | 442 | 1.4 | 1562.1 | 19 | 20 |
| | | 1.5 | 1562.2 | 21.5 | 1645.0 | --- | --- | 27300 | 27300 | | 1.5 | 1562.2 | 20 | 21 |
| | | 1.6 | 1562.3 | 22.9 | 1650.0 | --- | --- | 34000 | 34000 | | 1.6 | 1562.3 | 21 | 23 |
| | | 1.7 | 1562.4 | 24.3 | 1655.0 | --- | --- | 42500 | 42500 | | 1.7 | 1562.4 | 23 | 24 |
| | | 1.8 | 1562.5 | 25.7 | 1660.0 | --- | --- | 51300 | 51300 | | 1.8 | 1562.5 | 24 | 26 |
| | | 1.9 | 1562.6 | 27.2 | 1665.0 | --- | --- | 62400 | 62400 | | 1.9 | 1562.6 | 25 | 27 |
| | | 2.0 | 1562.7 | 28.6 | 1670.0 | --- | --- | 74500 | 74500 | | 2.0 | 1562.7 | 27 | 28 |
| | | 2.1 | 1562.8 | 30.0 | 1675.0 | --- | --- | 88500 | 88500 | | 2.1 | 1562.8 | 28 | 30 |
| | | 2.2 | 1562.9 | 31.5 | 1680.0 | --- | --- | 103200 | 103200 | | 2.2 | 1562.9 | 29 | 31 |
| | | 2.3 | 1563.0 | 32.9 | | | | | | | 2.3 | 1563.0 | 31 | 33 |
| | | 2.4 | 1563.1 | 34.3 | | | | | | | 2.4 | 1563.1 | 32 | 34 |
| | | 2.5 | 1563.2 | 35.8 | | | | | | | 2.5 | 1563.2 | 33 | 35 |
| | | 2.6 | 1563.3 | 37.2 | | | | | | | 2.6 | 1563.3 | 35 | 37 |
| | | 2.7 | 1563.4 | 38.6 | | | | | | | 2.7 | 1563.4 | 36 | 38 |
| | | 2.8 | 1563.5 | 40.0 | | | | | | | 2.8 | 1563.5 | 37 | 40 |
| | | 2.9 | 1563.6 | 41.5 | | | | | | | 2.9 | 1563.6 | 39 | 41 |
| | | 3.0 | 1563.7 | 42.9 | | | | | | | 3.0 | 1563.7 | 40 | 43 |
| | | 3.1 | 1563.8 | 44.3 | | | | | | | 3.1 | 1563.8 | 41 | 44 |
| | | 3.2 | 1563.9 | 45.8 | | | | | | | 3.2 | 1563.9 | 43 | 45 |
| | | 3.3 | 1564.0 | 47.2 | | | | | | | 3.3 | 1564.0 | 44 | 47 |

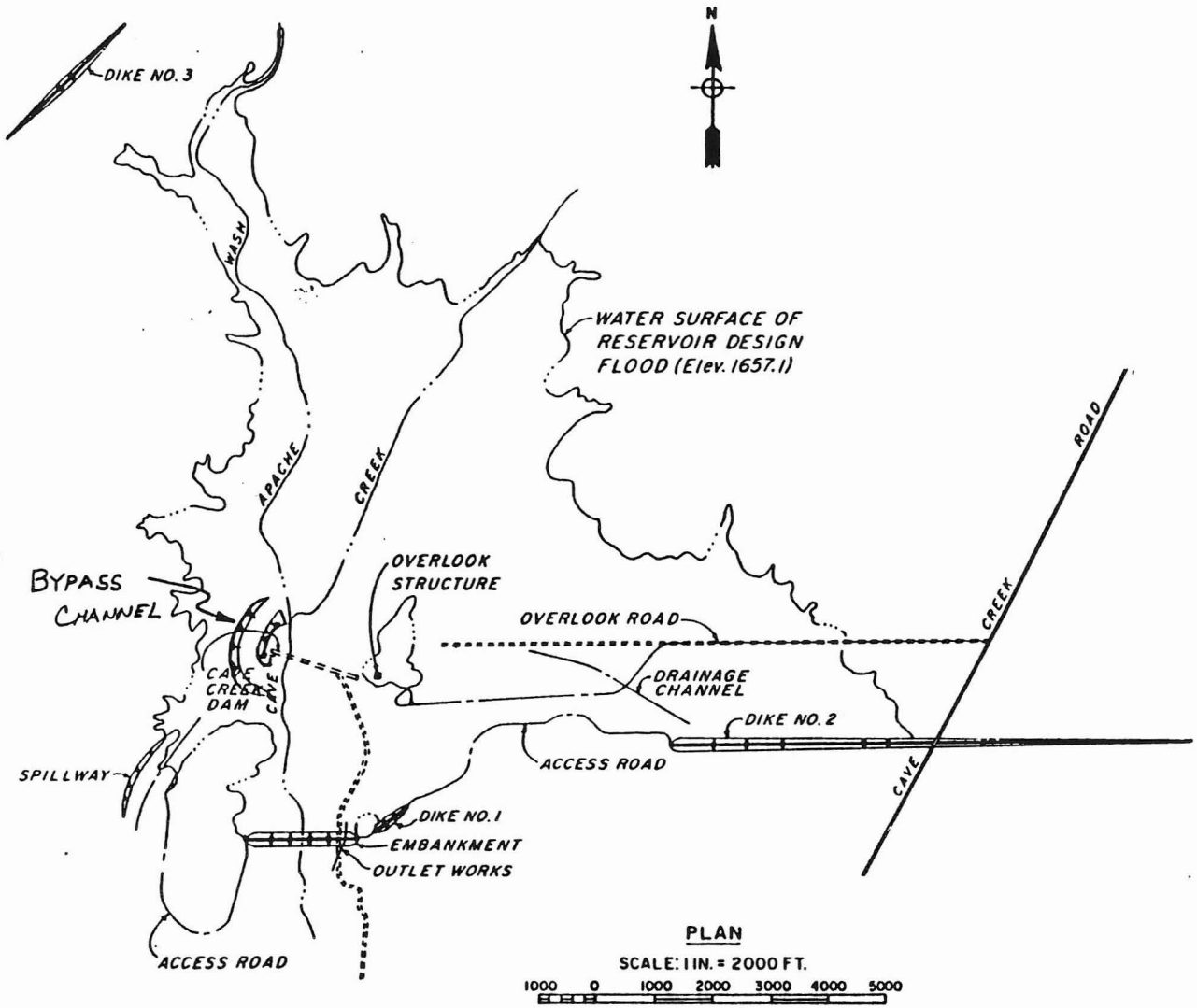
Table A-2

Inflow calibration lookup data for Cave Buttes Dam and Cave Creek Dam

| Cave Creek Dam | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Outlet Lookup Table Interpolated values | | | | | Total Cave Buttes Dam Volume | | Volume Between Cave Buttes and Cave Creek Dams | |
| Depth | Orifice | Weir | Total Discharge | Stage | Volume | Depth | Stage | Volume | Stage | Volume |
| feet | cfs | cfs | cfs | feet | Acre-feet | feet | feet | ac-ft | feet | ac-ft |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| 0.00 | 0 | | 0 | 1596.20 | 0.0 | 0.00 | 1596.20 | 1968.00 | 1596.20 | 2044.00 |
| 0.01 | 28 | | 28 | 1596.21 | 0.0 | 0.01 | 1596.21 | 1969.40 | 1596.21 | 2045.24 |
| 0.02 | 39 | | 39 | 1596.22 | 0.0 | 0.02 | 1596.22 | 1970.80 | 1596.22 | 2046.48 |
| 0.03 | 48 | | 48 | 1596.23 | 0.0 | 0.03 | 1596.23 | 1972.20 | 1596.23 | 2047.72 |
| 0.04 | 56 | | 56 | 1596.24 | 0.0 | 0.04 | 1596.24 | 1973.60 | 1596.24 | 2048.96 |
| 0.05 | 62 | | 62 | 1596.25 | 0.0 | 0.05 | 1596.25 | 1975.00 | 1596.25 | 2050.20 |
| 0.06 | 68 | | 68 | 1596.26 | 0.0 | 0.06 | 1596.26 | 1976.40 | 1596.26 | 2051.44 |
| 0.07 | 74 | | 74 | 1596.27 | 0.0 | 0.07 | 1596.27 | 1977.80 | 1596.27 | 2052.68 |
| 0.08 | 79 | | 79 | 1596.28 | 0.0 | 0.08 | 1596.28 | 1979.20 | 1596.28 | 2053.92 |
| 0.09 | 84 | | 84 | 1596.29 | 0.0 | 0.09 | 1596.29 | 1980.60 | 1596.29 | 2055.16 |
| 0.10 | 88 | | 88 | 1596.30 | 0.0 | 0.10 | 1596.30 | 1982.00 | 1596.30 | 2056.40 |
| 0.11 | 93 | | 93 | 1596.31 | 0.0 | 0.11 | 1596.31 | 1983.40 | 1596.31 | 2057.64 |
| 0.12 | 97 | | 97 | 1596.32 | 0.0 | 0.12 | 1596.32 | 1984.80 | 1596.32 | 2058.88 |
| 0.13 | 101 | | 101 | 1596.33 | 0.0 | 0.13 | 1596.33 | 1986.20 | 1596.33 | 2060.12 |
| 0.14 | 104 | | 104 | 1596.34 | 0.0 | 0.14 | 1596.34 | 1987.60 | 1596.34 | 2061.36 |
| 0.15 | 108 | | 108 | 1596.35 | 0.0 | 0.15 | 1596.35 | 1989.00 | 1596.35 | 2062.60 |
| 0.16 | 112 | | 112 | 1596.36 | 0.0 | 0.16 | 1596.36 | 1990.40 | 1596.36 | 2063.84 |
| 0.17 | 115 | | 115 | 1596.37 | 0.0 | 0.17 | 1596.37 | 1991.80 | 1596.37 | 2065.08 |
| 0.18 | 118 | | 118 | 1596.38 | 0.0 | 0.18 | 1596.38 | 1993.20 | 1596.38 | 2066.32 |
| 0.19 | 122 | | 122 | 1596.39 | 0.0 | 0.19 | 1596.39 | 1994.60 | 1596.39 | 2067.56 |
| 0.20 | 125 | | 125 | 1596.40 | 0.0 | 0.20 | 1596.40 | 1996.00 | 1596.40 | 2068.80 |
| 0.21 | 128 | | 128 | 1596.41 | 0.0 | 0.21 | 1596.41 | 1997.40 | 1596.41 | 2070.0 |
| 0.22 | 131 | | 131 | 1596.42 | 0.0 | 0.22 | 1596.42 | 1998.80 | 1596.42 | 2071.28 |
| 0.23 | 134 | | 134 | 1596.43 | 0.0 | 0.23 | 1596.43 | 2000.20 | 1596.43 | 2072.52 |
| 0.24 | 137 | | 137 | 1596.44 | 0.0 | 0.24 | 1596.44 | 2001.60 | 1596.44 | 2073.76 |
| 0.25 | 140 | | 140 | 1596.45 | 0.0 | 0.25 | 1596.45 | 2003.00 | 1596.45 | 2075.00 |
| 0.26 | 142 | | 142 | 1596.46 | 0.0 | 0.26 | 1596.46 | 2004.40 | 1596.46 | 2076.24 |
| 0.27 | 145 | | 145 | 1596.47 | 0.0 | 0.27 | 1596.47 | 2005.80 | 1596.47 | 2077.48 |
| 0.28 | 148 | | 148 | 1596.48 | 0.0 | 0.28 | 1596.48 | 2007.20 | 1596.48 | 2078.72 |
| 0.29 | 150 | | 150 | 1596.49 | 0.0 | 0.29 | 1596.49 | 2008.60 | 1596.49 | 2079.96 |
| 0.30 | 153 | | 153 | 1596.50 | 0.0 | 0.30 | 1596.50 | 2010.00 | 1596.50 | 2081.20 |
| 0.31 | 155 | | 155 | 1596.51 | 0.0 | 0.31 | 1596.51 | 2011.40 | 1596.51 | 2082.44 |
| 0.32 | 158 | | 158 | 1596.52 | 0.0 | 0.32 | 1596.52 | 2012.80 | 1596.52 | 2083.68 |
| 0.33 | 160 | | 160 | 1596.53 | 0.0 | 0.33 | 1596.53 | 2014.20 | 1596.53 | 2084.92 |
| 0.34 | 163 | | 163 | 1596.54 | 0.0 | 0.34 | 1596.54 | 2015.60 | 1596.54 | 2086.16 |
| 0.35 | 165 | | 165 | 1596.55 | 0.0 | 0.35 | 1596.55 | 2017.00 | 1596.55 | 2087.40 |
| 0.36 | 168 | | 168 | 1596.56 | 0.0 | 0.36 | 1596.56 | 2018.40 | 1596.56 | 2088.64 |
| 0.37 | 170 | | 170 | 1596.57 | 0.0 | 0.37 | 1596.57 | 2019.80 | 1596.57 | 2089.88 |
| 0.38 | 172 | | 172 | 1596.58 | 0.0 | 0.38 | 1596.58 | 2021.20 | 1596.58 | 2091.12 |
| 0.39 | 174 | | 174 | 1596.59 | 0.0 | 0.39 | 1596.59 | 2022.60 | 1596.59 | 2092.36 |
| 0.40 | 177 | | 177 | 1596.60 | 0.0 | 0.40 | 1596.60 | 2024.00 | 1596.60 | 2093.60 |
| 0.41 | 179 | | 179 | 1596.61 | 0.0 | 0.41 | 1596.61 | 2025.40 | 1596.61 | 2094.84 |
| 0.42 | 181 | | 181 | 1596.62 | 0.0 | 0.42 | 1596.62 | 2026.80 | 1596.62 | 2096.08 |
| 0.43 | 183 | | 183 | 1596.63 | 0.0 | 0.43 | 1596.63 | 2028.20 | 1596.63 | 2097.32 |
| 0.44 | 185 | | 185 | 1596.64 | 0.0 | 0.44 | 1596.64 | 2029.60 | 1596.64 | 2098.56 |
| 0.45 | 187 | | 187 | 1596.65 | 0.0 | 0.45 | 1596.65 | 2031.00 | 1596.65 | 2099.80 |
| 0.46 | 189 | | 189 | 1596.66 | 0.0 | 0.46 | 1596.66 | 2032.40 | 1596.66 | 2101.04 |
| 0.47 | 191 | | 191 | 1596.67 | 0.0 | 0.47 | 1596.67 | 2033.80 | 1596.67 | 2102.28 |
| 0.48 | 193 | | 193 | 1596.68 | 0.0 | 0.48 | 1596.68 | 2035.20 | 1596.68 | 2103.52 |

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS




PLAN

SCALE: 1 IN. = 2000 FT.

1000 0 1000 2000 3000 4000 5000

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN

NEW RIVER AND PHOENIX
CITY STREAMS, ARIZONA
RECOMMENDED PLAN
CAVE BUTTES DAM

FILE NO. 242/140

PLATE 3

9

## Table B

### Summary of inlflow hydrograph calculations for Cave Buttes and Cave Creek Dams

| | Cave Buttes Dam | | | | | Cave Creek Dam | | | | System Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time hours (1) | Pool Depth feet (2) | Stage feet (3) | Discharge cfs (4) | Intermediate Volume ac-ft (5) | Total Volume ac-ft (6) | Average Discarge cfs (7) | Discharge cfs (8) | Stage feet (9) | Storage Volume ac-ft (10) | Average Inflow cfs (11) | Inflow cfs (12) | Actual Avg. Inflow Calcs. Before Zeroing cfs (13) |
| 288 | 28.0 | 1588.7 | 262 | 1196 | --- | | 1171 | 1613.77 | 559 | | 6756 | |
| | | | | | | 1332 | | | | 11396 | | 11396 |
| 294 | 32.8 | 1593.5 | 283 | 1722 | --- | | 3287 | 1628.42 | 5105 | | 13349 | |
| | | | | | | 5242 | | | | 15302 | | 15302 |
| 295 | 36.0 | 1596.7 | 297 | 2131 | --- | | 7443 | 1630.21 | 5926 | | 16658 | |
| | | | | | | 9645 | | | | 18015 | | 18015 |
| 296 | 41.7 | 1602.4 | 320 | 2902 | --- | | 11018 | *1631.42* | 6652 | | 15377 | |
| | | | | | | 12391 | | | | 12738 | | 12738 |
| 297 | 48.4 | 1609.1 | 344 | 3899 | --- | | 11409 | *1631.63* | 6778 | | 10507 | |
| | | | | | | 10427 | | | | 8276 | | 8276 |
| 298 | 54.0 | 1614.7 | 364 | 4732 | --- | | 10225 | *1631.28* | 6568 | | 7942 | |
| | | | | | | 10023 | | | | 7609 | | 7609 |
| 299 | 59.5 | 1620.2 | 382 | 5529 | --- | | 9059 | *1631.00* | 6400 | | 7376 | |
| | | | | | | 8095 | | | | 7143 | | 7143 |
| 300 | 63.0 | 1623.7 | 394 | 6166 | --- | | 8277 | *1630.80* | 6274 | | 6068 | |
| | | | | | | 8458 | | | | 4994 | | 4994 |
| 301 | 66.7 | 1627.4 | 405 | *6832* | 11488 | | 6938 | *1630.43* | 6058 | | 3944 | |
| | | | | | | *5418* | | | | 2894 | | 2894 |
| 302 | 69.0 | 1629.7 | 412 | *7246* | 12914 | | 5095 | *1630.00* | 5800 | | 9840 | |
| | | | | | | *4771* | | | | 16786 | | 16786 |
| 303 | 71.0 | 1631.7 | 418 | *7606* | 14426 | | 3357 | *1631.73* | 6838 | | 11906 | |
| | | | | | | *1944* | | | | 7026 | | 7026 |
| 304 | 71.7 | 1632.4 | 420 | *7732* | 14972 | | 1237 | --- | --- | | 3959 | |
| | | | | | | *529* | | | | 892 | | 892 |
| 306 | 71.8 | 1632.5 | 421 | *7750* | 15050 | | 475 | --- | --- | | 656 | |
| | | | | | | *421* | | | | 421 | | 421 |
| 312 | 71.8 | 1632.5 | 421 | *7750* | 15050 | | 421 | --- | --- | | 210 | |
| | | | | | | *421* | | | | *0* | | 421 |
| 318 | 71.8 | 1632.5 | 421 | *7750* | 15050 | | 421 | --- | --- | | 0 | |
| | | | | | | *421* | | | | *0* | | 421 |
| 324 | 71.8 | 1632.5 | 421 | *7750* | 15050 | | 366 | --- | --- | | 0 | |

# Spreadsheet Logic Diagram

(Table B, column 9)

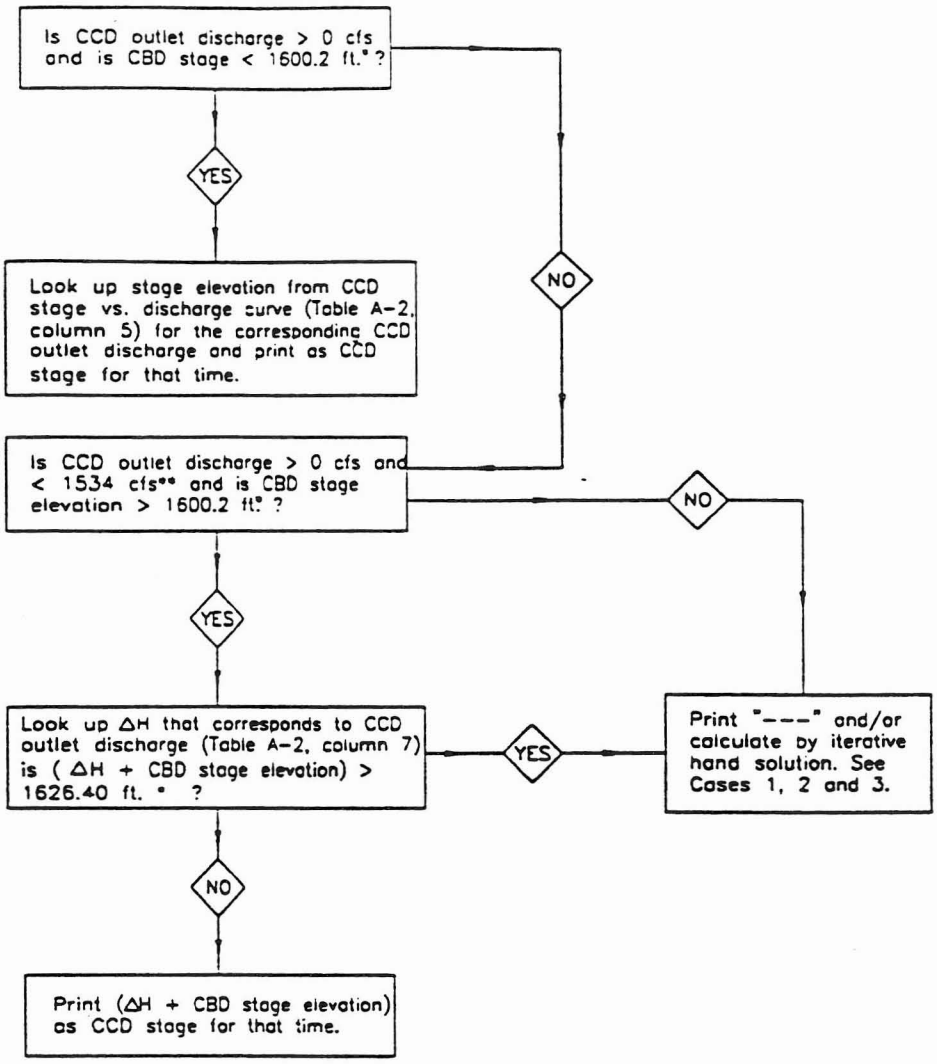
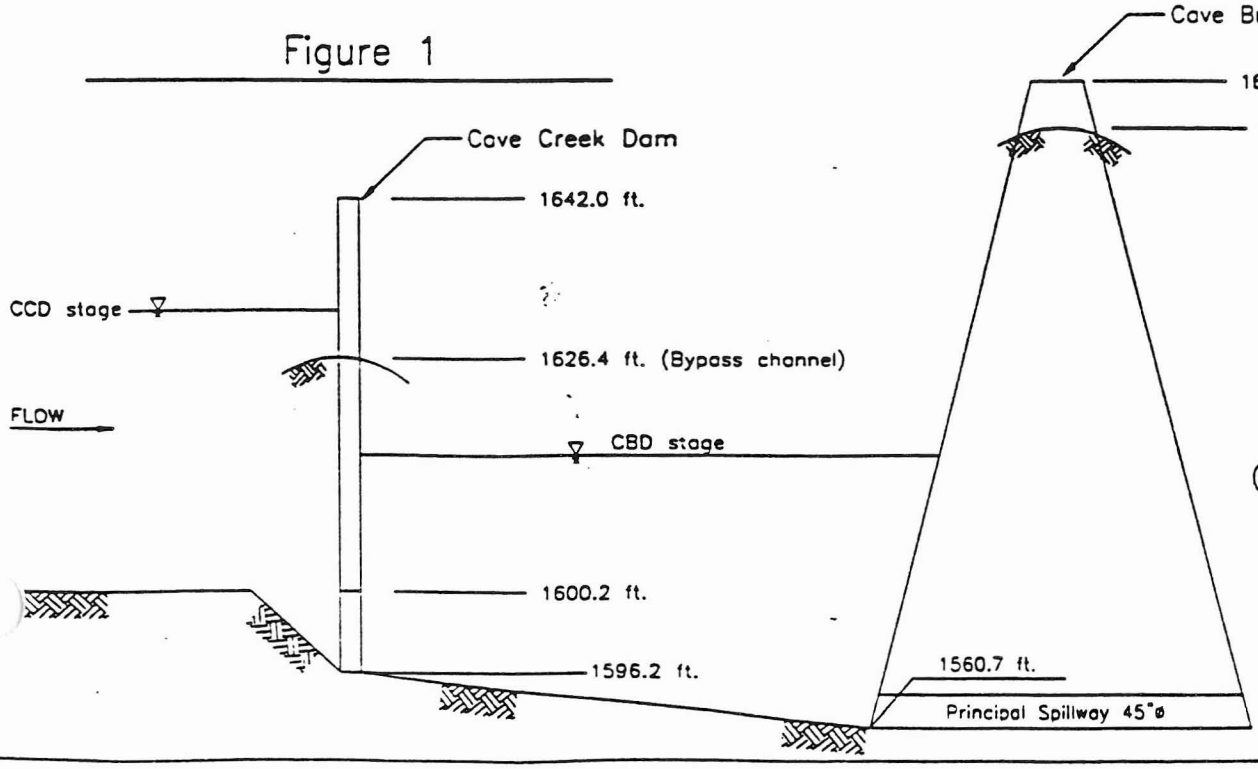



Figure 1




Hand

Case 1:

Se
to

Case 2:

Using HEC

1. Calculate 15 profile Q's and a starting the CBD stage elev a rating curve for
2. Using that curve ar spillway ΔH (Table vs. discharge (Table rating curve, determ elevation correspon discharge by trial c

Case 3: CCD outl

CBD stac

(CBD stc

Hours:

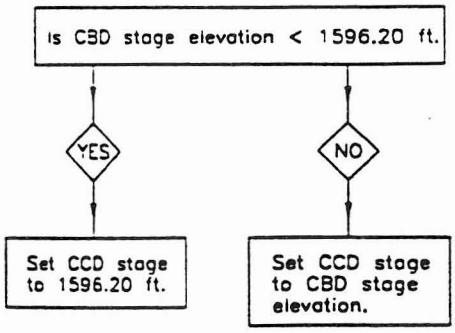
Do a tric discharge to determ

# Hand Calcs. For CCD Stage

## Case 1:

CCD outlet discharge is < 0 cfs

Hours: all cases where CCD outlet discharge is < 0 cfs




## Case 2:

CCD outlet discharge is > 0 cfs
and
CBD stage elevation is > 1626.40 ft.

Hours: 301–303, 354–360, 684–708

Do a trial and error iterative solution to determine the CCD stage elevation. Analyze possible backwater effects of CBD stage on weir flow assumption through bypass channel using HEC–RAS. If no backwater effects, then use COE weir program results for bypass channel.

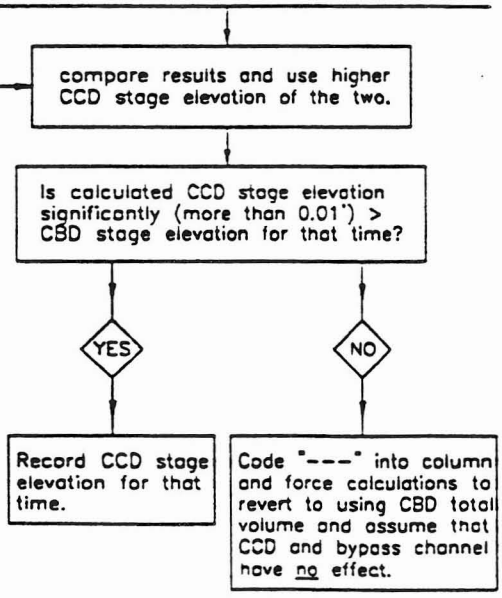
The following is a summary of the trial and error for Case 2. CCD stage values are calculated for the specific hour.

### Using HEC–RAS

1. Calculate 15 profiles using varying Q's and a starting WSEL equal to the CBD stage elevation, to develop a rating curve for the specific hour.
2. Using that curve and the CCD principal spillway ΔH (Table A–2, column 7) vs. discharge (Table A–2, column 2) rating curve, determine CCD stage elevation corresponding to CCD outlet discharge by trial and error.

### Using COE Weir Curve

1. Determine CCD stage elevation by trial and error analysis using CCD ΔH vs. discharge curve and COE weir capacity curve.




Cave Buttes Dam

1679.1 ft. (crest)

1657.1 ft. (Emergency spillway)

## Case 3:

CCD outlet discharge is > 0 cfs
and
CBD stage elevation is > 1600.20 ft. and < 1626.40 ft.
and
(CBD stage + ΔH) is > 1626.40 ft.

Hours: 295–300, 714, 720

Do a trial and error analysis using the COE weir program stage (Table A–2, column 5) vs. discharge (Table A–2, column 3) curve and the CCD principal spillway ΔH vs. discharge curve, to determine the CCD stage elevation for the corresponding outlet discharge.

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FOR
CAVE CREE
CAREFREE

FCDMC PROJECT

LEGE

CCD = Cave Cr
CBD = Cave Bu
ΔH = Differenc
CCD sta
* = See Figu
** = Max. Q t
before b
operates
backwate

PLAT

LOGIC DIAGRAM AND FLOW
CALCULATIONS OF INFLO
CAVE BUTTES AND C

George V. Sabol Consu
IN ASSOCIAT
MCLAUGHLIN KMETT

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12

Table B

Summary of inlflow hydrograph calculations for Cave Buttes and Cave Creek Dams

| | Cave Buttes Dam | | | | | Cave Creek Dam | | | | System Totals | | Actual Avg. Inflow Calcs. Before Zeroing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time hours (1) | Pool Depth feet (2) | Stage feet (3) | Discharge cfs (4) | Intermediate Volume ac-ft (5) | Total Volume ac-ft (6) | Average Discarge cfs (7) | Discharge cfs (8) | Stage feet (9) | Storage Volume ac-ft (10) | Average Inflow cfs (11) | Inflow cfs (12) | cfs (13) |
| 840 | 51.0 | 1611.7 | 353 | 4297 | --- | | 19 | 1611.70 | 280 | | 0 | |
| | | | | | | -25 | | | | 0 | | -313 |
| 846 | 49.8 | 1610.5 | 348 | 4110 | --- | | 9 | 1610.50 | 118 | | 0 | |
| | | | | | | 42 | | | | 0 | | -125 |
| 852 | 48.8 | 1609.5 | 345 | 3959 | --- | | 25 | 1609.50 | 47 | | 0 | |
| | | | | | | 8 | | | | 0 | | 17 |
| 858 | 47.6 | 1608.3 | 341 | 3793 | --- | | 37 | 1608.31 | 40 | | 0 | |
| | | | | | | 66 | | | | 0 | | 57 |
| 864 | 46.8 | 1607.5 | 338 | 3657 | --- | | 95 | 1607.61 | 36 | | 0 | |
| | | | | | | 124 | | | | 0 | | 84 |
| 870 | 46.0 | 1606.7 | 336 | 3552 | --- | | 92 | 1606.80 | 31 | | 0 | |
| | | | | | | 60 | | | | 0 | | 17 |
| 876 | 45.1 | 1605.8 | 333 | 3416 | --- | | -33 | 1605.80 | 25 | | 0 | |
| | | | | | | -127 | | | | 0 | | -53 |
| 882 | 43.6 | 1604.3 | 327 | 3189 | --- | | -38 | 1604.30 | 16 | | 0 | |
| | | | | | | 52 | | | | 0 | | -3 |
| 888 | 42.8 | 1603.5 | 324 | 3053 | --- | | 50 | 1603.53 | 12 | | 0 | |
| | | | | | | 48 | | | | 0 | | -60 |
| 894 | 41.9 | 1602.6 | 320 | 2918 | --- | | -148 | 1602.60 | 6 | | 0 | |
| | | | | | | -345 | | | | 0 | | -189 |
| 900 | 39.7 | 1600.4 | 313 | 2590 | --- | | -205 | 1600.40 | 0 | | 0 | |
| | | | | | | -66 | | | | 0 | | -112 |
| 906 | 38.2 | 1598.9 | 306 | 2404 | --- | | -18 | 1598.60 | 0 | | 0 | |
| | | | | | | 29 | | | | 0 | | -15 |
| 912 | 37.1 | 1597.8 | 302 | 2267 | --- | | -11 | 1597.80 | 0 | | 0 | |
| | | | | | | -51 | | | | 0 | | -26 |
| 918 | 35.8 | 1596.5 | 296 | 2094 | --- | | -42 | 1596.50 | 0 | | 0 | |
| | | | | | | -32 | | | | 0 | | -44 |
| 924 | 34.4 | 1595.1 | 290 | 1932 | --- | | -47 | 1596.20 | 0 | | 0 | |

(3)

# *George V. Sabol Consulting Engineers, Inc.*

**Cave Creek Floodplain Delineation Study, FCD 95-28**

**Minutes of Meeting**
**3 February 1997, 10:00 am**

Attendees: Kofi Awumah, PhD, PE, Flood Control District of Maricopa County (FCDMC)
Frank Brown, PE, McLaughlin, Kmetty Engineers, Ltd. (MKE)
W. Scott Ogden, PE, SFC Engineering Company (SFC) W. Scott Ogden

The meeting commenced at 10:00 a.m. and was held at MKE's office in Phoenix. The meeting was held to review the floodplain hydraulics submitted to the FCDMC by Willdan Associates, Inc. (WA) for the reach of Cave Creek below Carefree Highway, and to establish a match location for the two studies (GVSCE's and WA's). GVSCE was also authorized to finalize its Hydraulics TDN.

These notes are our understanding of the major items of interest discussed at this meeting. Please inform Mr. W. Scott Ogden at SFC (438-2200) if corrections or additions are appropriate. The following is a list of items discussed:

1. Project coordination between the GVSCE and WA projects was discussed by Kofi Awumah and Frank Brown prior to Scott Ogden's arrival. Those discussions were reiterated for Scott Ogden.

2. WA's floodplain maps, HEC-2 analysis and hydraulics TDN was viewed. It was noted by Kofi Awumah and confirmed by inspection of the material that the water surface elevations between the two studies match at River Mile 30.2.

3. Kofi Awumah left the WA floodplain maps, TDN and HEC-2 disk with MKE. MKE is to use this information to revise its maps and TDN to begin at River Mile 30.2. The revised maps will show contours as presently indicated on Sheet 1, but will delete the floodplain/floodway downstream of River Mile 30.2 and add a note directing the map user to the WA maps and study.

4. Kofi Awumah will contact WA and verify that they will extend their floodplain maps to include the area up to River Mile 30.2. Kofi Awumah will call Scott Ogden by the end of the week (7 February 1997) to confirm finalization of GVSCE's hydraulic TDN and maps. It was agreed that WA should use data from MKE's map to extend its maps. In order to facilitate that transfer of data, MKE gave to Kofi Awumah a vellum plot and AutoCad drawing file on diskette, of Sheet 1 of the GVSCE floodplain delineation maps. The MKE HEC-2 files were previously transmitted to WA via the District.

5. Frank Brown showed Kofi Awumah and Scott Ogden the current copy of the GVSCE hydraulics TDN. It was noted that plots of the cross sections to be included

in the WA study, should be removed. It was also noted that the floodplain profile sheet should be revised to delete data below River Mile 30.2, and that text should be added to the main body of the report and exhibits to refer the reader to the WA study. The HEC-2 files will be modified and notations will be made in the models to discuss the use of the WA's water surface and floodway station conditions at River Mile 30.2.

6. The semi-rectified aerial photographs have been completed and a blueline copy was given to Scott Ogden and to Kofi Awumah. Frank Brown displayed his set that has the floodplain and floodway boundaries transferred to them by light table overlay. Kofi Awumah may use these sheets for the next public meeting, and the District could add street names for ease of public reference.

7. MKE is to prepare the FEMA map overlays and submit to Scott Ogden with the final hydraulics TDN for one last in-house review. Kofi Awumah requested that the next submittal to the District be a FEMA-ready package that will include the full hydrology and hydraulics TDNs, the FIRM panel overlays, and the completed FEMA forms.

The meeting adjourned about 10:40 a.m.

Distribution: Attendees
Joyce Sabol, GVSCE

# 1.3 GENERAL CORRESPONDENCE

# 1.3.1 COMMUNITY

Job file
92-40-003 RECEIVED JAN 19 19

# TRANSMITTAL

1/1

**TO:** MKE
Attn: Frank Brown

**FROM:** *George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211
Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

**DATE:** 17 January 1996

**PROJECT No./Name:** #84 / Cave Creek FDS

**SUBJECT:** Property ownership info

## ENCLOSED ARE THE FOLLOWING

1- copy of parcel ownership and addresses for the project
1- set of Assessors maps (incomplete)

## REMARKS

Please use this information to identify property owners that need to contacted for rights of entry during surveying. Return the contact list to me and I will send out the letters.

**COPIES**

**SIGNED** W. Scott Ogle

MKE

McLaughlin Kmetty Engineers, Ltd

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602) 248-785

1/3

| LETTER OF TRANSMITTAL | Date: 22 Jan 1996 | Job No.: 92-404.003 |
|---|---|---|
| To: George V. Sabol Consulting Engineers, Inc. | Attention: Mr. Scott Ogden | |
| | Re: Cave Creek FDS | |

WE ARE SENDING YOU X ATTACHED ___ VIA Deliver

| Original: | Copies | Date | Description |
|---|---|---|---|
| | 1 | Jan 1996 | Manning's n Value Report stamped "Preliminary For Review Only" |
| 1 set | | 1-12-96 | 6 original Black and White aerial photographs with acetate overlays |
| | 1 | Jan 1996 | Properties which may Require Notice for Survey Entrance |
| | | | |

Remarks: Scott, please forward the n value study to Kofi A.. The original photographs are sent because the photocopies may be hard to read. Please add a cover sheet, and edge binder label, as we previously agreed.

The District should keep the n value report until near the end of the study, at which time we would like to recycle the color photocopies into a final report copy. The aerial photos should be returned with the n value report approval letter, since we will need them to continue our work.

The parcel list is solely for ERM panel, aerial mapping panels, and field check sections. Please send me a copy of the addresses for letters that were sent, and a copy of one actual letter sent out. I will pass this data onto ALS, so that they may have it in hand while surveying.

COPY TO _____

SIGNED Frank Edward Brown

Frank Edward Brown, P. E.

## Properties Which May Require Notice for Survey Entrance

2/3

| BOOK | MAP | PARCEL | NAME | ADDRESS |
|---|---|---|---|---|
| | | | | |
| 211 | 1 | 5B | Breckenridge Enterprises | 1055 Wayzata Blvd. E / Wayzata Mn 55391 |
| | | 6W | | |
| | | 2Z | | |
| | | 21 | | |
| | | 31 | | |
| | | 6-L | | |
| | | 11-F | | |
| | | 11-G | | |
| | | 11-T | | |
| | | 12-M | Thomas E Neely Trust | 55 E Monroe St. #4200 / Chicago Il 60603 |
| | | 12-G | Harris, Kenneth Michael | 401 W Baseline Rd. / Tempe AZ 85283 |
| | | 12-H | Harris, Kenneth Michael | 401 W Baseline Rd. / Tempe AZ 85283 |
| | | 12-W | | |
| | | 12-X | | |
| | | | | |
| | | | | |
| 211 | 4 | 16 | | |
| | | | | |
| | | | | |
| 211 | 12 | 139 | | |
| | | 137 | | |
| | | | | |
| | | | | |
| 211 | 17 | 13K | unknown | on list of parcels in floodplain |
| | | 13L | | |
| | | 12K | unknown | on list of parcels in floodplain |
| | | 13M | unknown | on list of parcels in floodplain |
| | | 13N | | |
| | | 11B | Flatt, David C; Shari R. | PO Box 11090 / Telluride CO 81435 |
| | | 11C | Allfred, Ronald D | PO Box 11155 / Telluride CO 81435 |
| | | 9 | | |
| | | 16 | | |
| | | | | |
| | | | | |
| 211 | 2 | 4H | | |
| | | | | |
| | | | | |
| 211 | 16 | 1M | Wilenchik, Dennis I : Becky A | 2828 N Central Ave #13th / Phoenix AZ 85004 |
| | | 1K | | |
| | | 1Z | | |
| | | 1Y | | |
| | | 2P | Schubert Family Trust | 8207 E Rovey Ave / Scottsdale AZ 85250 |
| | | 4 | | |
| | | 5 | | |
| | | U.S.A | | |
| | | | | |

## Properties Which May Require Notice for Survey Entrance



| BOOK | MAP | PARCEL | NAME | ADDRESS |
|---|---|---|---|---|
| | | | | |
| 211 | 59 | 60F | Bridge, William H; Gladys G. | PO Box 1850 / Cave Creek AZ 85331 |
| | | 60C | | |
| | | 60A | | |
| | | 60G | | |
| | | 1V | | |
| | | 3M | | |
| | | 8Z | | |
| | | 8P | | |
| | | 8J | | |
| | | 9G | Andermann, Richard A. | 1088 Park Ave. / New York NY 10128 |
| | | 3K | | |
| | | 3C | | |
| | | 65 | | |
| | | 8F | | |
| | | 64 | | |
| | | 7P | | |
| | | 7Q | | |
| | | 7K | | |
| | | 7A | | |
| | | 7C | | |
| | | 9-B | Digiorgio, Josephine J. | PO Box 221942 / Carmel CA 93922 |
| | | 3P | | |
| | | 7J | | |
| | | 9D | | |
| | | | | |

Other maps required : T5N R4E Sec. 5, T5N R4E Sec. 6

Job file

RECEIVED FEB 7 1996

92-404.003

# TRANSMITTAL

1/4

TO: MKE

Attention: Frank Brown

FROM: *George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211
Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

DATE: 5 February 1996

PROJECT No./Name: #84/ Cave Creek FDS FCD 95-23

SUBJECT: Right of entry letters and recipients.

## ENCLOSED ARE THE FOLLOWING

2 copies of example right of entry letter.
2 copies of list of letter recipients names and addresses.

## REMARKS

Frank - Here are copies of the right of entry letter and list of property owners to which it has been sent. Please give a copy to Richard for his files. According to Kafi, these are the only names that he could find and the District will be satisfied with this distribution.

COPIES 1 set of copies to Richard Alcocer (ALS) via MKE

SIGNED W. Scott Ogden

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, AZ 85260-6962
(602) 483-3368 FAX (602) 483-3990

February 2, 1996

2/4

Loringwood Estates
P.O. Box 1743
Cave Creek, AZ 85331

Subject: Right of entry for surveying purposes

Dear Property Owner:

The Flood Control District of Maricopa County, Arizona, has contracted with George V. Sabol Consulting Engineers, Inc. (GVSCE), and subcontractor, McLaughlin Kmetty Engineers, Ltd. (MKE), to perform a Flood Delineation Study for approximately 5.5 miles of Cave Creek from Morning Star Road to the Carefree Highway. The purpose of this study is to determine flood related hazard zones and delineate areas that may be subject to inundation during a "100-year flood" event. According to records at the Maricopa County Assessor's office, you own one or more parcels of land within the limits of the study area.

The intent of this letter is to notify you of the commencement of surveying activities in support of the above mentioned study. In order to perform these surveys, it may be necessary to enter your property. This activity should not result in any inconvenience or damage to property. If you have any objections to entrance onto your property, you must notify Dr. Kofi Awumah of the Flood Control District at (602) 506-1501. Otherwise, it will be assumed that you consent to entry onto your property.

The study and resulting maps will be used for floodplain management purposes and submitted to the Federal Emergency Management Agency for flood insurance information and revisions of Flood Insurance Rate Maps. This study should be available to the public in about 12 to 18 months.

The Flood Control District and its representatives appreciate your help in assuring the accuracy of this study by allowing surveyors access to your property and providing any information you may have regarding past flooding or related problems. If you have any general questions regarding this study, please contact Dr. Kofi Awumah of the Flood Control District. If you have specific questions regarding right of entry and surveying, please contact Mr. W. Scott Ogden of George V. Sabol Consulting Engineers at (602) 483-3368.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE
Project Engineer

# Cave Creek Above Carefree Highway FDS

## FCDMC Project No. FCD 95-28

### Properties Which May Require Notice for Survey Entrance

| BOOK | MAP | PARCEL | NAME | ADDRESS |
|---|---|---|---|---|
| | | | | |
| 211 | 1 | 5B | Breckenridge Enterprises | 7831 Glenroy Rd., #335, Minneapolis MN 55439 |
| 211 | 1 | 6W | Gossen Joseph J. & Johanna E | 8031 E. Indianola Ave., Scottsdale, AZ 85251 |
| 211 | 1 | 2Z | | |
| 211 | 1 | 21 | | |
| 211 | 1 | 31 | | |
| 211 | 1 | 6-L | Hobin, Wayne P. & Kiki A. | P.O. Box 4363, Cave Creek, AZ 85331 |
| 211 | 1 | 11-F | Crerie Revocable Trust | 10016 Adele Court, Scottsdale AZ 85253 |
| 211 | 1 | 11-G | | |
| 211 | 1 | 11-T | Biglaiser, Marcia M & Leo TR | 7169 E. McDonald Dr., Scottsdale AZ 85253 |
| 211 | 1 | 12-M | Thomas E Neely Trust | 55 E Monroe St. #4200 / Chicago Il 60603 |
| 211 | 1 | 12-G | Harris, Kenneth Michael | 401 W Baseline Rd. / Tempe AZ 85283 |
| 211 | 1 | 12-H | Harris, Kenneth Michael | 401 W Baseline Rd. / Tempe AZ 85283 |
| 211 | 1 | 12-W | | |
| 211 | 1 | 12-X | | |
| | | | | |
| | | | | |
| 211 | 4 | 16 | Loringwood Estates | P.O. Box 1743, Cave Creek AZ 85331 |
| | | | | |
| | | | | 4909 E. McDowell Rd., Ste. 103, Phoenix AZ |
| 211 | 12 | 139 | Rancho Manana Ltd. Partnershi | 85008 |
| 211 | 12 | 137 | Mitchcock, Edward B. | P.O. Box 5417, Phoenix AZ 85010 |
| | | | | |
| | | | | |

# Cave Creek Above Carefree Highway FDS

## FCDMC Project No. FCD 95-28

### Properties Which May Require Notice for Survey Entrance

| BOOK | MAP | PARCEL | NAME | ADDRESS |
|---|---|---|---|---|
| 211 | 17 | 13K | Daiss, David E. & Dorene L. | P.O. Box 4329, Cave Creek AZ 85351 |
| 211 | 17 | 13L | Kingsley, Charles E. TR | 1106 Brummel St., Evanston IL 60202 |
| 211 | 17 | 12K | unknown | on list of parcels in floodplain |
| 211 | 17 | 13M | Sands, Louis IV | 6932 N. Highlands Dr. Paradise Valley AZ 85253 |
| 211 | 17 | 13N | McKinstry, Donald C. & Mary B | P.O. Box 1635 Cave Creek AZ 85351 |
| 211 | 17 | 11B | Flatt, David C; Shari R. | P.O. Box 11090, Telluride CO 81435 |
| 211 | 17 | 11C | Allfred, Ronald D | P.O. Box 1115, Telluride CO 81435 |
| 211 | 17 | 9 | Management Executives | PO Box 1750, Cave Creek AZ 85351 |
| 211 | 17 | 16 | Hutson, Anthony & Linda P. | 5535 E. Desert Hills Dr. Cave Creek AZ 85351 |
| | | | | |
| | | | | |
| 211 | 2 | 4H | | |
| | | | | |
| | | | | |
| 211 | 16 | 1M | Wilenchik, Dennis I & Becky A | 2828 N Central Ave #13th / Phoenix AZ 85004 |
| 211 | 16 | 1K | Nine Thousand Forty Five Inves | 6555 Pacific St., Prince George 0000 |
| 211 | 16 | 1Z | Omundson, Peter Roy | P.O. Box 1612, Cave Creek, AZ 85331 |
| 211 | 16 | 1Y | Omundson, Peter Roy | P.O. Box 1612, Cave Creek, AZ 85331 |
| 211 | 16 | 2P | Schubert Family Trust | 8207 E Rovey Ave / Scottsdale AZ 85250 |
| 211 | 16 | 4 | | |
| 211 | 16 | 5 | | |
| 211 | 16 | U.S.A | | |
| | | | | |
| | | | | |
| 211 | 59 | 60F | Bridge, William H; Gladys G. | P.O. Box 1850, Cave Creek AZ 85331 |
| 211 | 59 | 60C | | |
| 211 | 59 | 60A | | |
| 211 | 59 | 60G | Anderson, Roy H. & Louann I. | P.O. Box 4949, Cave Creek AZ 85351 |
| 211 | 59 | 1V | | |

# Cave Creek Above Carefree Highway FDS
## FCDMC Project No. FCD 95-28

### Properties Which May Require Notice for Survey Entrance

| BOOK | MAP | PARCEL | NAME | ADDRESS |
|---|---|---|---|---|
| 211 | 59 | 3M | | |
| 211 | 59 | 8Z | | |
| 211 | 59 | 8P | | |
| 211 | 59 | 8J | | |
| 211 | 59 | 9G | Andermann, Richard A. | 1088 Park Ave. / New York NY 10128 |
| 211 | 59 | 3K | Marshall, Don | P.O. Box 1783, Cave Creek AZ 85331 |
| 211 | 59 | 3C | | |
| 211 | 59 | 65 | | |
| 211 | 59 | 8F | | |
| 211 | 59 | 64 | | |
| 211 | 59 | 7P | | |
| 211 | 59 | 7Q | | |
| 211 | 59 | 7K | | |
| 211 | 59 | 7A | | |
| 211 | 59 | 7C | | |
| 211 | 59 | 9-B | Digiorgio, Josephine J. | PO Box 221942 / Carmel CA 93922 |
| 211 | 59 | 3P | | |
| 211 | 59 | 7J | | |
| 211 | 59 | 9D | | |
| | | | | |

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

26 March 1996

Kofi Awumah, PhD, PE
FCDMC
2801 W. Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
Right of Entry notification letters

Dear Kofi:

Enclosed are copies of the right of entry letter and the updated parcel, name, and address listing of property owners that were sent notifications. Several of the addresses provided by the District are not mailing addresses and those letters were returned to GVSCE. A follow up attempt was made by checking to see if the property owner is listed in the phone book and calling to request their mailing address. The letter was then sent to that address. We are unable to find correct mailing addresses for the following property owners:

Kenneth M. Harris, Parcels 211-1-12G & 211-1-12H,
Rancho Manana Ltd. Partnership, Parcel 211-12-139,
Roy and Louann Anderson, Parcel 211-59-60G, and
Anthony and Linda Hutson, Parcel 211-17-16.

If you have any questions or require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosures

# 1.3.2 STATE COORDINATION

# 1.3.3 OTHER AGENCIES

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

7 December 1995

Mr. Kofi Awuhma
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Upper Cave Creek Floodplain Delineation Study

Dear Kofi:

Enclosed please find a copy of the watershed subbasin delineation for your review. The subbasin boundaries are shown in red pencil and the main watercourse for Cave Creek Wash is shown in blue pencil. The base map used for delineation is a 1 inch = 2,000 feet mosaic of the Cave Creek, Cooks Mesa, Humbolt Mountain, New River Mesa, New River SE, Rover Peak, Union Hills, and Wildcat Hill USGS 7.5 Minute Quadrangle Maps.

If you have any questions or require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosure

MKE

McLaughlin Kmetty Engineers, Lt

8501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602)

GEZA E. KMET
RONALD C McLAUGHLIN
HALFORD E. ERICKSON
WILLIAM R. KENDALL
RALPH L. TAYLOR
TERRENCE P. KENT
RICHARD E. McLAUGHLIN

1/2

Page 1 of 2
INCL. this page

Date 3 Jan 96

From Frank Brown

Transmitted to Fax Number 506-4601

To Mr. Kofi Awumah Ph.D.

Company FCD of MC

Comments Enclosed is Field Investigation Schedule.

We will leave MKE office @ 8AM on Thurs 4 Jan 96

Go here to join us for entire day, or use the

enclosed information to meet us in the field.

Frank

We have maps available, call if you need one.

Job # 92-404.003

NOTE: If this transmission is incomplete, please call
(602) 248-7702

Admin\FaxForm.000

**MKE** McLaughlin Kmetty Engineers, Ltd.

Project Title Cave Creek Project No. 2/2 Date 2 Jan 91

Subject Time Table for Field Investigation Designed CLJ Page 1/1

| Description | Time | Begin | End |
|---|---|---|---|
| - Phx to Cave Creek | 1.5 hrs | 8 AM | 9:30 AM |
| - Walk 1st and 2nd reaches (1st ~1.3 mi, 2nd ~1.7 mi) | 2.0 hrs | 9:30 AM | 11:30 AM |
| - Coordinate notes, break, lunch at end of 1st & 2nd Reach | 1.0 hrs | 11:30 AM | 12:30 PM |
| - Walk 3rd and 4th reaches (3rd ~1.3 mi, 4th ~0.5 mi) | 1.5 hrs | 12:30 PM | 2:00 PM |
| - Coordinate notes, break review | 0.5 hrs | 2:00 PM | 2:30 PM |
| - Cave Creek to Phx return trip | 1.5 hrs | 2:30 PM | 4:00 PM |
| - Flex Time | 1.0 hrs | | 5:00 PM |
| | 9 hrs (includes 1 hr of flex time) | | |

① Drop off car on Cottille Rd

② Drive back to start of study and drop off 1 person (1st reach)

③ Park car (at 56th St) and one person walks 2nd reach to Cottille Rd ①

④ Person walking 1st Reach drives parked car on 56th St (③) to Cottille Rd. to meet other person. Coordinate notes, rest and break for lunch

⑤ Both drive cars to end of Morning Star Rd leave one car

⑥ Return to Cottille Rd and leave one person to walk reach 3. to Rockaway Hills Dr

⑦ Other person drives to Rockaway Hills Dr, parks car and walks reach 4. to Morning Star Rd.

⑧ Both people (and cars) meet, review notes, etc. at Morning Star Rd

JCB

# MKE

## McLaughlin Kmetty Engineers, Lt

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602 8-7

1/1

LETTER OF TRANSMITTAL

Date: 10 Jan 96 | Job No.: 92-404.003

To: Flood Control District of Maricopa County

Attention: Mr. Kofi Awumah

Re: Cave Creek & FCD 95-28

WE ARE SENDING YOU ✓ ATTACHED ___ VIA Deliver

| Original: | Copies | Date | Description |
|---|---|---|---|
| 1 | | dated | Harris-Towns FIS work sheets, mylar, 2 sheets, 42" x 52" |

Remarks:

Being returned in pdf. Thanks for the loan

COPY TO Mr. Scott Ogden, GVSCE

SIGNED Frank Edward [illegible]

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

23 January 1996

Kofi Awumah, PhD, PE
FCDMC
2801 W. Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28

Dear Kofi:

Enclosed are the following items:

1. One copy of the interim report titled Manning's Roughness Coefficient Determination for your review. Please respond with written comments or a letter of approval and keep the report for reference purposes. At some date near the end of the project, we will request that the color photocopies of reach photographs be returned so that we can recycle them into the final hydraulics TDN. Also included in a separate envelope are the original aerial photographs with attached acetate overlays that were used to prepare the maps indicating the reach limits. We request that those items be returned to GVSCE with the letter of approval for the interim report because they are needed for later work on the project.

2. A copy of additional parcels identified for right of entry notification that were not included in the list of parcel owners initially provided to GVSCE by the District. Survey work has begun in the area, so it is critical that we obtain the addresses to get the letters out as soon as possible.

3. A photocopy of the proposed southern watershed boundary changes precipitated by results of the recent field reconnaissance conducted by GVSCE and discussed at the 12 January hydrology meeting. In order to keep the hydrology moving, I am going to assume that these changes are okay and proceed with developing the necessary information to obtain the ArcInfo data for our watershed. Accordingly, please let me know if there is any problem with these changes as soon as possible.

Any questions or further information requirements that you may have regarding the Manning's Roughness Coefficient Determination report should be directed to Mr. Frank Brown of McLaughlin Kmetty Engineers, Ltd., phone number (602) 248-7702, or myself. Questions regarding items 2 and 3 should be directed to me. Please do not hesitate to call should you require anything else.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Copy w/o enclosures: Frank Brown, PE

**FLOOD CONTROL DISTRICT**
**OF MARICOPA COUNTY**
2801 West Durango Street
Phoenix, Arizona 85009

(602) 506-1501

Received 2 Feb. '96

# LETTER OF TRANSMITTAL

| | |
|---|---|
| DATE 1/29/96 | JOB NO |
| ATTENTION Scott Ogden | |
| RE Cave Creek Wash FDS | |

TO Scott Ogden
GVSCE Inc. 7950 E. Acoma Dr
Scottsdale AZ 85260

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ _____

| COPIES | DATE | NO. | DESCRIPTION |
|---|---|---|---|
| 1 | | | Diskette of Jurisdictional Boundaries |
| 1 | | | List of Property Owners' Addresses |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☑ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 19 _____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS _____

COPY TO _____

SIGNED: _____

6910-009 R8-93

*If enclosures are not as noted, kindly notify us at once.*

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

1 February 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
Contract FCD 95-28
Base rainfall loss parameter estimates

Dear Kofi:

Enclosed are the following items for the District's review:

1. One copy of the preliminary soils hydrology exhibit map at a scale of 1 inch = 2,000 feet. The soils map shows the NRCS and Tonto National Forest Cartwright Allotment and General TES soil unit polygons with respect to the watershed subbasin boundaries.

2. One copy of the preliminary land use hydrology exhibit map at a scale of 1 inch = 2,000 feet. The land use map shows the land use elements received from the District with respect to the watershed subbasin boundaries. Also shown are the additional polygons digitized from 19 February 1995 aerial photography by Landis Corporation for the developed area east of the District's HIS data file limits. I am including a photocopy taken from the aerial photography for your reference.

3. One blackline print of the base USGS topography map at a scale of 1 inch = 2,000 feet for use as a reference overlay with a light table. That map and the soils and land use have tick marks drawn at four perimeter locations to facilitate overlaying the exhibits.

4. One copy each of tables summarizing the NRCS, Tonto National Forest Cartwright Allotment TES, and Tonto National Forest General TES composite XKSAT and rock outcrop percentage estimates. The NRCS values are obtained from the Maricopa County Hydrology Manual and supporting information sheets documenting the Tonto National Forest TES study's soil classifications and corresponding assigned soil textures, and soil descriptions with component breakdowns as they were available.

5. A table summarizing the assigned IA value and vegetation cover density estimates by subbasin, for natural (undeveloped) conditions. The vegetation cover density estimates are the result of examination and evaluation of photographs and video taken during aerial and field reconnaissance and transect data and photographs obtained at various locations within the watershed. The IA values are estimated with respect to the general terrain associated with each subbasin. The transect locations are indicated on the soils map. I am including photocopies of the transect field notes, the photographs

taken at each transect, and pertinent photographs from the aerial reconnaissance on 8 January 1996, to facilitate your review. Please return all photographs to GVSCE upon completion of the District's review.

6. A table summarizing the vegetation cover density, RTIMP, and IA value estimates assigned for all of the land use classes occurring within the watershed. Those values are estimated with guidance from the Maricopa County Hydrology Manual.

Please note that the soils and land use maps are preliminary and are to be used in reviewing the soils and land use polygon delineations and rainfall loss base parameter estimates only. The finalized version of these exhibits will be submitted at a later date for review. Please respond with comments or acceptance as soon as possible so that we can finalize the rainfall loss calculations. If you have any questions or require further information please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosures

Copy w/enclosures (except photographs): Mr. Tom Loomis, PE, RLS, ASL/Sierra

MKE McLaughlin Kmetty Engineers, Ltd

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602) 248-78

1/1

# LETTER OF TRANSMITTAL

Date: 02/05/96 Job No.: 92-404.003

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

Attention: Dr. Kofi Awumah

Re: Cave Creek Wash above Carefree Hwy.
FCD No. 95-28

WE ARE SENDING YOU X ATTACHED ___ VIA Hand Deliver

| Original: | Copies | Date | Description |
|---|---|---|---|
| | 1 | Jan 1996 | Revised 5 Feb 96 3-ring notebook of n value study. |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Remarks: Kofi,

Per your verbal comments, we have revised the n values report to show numbers rounded to the nearest 0.005. Please see previous letter of transmittal from GVSCE for instructions on the color photocopies. We are retaining the aerial photograph originals. After we receive the new mapping, let's discuss if the final n value map should be based on the computerized maps, or based on the aerial photographs with cleaner graphics and lettering.

COPY TO Mr. Scott Ogden, GVSCE

SIGNED Frank Edward Brown

Frank Edward Brown, P.E.

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


February 7, 1996

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
7950 E. Acoma Dr., Ste 211
Scottsdale, Arizona 85260

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**Base Rainfall Loss Parameter Estimates**

The following are our comments regarding the preliminary rainfall loss parameter estimates.

1. The transect field notes for vegetation cover of natural areas should include some descriptive information about the site such as upper or lower part of the watershed, elevation, slope aspect, etc.

2. The table entitled "Surface retention loss and vegetation cover for each subbasin in its natural condition" should include some descriptive information as to why for example subbasins CC1 and BMM1, which are adjacent to each other have such different vegetation cover, i.e. 39% and 20% respectively.

3. The worksheet table for landuse parameters should include definitions for S, N, and F. The N and F values for RTIMP, VEG. COVER, and IA should read varies rather than 0.

Please feel free to give me a phone call if you have any questions.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


February 7, 1996

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
7950 E. Acoma Dr., Ste 211
Scottsdale, Arizona 85260

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**Mannings' Roughness Coefficient Report**

I have reviewed the Mannings' Roughness Coefficient Preliminary Report and found the 'n' values to be acceptable.

I would however like you to coordinate the results with Wildan Associates to ensure that your values compare favorably with theirs, especially in the reach common to both studies. If there should any major discrepancies, arrange a meeting to iron out the difference.

If you need further clarification or have some input to discuss, please give me a phone call.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
2801 West Durango Street
Phoenix, Arizona 85009

(602) 506-1501

# LETTER OF TRANSMITTAL

1/4

DATE 2/7/96 JOB NO

ATTENTION

RE

TO Mr. Hal Marron P.E.
Willdan Associates

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ _____

| COPIES | DATE | NO | DESCRIPTION |
|---|---|---|---|
| 1 | 2/7/96 | | Revised Southern Boundary of Watershed (for North part of Cave Creek) from GVS Consulting Engineers, Inc. |

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☑ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 19 _____ ☐ PRINTS RETURNED AFTER LOAN TO US

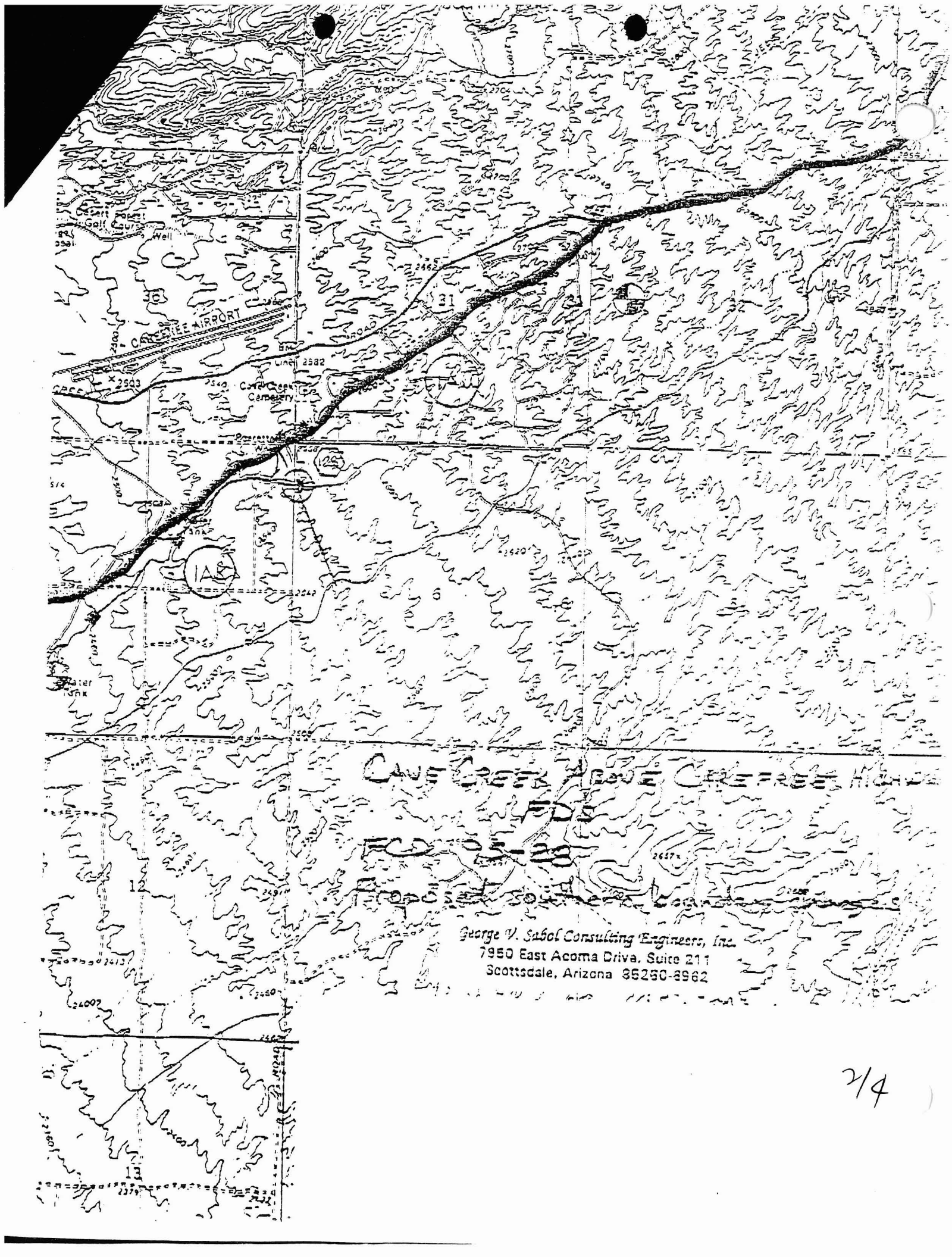
REMARKS

COPY TO NM.

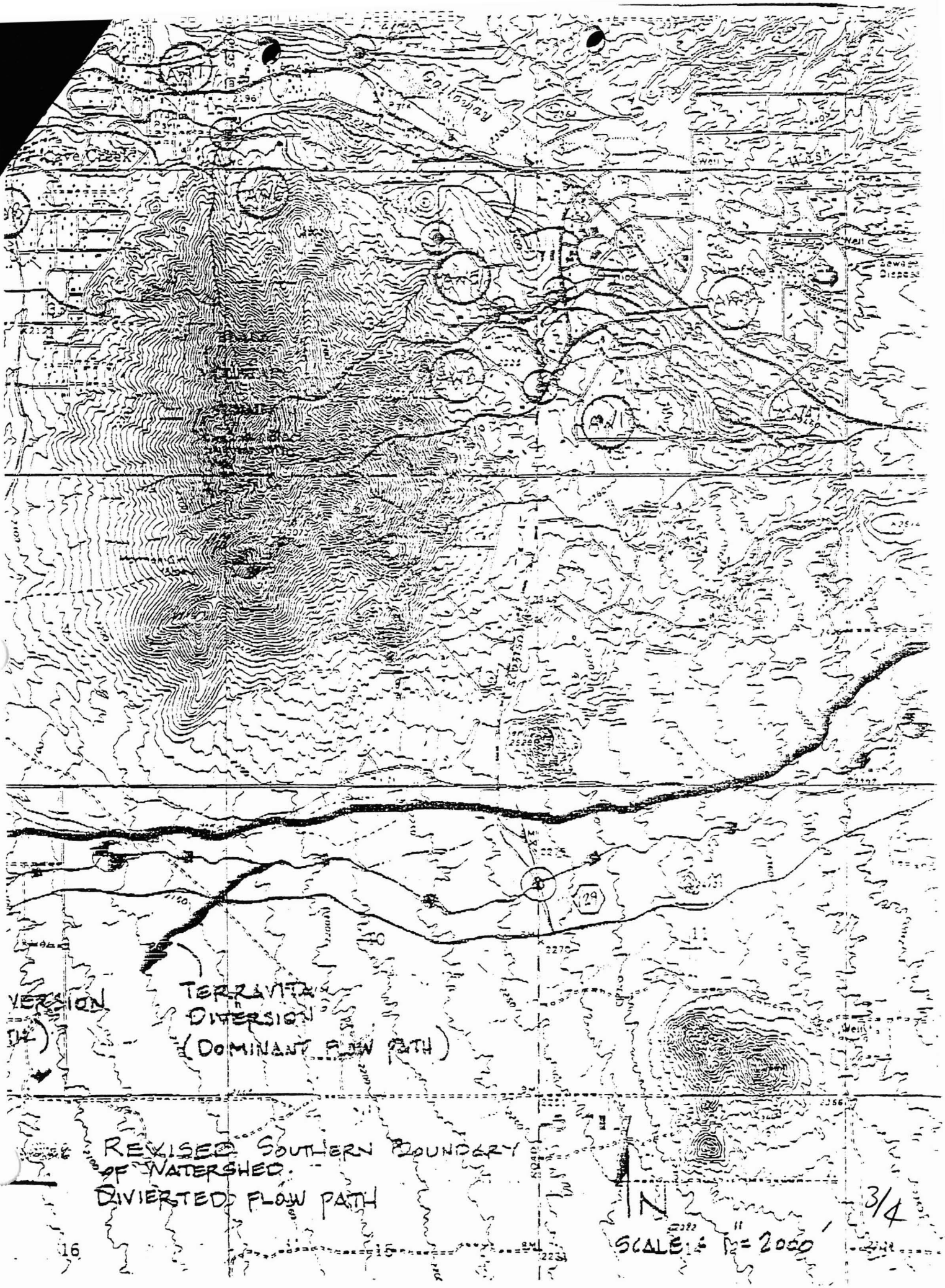
SIGNED: [signature]

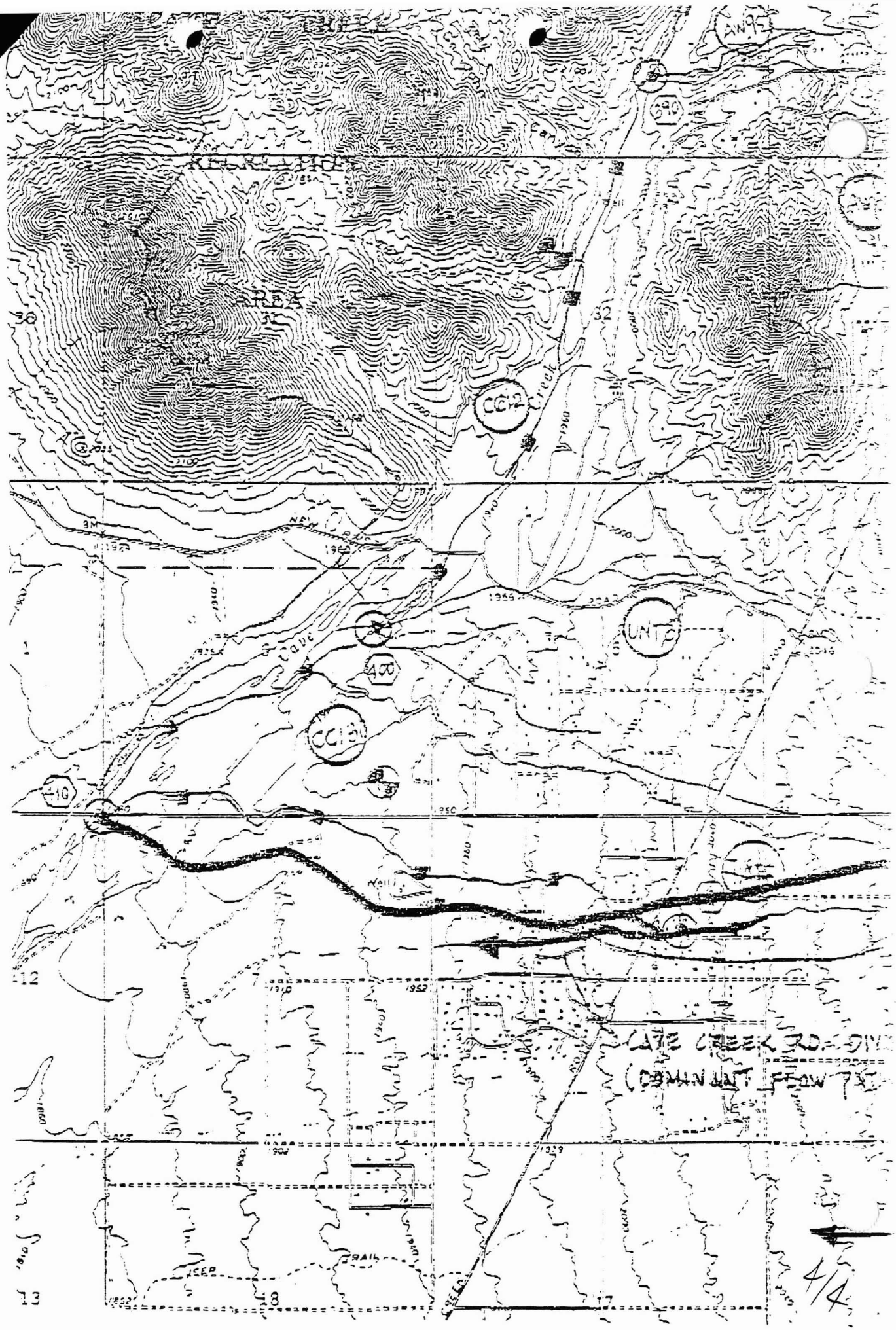
6910-009 R8-93

If enclosures are not as noted, kindly notify us at once.


Desert Forest Golf Course
Well
30
31
32
CAREFREE AIRPORT
ROAD
BM
Line 2582
2503
Cave Creek Cemetery
Powerline
125
1A&
6
Water Tank
12
13
CAVE CREEK ABOVE CAREFREE HIGHWAY
FDS
FCD 95-28
PROPOSED SOUTHERN BOUNDARY
George V. Sabol Consulting Engineers, Inc.
7950 East Acoma Drive, Suite 211
Scottsdale, Arizona 85260-6962

2/4


Cave Creek
Well
Wash
Sewage Disposal
Well
TERRAVITA
DIVERSION
(DOMINANT FLOW PATH)
REVISED SOUTHERN BOUNDARY
OF WATERSHED.
DIVERTED FLOW PATH
N
SCALE: 1" = 2000'
3/4


RECREATION
AREA
CC12
Creek
Cave
UNT
400
CC13
10
Neill
JEEP
TRAIL
36
32
1
12
13
18
17

4/4

MKE

McLaughlin Kmetty Engineers, Ltd

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602) 248-785

GEZA E. KMETY
RONALD C. McLAUGHL
HALFORD E. BRICKS
WILLIAM R. KENDAL
RALPH L. TORE
TERRENCE P. KENY
RICHARD E. McLAUGHL

1/2

Date 2/13/96

Page 1 of 2
INCL. this page

From Frank Brown

Transmitted to Fax Number 506-4601

To Kofi Awumah

Company F.C.D.M.C.

Comments Re: Contract 95-28

Memo re: numbering system for ERM's.

Hard copy to follow

Job # 92-404.003

NOTE: If this transmission is incomplete, please call
(602) 248-7702

Admin\FaxForm.000

MKE

92-404.003

McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 Fax (602) 24 351

GEZA E. KMETT
RONALD C. McLAUGHL
LEO M. EISE
HALFORD E. ERICKSO
WILLIAM R. KENDA
RALPH L. TORE
TERRENCE P. KENYO
RICHARD E. McLAUGHL

MEMORANDUM

2/2

**TO:** Kofi Awumah, Flood Control District of Maricopa County

**FROM:** Frank Brown, McLaughlin Kmetty Engineers, Ltd. Frank Edward Brown

**DATE:** February 13, 1996

**SUBJECT:** Cave Creek FDS
FCD Contract No. 95-28

The purpose of this memorandum is to propose a numbering system for the brass cap Elevation Reference Marks (ERM's) for both Cave Creek Wash above Carefree Highway and Cave Creek Wash below Carefree Highway.

ERM's are proposed to be labeled per the following samples:

"CC312"

"CC061"

Where CC means Cave Creek, the next two digits refer to the Section number that the ERM is placed in, and the last digit is the actual ERM number.

This numbering system was worked out jointly between Mr. Hal Marron and me. There are no duplicate section numbers between the two study areas. I have conferred with Alcocer Land Surveyors and Aerial Mapping Company, and they see no conflict with other benchmark numbering systems in the area. This system is compatible with the HIS Arc/Info specifications, which allow for 7 characters, with any combination of alphanumeric data. This system is preferred to a sequential numbering system between the two Cave Creek projects, because there are two projects, and work is being done concurrently.

Please confer with other District/County staff as appropriate, and indicate your approval of this system. We would like to know by Friday, 16 February 1996.

c: Mr. Scott Ogden, GVSCE, Inc.
Mr. Hal Marron, Willdan & Associates

G:\P\92404003\WP\BrassCap.Mem

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

19 February 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek FDS - Affidavits of Publication

Dear Kofi:

As required in Task 1, item 1.5 of Contract FCD 95-28, we are enclosing the original affidavits of publication announcing the commencement of the flood hazard study near the community of Cave Creek.

Please contact me if you have questions.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosures: Affidavits from Arizona Business Gazette and Tribune

FLOOD CONTROL DISTRICT
of
Maricopa County
2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-3653

BOARD OF DIRECTORS
Mary Rose Garrido Wilcox

1/1

February 28, 1996

RECEIVED MAR 0 1 1996

Frank Brown
McLaughlin Kmetty Engineers, Inc.
3501 North 16th Street
Phoenix, Arizona 85016

Dear Frank:

**SUBJECT: Cave Creek above Carefree Floodplain Delineation Study - FCD 95-28**
**Elevation Reference Marks Numbering Sequence**

I have reviewed your proposal on the numbering sequence for the Elevation Reference Marks to be installed for the Cave Creek Wash floodplain study. After conferring with other District Staff, I have found this proposal to be acceptable.

You may therefore go ahead with the installation of the monuments.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

26 March 1996

Kofi Awumah, PhD, PE
FCDMC
2801 W. Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
Right of Entry notification letters

Dear Kofi:

Enclosed are copies of the right of entry letter and the updated parcel, name, and address listing of property owners that were sent notifications. Several of the addresses provided by the District are not mailing addresses and those letters were returned to GVSCE. A follow up attempt was made by checking to see if the property owner is listed in the phone book and calling to request their mailing address. The letter was then sent to that address. We are unable to find correct mailing addresses for the following property owners:

Kenneth M. Harris, Parcels 211-1-12G & 211-1-12H,
Rancho Manana Ltd. Partnership, Parcel 211-12-139,
Roy and Louann Anderson, Parcel 211-59-60G, and
Anthony and Linda Hutson, Parcel 211-17-16.

If you have any questions or require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosures

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

27 March 1996

Kofi Awumah, PhD, PE
FCDMC
2801 W. Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
Data Collection Summary Report

Dear Kofi:

Enclosed is a copy of the Data Collection Summary Report as required by Task 2.2. As we discussed in our phone conversation on 26 March 1996, I will append or revise the report as necessary after reviewing the District's files on Cave Creek, and submit those revisions to the District.

If you have any questions or require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosures

# McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602)248-7702 Fax (602)248-785

Geza E. Kmetty
Ronald C. McLaughlin
Leo M. Eisel
Halford E. Erickson
Ralph L. Toren
Terrence P. Kenyon
Richard E. McLaughlin


JOB

1/1

## LETTER OF TRANSMITTAL

Date: 15 MAY 1996 | Job No.: 92-404.003

To: FCD OF MC

Attention: KOFI AWUMAH

Re: Contract No.: 95-28

Project Name: CAVE CREEK ABOVE CAREFREE

WE ARE SENDING YOU X ATTACHED ___ VIA DELIVER

| Original: | Copies | Date | Description |
|---|---|---|---|
| 1 SET | | 15 MAY 96 | ORIGINAL RED-MARK OF HEC-2 CROSS SECTION LOCATIONS. SHEETS 1 THROUGH 5 OF 5 |
| | 1 SET | 15 MAY 96 | CROSS SECTION PLOTS OF CHECK SECTION 1 THROUGH 6 OF 6 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Remarks: KOFI, PLEASE REVIEW AND APPROVE THE LOCATION OF THE HEC-2 CROSS SECTIONS. AND THE LOCATION OF THE THALWEG. WE WILL GO OVER YOUR COMMENTS AT THE MEETING ON MONDAY AT 2 P.M.

THE RMSE CALCULATIONS FOR THE CHECK SECTIONS WILL FOLLOW SOON.

COPY TO SCOTT OGDEN, GVSCE (TRANSMITTAL ONLY)

Frank Edward Brown
SIGNED

H:\p\blankdoc\wp\ltrtrans.frm

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211
Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

# TELECOPY TRANSMITTAL

**Date:** 23 May 1996 **Time:** _____

**Send To:** **FAX No.** FCDMC

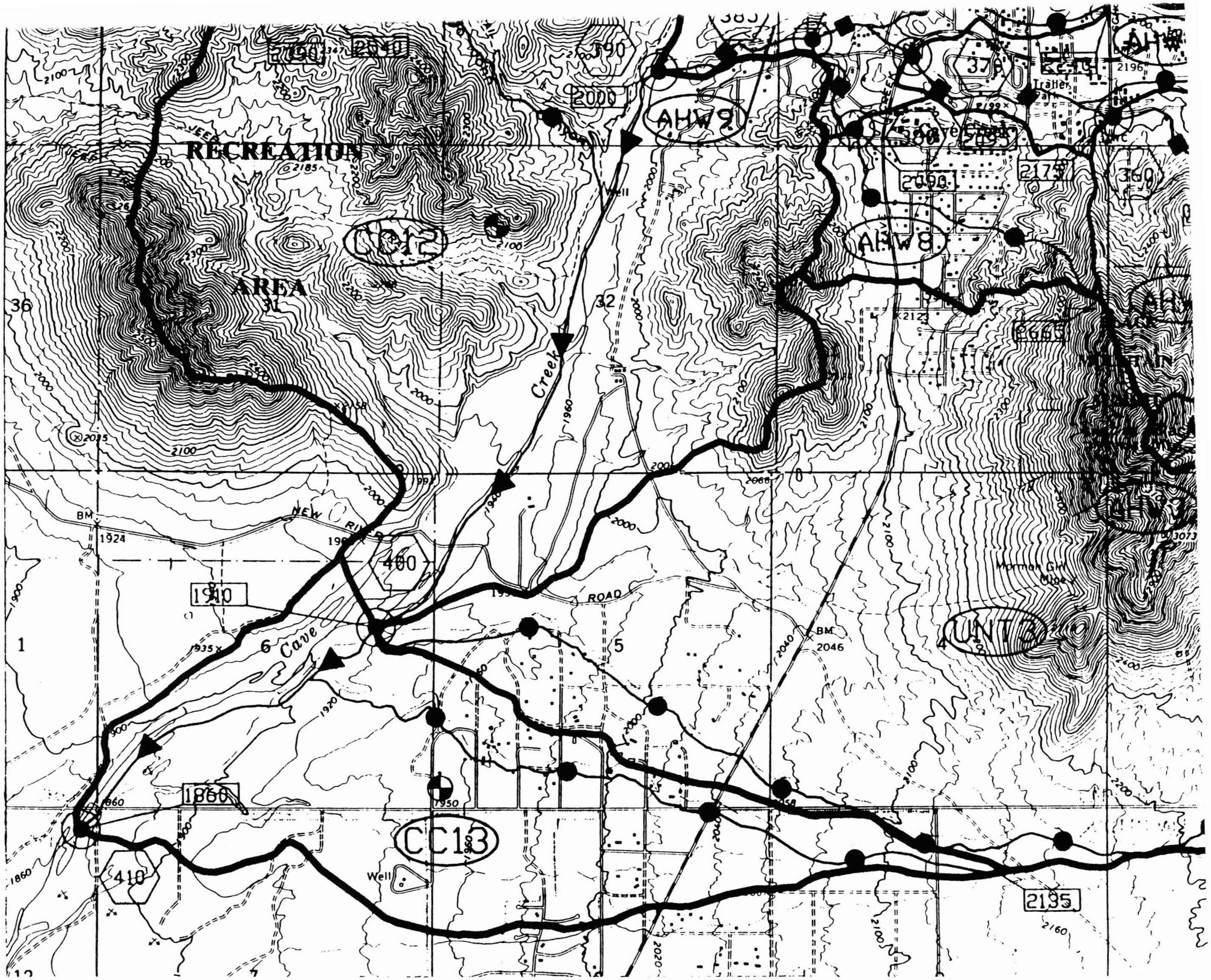
Attn: Valerie Swick

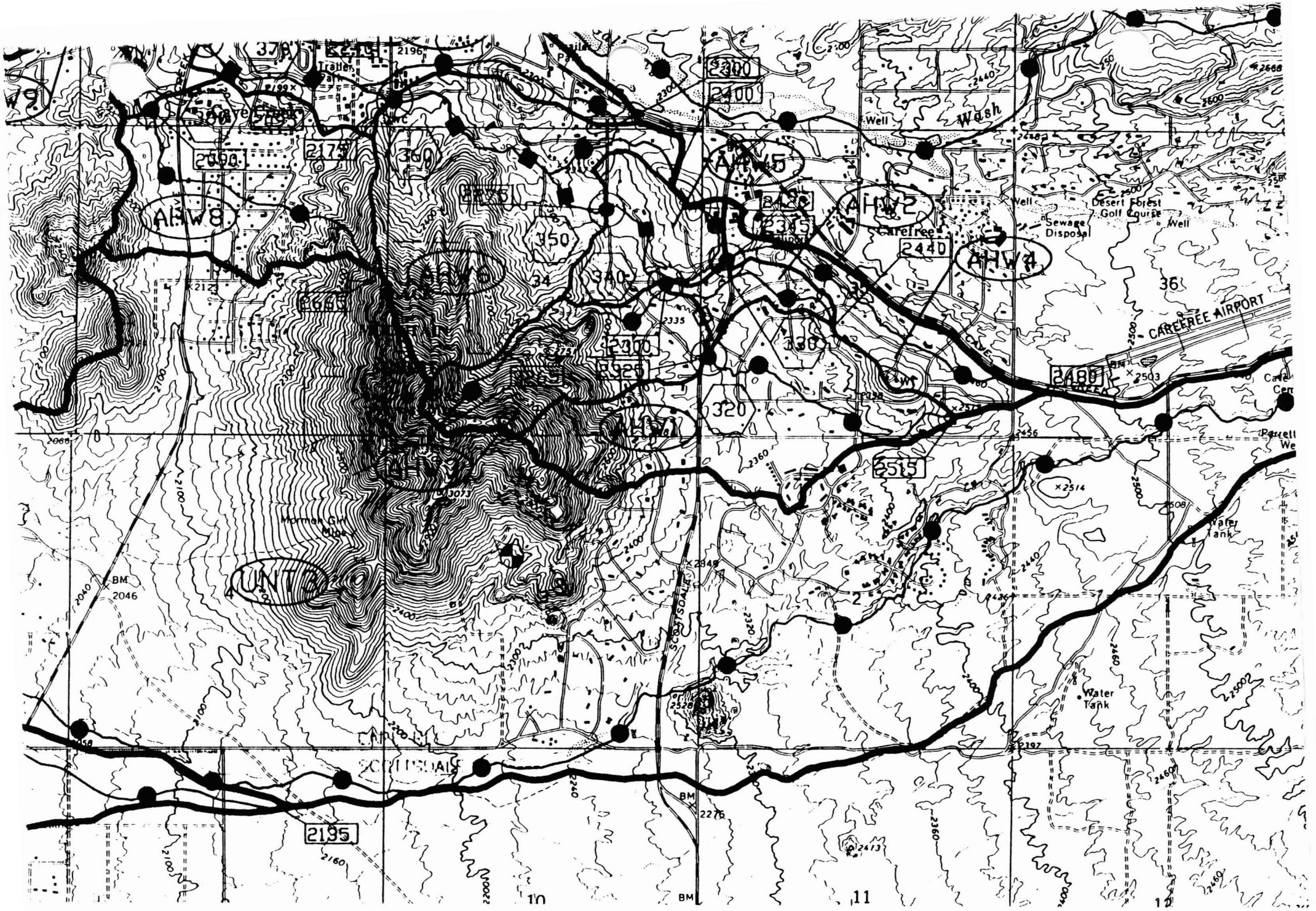
**From:** Scott Ogden

**Project No./Name:** #84 / Cave Creek FDS

**Remarks:** Here are some photocopies of my southern boundary in the area we discussed. I believe that these reflect the redlined changes you already have. Please note that there may be some stretch involved with this overlay, but for the most part it is negligible.
Scale: 1" = 2,000'
Call me if you need anything else

**Total number pages including this Transmittal:** 4


RECREATION
AREA
CC12
CC13
AHW9
AHW8
UNT3
400
410
390
380
360
2000
1910
1860
2090
2175
2665
2135
Cave
Creek
NEW RIVER
ROAD
Well
BM 1924
BM 2046
Mormon Girl Mine
Trailer Park
36
31
32
1
6
5


AHW8
AHW6
AHW5
AHW2
AHW4
AHW1
UNT3
Carefree
Desert Forest Golf Course
Sewage Disposal
Well
Wash
CAREFREE AIRPORT
Mormon Girl Mine
SCOTTSDALE
Water Tank
BM 2046
BM 2276
2195
2515
2480
2440
2400
2175
2090
2370
2320
2335
2315
2503
2514
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2397
2413
2548
3073
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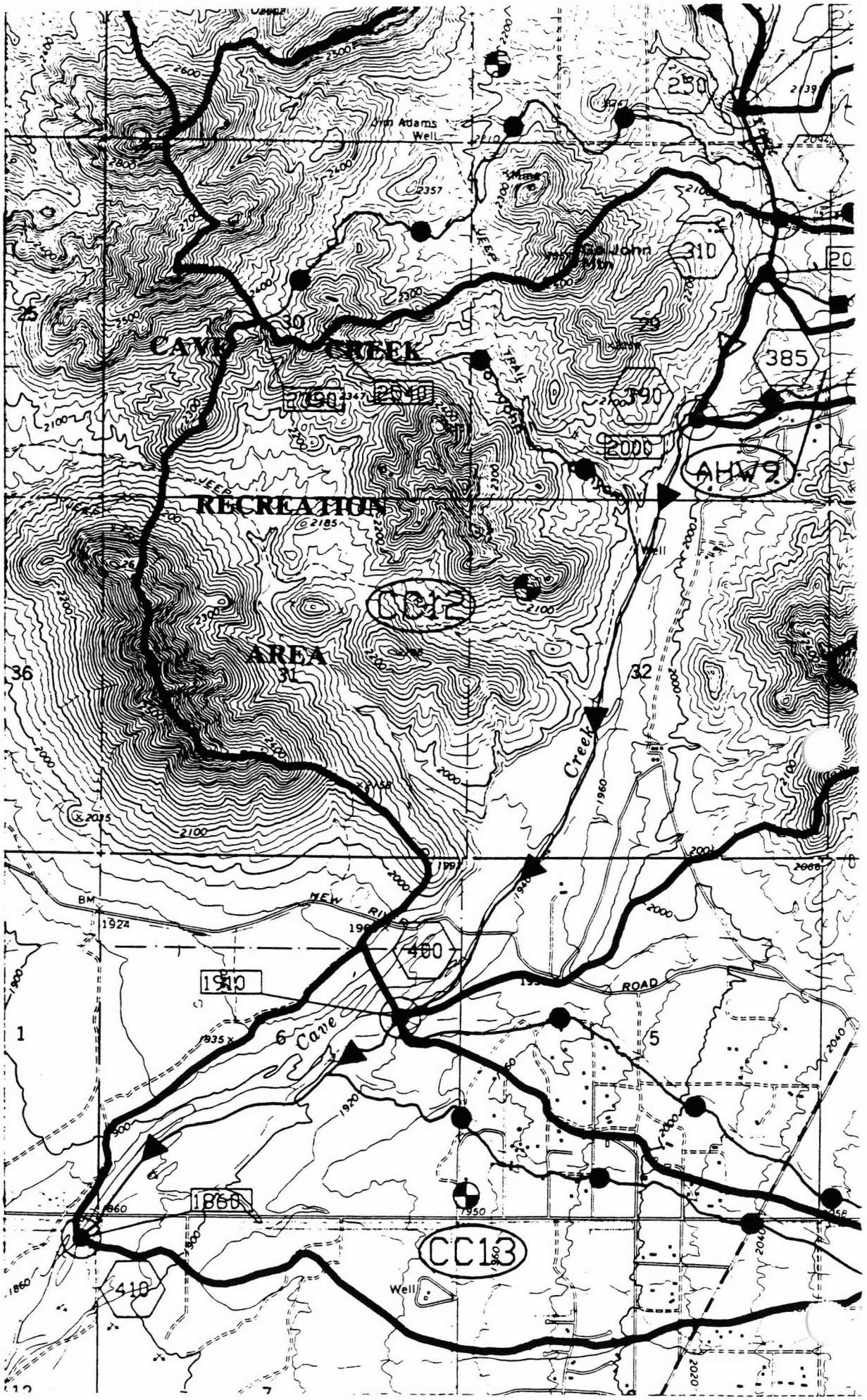
11
12


CAVE CREEK
RECREATION
AREA
Creek
Cave
NEW
ROAD
Well
Mine
JEEP
TRAIL
CC12
CC13
AHW2
250
310
385
390
2000
400
1910
1860
410
36
31
32
1
6
5
25
30
29

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

30 May 1996

Mr. Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
Final Hydrology Parameter and HEC-1 Model Submittal

Dear Kofi:

Enclosed are a Final Parameter and HEC-1 model review package and a separately bound photograph notebook cataloging routing reach and vegetation transect photos.

The review package includes all of the calculation and summary spreadsheet printouts used for developing the modeling parameters, level 5 HEC-1 model output printouts for each model, a diskette containing the HEC-1 input and output (level 3) files, and the appropriate exhibit maps. A preliminary portion of the Hydrology TDN Section 3, covering the discussion on parameter estimation and modeling operations, is also included in the review package to facilitate your review. An identical review package to yours, is being sent to Mr. Tom Loomis for his review and comment as well.

The photograph notebook catalogs photographs taken during field reconnaissance at vegetation transect and routing reach locations, and is provided for the District's project file and reference.

Please respond with review comments by 7 June 1996 so that I can finalize the TDN and submit it for review. Should questions arise during the course of your review, or should you require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Copy with enclosures: Mr. Tom Loomis, PE, RLS, ASL/Sierra

Enclosures

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


June 10, 1996

Mr.Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
7950 E. Acoma Dr., Suite 211
Scottsdale, Arizona 85260

Dear Scott:

**SUBJECT: Cave Creek Wash Above Carefree Highway Floodplain Delineation - Contract No: FCD 95-28: Draft Hydrology Report Approval**

We have reviewed the above draft report and hereby inform you that we accept the hydrologic analysis, subject to the comments below.

The hydrology parameters appear reasonable and realistic. The report explains the difference between the USGS estimated 100 year peak discharge on Cave Creek. However, the report needs to complete the summary of gage data in Section 3.3.

The format and organization of the draft was well done and can be used as the basis of the final report. However, we suggest that a little bit color be applied to the maps to help make information stand out.

If you need further clarification or have any comments, please call. Thanks.

Yours Sincereiy,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

20 June 1996

Kofi Awuhma, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
FEMA Acceptance of HEC-RAS

Dear Kofi:

It has come to my attention that there is a possibility that FEMA is not accepting HEC-RAS submittals for studies that are to tie into existing FIS studies prepared using HEC-2. This information was relayed to me by Mr. Tom Loomis, PE, RLS, of ASL/Sierra, who as you know, is part of our project team as a technical reviewer and consulting advisor. Tom obtained this information while attending a FEMA sponsored workshop at the Spring ASFPM Conference in San Diego, California. It was his understanding that FEMA would accept HEC-RAS for new studies, but that they will require the use of HEC-2 for re-studies or LOMRs that tie into existing floodplains established using HEC-2. The CH2M Hill study, to which we are tieing into at our northern boundary and also matching at various major tributaries along our study reach, was prepared using HEC-2. Based on that information, we would expect that our study would not meet the FEMA criteria for accepting HEC-RAS submittals. In addition, if Willdan does not use HEC-RAS for their study, then that may also provide basis for possible rejection.

We previously agreed to use HEC-RAS on this project as per the District's request. At this time, we will continue to compile data that can be implemented in either HEC-RAS or HEC-2, but will not code either until this issue is resolved. We therefore request that the District check with FEMA regarding the acceptance of HEC-RAS submittals, with specific regard to re-studies tieing into existing HEC-2 data. Please respond verbally by 26 June 1996 to Mr. Scott Ogden regarding the information that you receive from FEMA, with a written response following that communication.

We greatly appreciate your investigation of this matter. If you have any questions or require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol, PhD, PE
President

cc: Frank Brown, MKE
Tom Loomis, ASL\Sierra

# FLOOD CONTROL DISTRICT
*of*
***Maricopa County***

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


June 25, 1996

George V. Sabol, PhD., PE., President
George V. Sabol Consulting Engineers, Inc.
7950 E. Acoma Dr., Suite 211
Scottsdale, Arizona 85260

Dear George:

**SUBJECT: Cave Creek Wash Above Carefree Highway Floodplain Delineation -: FCD 95-28: FEMA Acceptance of HEC-RAS**

I have investigated the possibility of FEMA not accepting this study if submitted as an HEC-RAS model, following your recent letter on this subject matter. Although nothing conclusive was obtained from FEMA officials, I would like the study to be performed using HEC-2 instead of HEC-RAS as originally planned. By so doing, we will avoid any unforeseen problems with FEMA. We will also have the same model type for all the other studies of this river, allowing for merging of models.

Please convey this information to the other sub-consultants of this study.

For further clarification, please call. Thanks.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

15 July 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 W. Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
Contract No. FCD 95-28
Hydrology TDN

Dear Kofi:

Enclosed is a copy of the final Hydrology TDN for your review and comment. Please note that inclusions for all of Section 1, except Section 1.4, are not provided since those files will not be completed until the end of the project. That documentation will be provided and included in the final report for submittal to FEMA. A copy of the Hydrology TDN is also being forwarded to Mr. Tom Loomis for his review as well.

This TDN addresses the prior submittal comments received from the District and Tom Loomis, with most of the revisions being editorial. The only significant change is in the modeling of Andora Hills Wash. Site specific precipitation values for the 6- and 24-hour storms, as opposed to overall watershed estimates, were estimated from the isopluvials. Those values were then coded to the HEC-1 models and the models were re-run and re-optimized. This resulted in an approximate 10 percent reduction in the peak discharge estimates for Andora Hills Wash. All other hydrology results are unchanged from the previous submittal.

If you have any questions or require further information, please do not hesitate to call.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol, PhD, PE

Enclosures

cc: Tom Loomis, PE, RLS, (ASL/Sierra)

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


August 5, 1996

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
7950 E. Acoma Dr., Ste 211
Scottsdale, Arizona 85260

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**Final Hydrology Report**

After reviewing the final report, we find the hydrology parameters and the HEC-1 results to be reasonable and realistic. The report explains the difference between the USGS and the estimated 100 year peak discharges for Cave Creek.

The following minor corrections need to be done to the report.

1. Page 3-32. The summary of the gaging station at Cave Creek at Spur Crossing is repeated on Page 3-33. Delete one of these paragraphs.

2. Page 3-34. The first paragraph is not clear. ".....Data from these gages are therefore, not used in this study. It should be noted that the *District's Cave Creek near Cave Creek gage* is placed at essentially the same location as the previously mentioned USGS crest-stage gage station.... Since Cave Creek near Cave Creek is the name of the gage, this name should either be set in quotes or the sentence be re-worded to make this clearer.

3. The summary table 3-11 on page 3-3 should include the referenced map subbasin ID numbers. This would make identification of specific subbasin or concentration point easier.

After these minor corrections are taken care of, the report can be considered to be approved. Please feel free to give me a phone call if you have any questions.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

9 August 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 W. Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
Contract FCD 95-28

Dear Kofi:

On 8 August 1996, Ms. Lee Abbott at Willdan Associates was contacted by Mr. Scott Ogden in an attempt to coordinate the GVSCE HEC-2 modeling efforts of Cave Creek with regard to the match point of the two studies. During that conversation, Scott requested Willdan's ending (GVSCE starting) river mile stationing and floodplain and floodway water surface elevations. Ms. Abbott informed Scott that they had just received the topographic mapping for Willdan's study reach and they were in the process of preliminary cross section identification. She also stated that they had not yet performed map verifications and still have significant work to do on watershed hydrology. Consequently, none of the information requested is available.

Currently, our sub-consultant, McLaughlin Kmetty Engineers, Ltd. (MKE) is progressing with the HEC-2 modeling of the GVSCE study reach without the benefit of the requested information. We will proceed without the information from Willdan for most of the basic floodplain and floodway analyses since the backwater impacts at our match location are probably ineffective 4 to 5 cross sections upstream, and the river mile designations are merely labels and have no effect other than editorial. We can not, however, finalize the HEC-2 models, exhibit maps, TDN report and FEMA forms until the information requested of Willdan is supplied.

It is evident from Scott's discussion with Ms. Abbott that the present status of the Willdan project will detrimentally impact our ability to complete our project according to our contractual schedule. This delay will be through no fault on our part. As a consequence, the following are likely. First, we will be forced to request a change order from the District for a time extension. Second, we will eventually have to cease work on our contract until Willdan is able to provide the information that is required. Third, we may have the burden of an incomplete project on our record for an indefinite time which is extremely undesirable in that it may preclude us from competing for future projects with the Flood Control District.

Therefore, I request a meeting with the District to discuss this matter. It is imperative that we receive a reasonable schedule from the District as to when Willdan will be able to provide the requested information.

Please coordinate a meeting time with Scott and direct any questions that you may have to him. We look forward to a resolution of this unfortunate problem.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol, PhD, PE

cc: Mr. Geza Kmetty, PE (MKE)

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
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Mary Rose Garrido Wilcox


August 19, 1996

George V. Sabol, Ph.D, PE
George V. Sabol Consulting Engineers, Inc.
7950 E. Acoma Dr., Ste. 211
Scottsdale, Arizona 85260

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**Delay caused by Downstream Reach of Wildan and Associates**

This is in response to your letter dated August 9, 1996 regarding the time lag between your delineation effort and that of the downstream reach by Wildan and Associates. This time lag may obviously delay the completion of your contract. Since this delay would occur through no fault of your Company, the District would work with you and Wildan to reduce the effect. The following points will be addressed.

1. A time extension only Change Order will be granted when this becomes necessary.

2. We have to estimate the two parameters required to keep your hydraulic modeling effort going.

   The starting water surface elevation could be approximated such that when the actual value becomes known, the revision would not affect the final product significantly.

   The cross section numbering can also be estimated and Wildan notified to adjust their numbering scheme to match your first downstream number.

3. No negative points will be assessed against your Company for any delay because of this situation.

The second issue will be resolved in a future meeting with your company, the District and Wildan and Associates. Please feel free to give me a phone call if you have any questions.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

27 August 1996

Mr. Geza E. Kmetty, PE
McLaughlin Kmetty Engineers, Ltd.
3501 N. 16th Street, Suite A
Phoenix, Arizona 85016

Subject: Cave Creek FDS
Contract FCD 95-28

Dear Geza:

In regard to our discussions today and in reference to the letter from the Flood Control District of Maricopa County dated 19 August 1996, please proceed with the project with two deviations from the contractual scope of work.

1. The first downstream cross section location will be immediately upstream of the Carefree Highway bridge. Estimate a starting water surface elevation at that section based on critical flow in the bridge section. Obtain cross section geometry from the current topographic map. Proceed with HEC-2 modeling as planned.

2. Number the section at the bridge based on your best estimate from previous FEMA mapping and proceed with analyses and mapping using that numbering system.

Please provide information regarding items 1 and 2 to Dr. Kofi Awumah, Project Manager. The District can notify Willdan of the numbering system that we are using and which Willdan is to match. Submit your floodplain and floodway analyses, accordingly, to the District for review. Please proceed such that floodplain and floodway analyses are submitted to the District by 1 October 1996.

Please call me if you have questions.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol, PhD, PE
President

Copy: Kofi Awumah, PhD, PE (FCDMC)

MKE

McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602) 248-7851

LETTER OF TRANSMITTAL

Date: 10 Sep 96 Job No.: 92-404.003

To: FCD of MC

Attention: Kofi Awumah

Re: Cave Creek
Above Carefree Highway

FCD 95-28

WE ARE SENDING YOU X ATTACHED ___ VIA deliver

| Original: | Copies | Date | Description |
|---|---|---|---|
| | 1 | Sept 1996 | 100 year floodplain (natural) delineation, 3-ring notebook plus rolled floodplain maps, and HEC-2 diskette with input files only. |

Remarks:

COPY TO Scott Ogden, GVSCE

SIGNED Frank Edward Brown

Job #
92-404.003


# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


September 12, 1996

1/2

Rec'd 12 Sep 1996 @ FCDMC offices. FB

Frank Brown
McLaughlin Kmetty Engineers, Inc.
3501 N 16th Street
Phoenix, Arizona 85016

| Post-it® Fax Note 7671 | Date 13 Sep | # of pages ▶ 2 |
|---|---|---|
| To Scott Ogden | From Frank Brown | |
| Co./Dept. | Co. | |
| Phone # | Phone # | |
| Fax # | Fax # | |

Dear Frank:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**HEC-2 Model and Map of Natural Floodplain**

I have reviewed your HEC-2 model and the floodplain map for the Cave Creek Wash floodplain study. The following are comments that need your attention.

**1. HEC-2 Model**

a). NC cards are correctly represented as reported in the Mannings' n Evaluation report.

b) QT cards. There were some QT cards that appeared in the HEC-2 model that were interpolations from Concentration Points in HEC-1 models. These should be explained using comment cards.

c) At cross section 32.48, the right overbank area is made ineffective at Station 10300 approximately. For the natural floodplain delineation, should we not consider the ineffective flow areas as well?

d) At Cross section 34.87 a house was modeled in the middle of the wash. Use comment card to explain this structure.

**2. Floodplain Map**

a) There is a tributary between Cross Sections 31.54 and 31.62 in the Right Overbank. Its floodplain is detached from the main Cave Creek Wash floodplain. Review this location and see if this has to be combined with the

main wash.

b) Cross Section 31.62, extend the ENST to the correct station on the map.

c) Cross Section 31.75, extend the ENST to the correct station on the map.

d) Cross Section 34.08, extend the SSTA to the correct station on the map.

e) Cross Section 35.36, extend the ENST to the correct station on the map.

f) Cross Section 35.54, extend the SSTA to the correct station on the map.

If you need any explanation of these comments, please call me.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

Notes taken in meeting with Kofi on 12 Sep 96, 4PM:

* We should take a field trip next week to locate residential structures in the floodplain (vs horse barns)

1. Keep with firm HEC-2, but correct floodplain on side. (at the lake @ RM 31.86)

2. on Sheet 7, use notes to refer to CH2MHILL - FEMA FIRM maps.

3. @ U/S tie-in, once FEMA approves new hyrology, change in flow rate acceptable. OK w/ Kofi as modeled - CH2MHILL Q's on their X-S, GVSCE Q's on GVS X-S.

4. Kofi stated that this was a quick review. We agreed that if he has more review comments, we will address them.

Send a copy to Scott Ogden

MKE

McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 Fax (602) 24[illegible]51

Job fi
92-404-003

September 19, 1996

1/3

GEZA E. KMETTY
RONALD C. McLAUGHLIN
LEO M. EISEL

FRANK E. BROWN

ROBERT E. CONSONI
ROBERT J. STAVER

CHARLES L. JOY
RONALD E. HAUGHT

Kofi Awumah, Ph.D., P.E.
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

**Re: Cave Creek Above Carefree Highway**
**Floodplain Delineation Study -FCD 95-28**

Dear Kofi:

We have revised the natural floodplain delineation, incorporated the floodway, and are submitting under separate cover the following:

1. The floodplain maps showing revised natural floodplain and floodway per Method 4.

2. The HEC-2 output, hard copy.

3. The HEC-2 input file on a 3.5 inch diskette.

4. The cross section plots showing natural floodplain and floodway per Method 4.

The following explains how we have addressed your review comments contained in your 12 September 1996 letter to us. The response numbers follow that of your letter.

**1. HEC-2 Model**

a. No response is needed.

b. Comment records have been added listing the name of the HEC-1 operation, and where flowrates have been interpolated.

c. At RM 32.48, the right side of the cross section truly is ineffective flow due to the Go John Canyon channel. The main purpose for a cross section at this location is to model the horse barn in the floodplain. The right end of the cross section has been realigned to end on the nearby hillside.

G:\P\92404003\WP\Review.#1

d. The structure at RM 34.87 is a shed. Comment records will be incorporated into the next version of the HEC-2 model to explain all structures that were photographed on our joint site visit the morning of 18 September 1996.

**2. Floodplain Map**

a. The right bank tributary between RM 31.54 and 31.62 does not have a separate flow rate determined for it, per Scott Ogden at GVSCE. The size of the subbasin probably is not large enough to warrant such analysis, and my recommendation is to leave the floodplain maps as they are. Throughout the project, there are several such tributaries that are a short distance from the 100-year floodplain. My guess is that the flow out of these tributaries is not significant.

b., c., d., e., and f. The starting stations or ending stations have been revised at RM 31.62, 31.75, 34.08, 35.36, and 35.54 to better reflect values found in the HEC-2 model.

In addition to your review comments, we had our own in-house review of the floodplain maps and HEC-2 model. The following changes were made to the maps and model:

**In-house Revisions:**

1. The flowrate was revised to be 31,400 cfs at RM 31.90, and 31,300 cfs at RM 31.97.

2. The contraction and expansion coefficients at RM 29.74 were revised to be 0.3 and 0.5 to reflect the floodplain constriction going into the bridge opening.

3. The floodplain narrowing at RM 34.26 was modeled with revised contraction and expansion coefficients of 0.3 and 0.5.

4. Per our agreement, the HEC-2 model containing the lake berm near RM 31.86 is used for final floodplain delineation. The floodplain, however, is mapped as if the berm is removed, in order to avoid a Zone X on top of the berm. The TDN'S technical appendix will contain the no berm HEC-2 model so that the effect of removing the berm by hard-coded GR records can be seen.

**Planned Revisions for Next Submittal:**

1. The HEC-2 model ties-in to the previous CH2MHILL model at RM 35.59, at water surface elevation 2154.4. We will verify that we are on the same datum. The final floodway model (Method 1) will tie horizontally into the CH2MHILL model by using their values for encroachment stations. If for some reason it does not tie-in vertically, we will be within the 0.5 vertical tolerance range that FEMA allows. We will truncate the HEC-2 after RM 35.59. In the Technical Appendix, we will provide a photocopy showing the

floodplain and floodway match using the CH2MHILL maps spliced onto the GVSCE maps. The floodplain maps issued for the GVSCE project will end at the presently mapped location, without any splice of the CH2MHILL mapping.

2. We will revise the line work at the note "LIMIT OF CAVE CREEK FLOODPLAIN DELINEATION" at the major tributaries previously studied for FEMA. The limit note will be placed as close as possible to the Cave Creek floodplain.

**Planned Revisions for FEMA submittal:**

1. Scope of Work Task 8.1.7 requires 2 copies of the current FIRM panels showing the proposed delineations. The District's HIS/Arc-Info department has probably digitized the floodplain and floodway for Cave Creek. Will you check with Marta Dent and provide us with an AutoCAD translation of the FIRM panels?

I wish to thank you in advance for your prompt review of this floodplain and floodway data.

Very truly yours,
McLAUGHLIN KMETTY ENGINEERS, Ltd.

Frank Edward Brown

Frank Edward Brown, P.E.
Project Engineer

c: Scott Ogden, GVSCE

G:\P\92404003\WP\Review.#1

MKE

McLaughlin Kmetty Engineers, Ltd

8501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 FAX (602) 248-78

LETTER OF TRANSMITTAL

Date: 26 Sep 96 | Job No.: 92-404.00

To: FCD of MC

Attention: Mr. Kofi Awumah

Re: Cave Creek Wash

Above Carefree Hwy

WE ARE SENDING YOU X ATTACHED ___ VIA deliver

| Original: | Copies | Date | Description |
|---|---|---|---|
| | 1 | 26 Sep 96 | Pre-Final Floodplain / Floodway Maps. |
| | 1 | - | Disk with *FW1.IH2 and *FW4.IH2 |
| | 1 | 26 Sep 96 | HEC-2 printout. |

Remarks:

Kofi, please review on a general level. If this floodway looks okay to you, these maps will become the FINAL maps. We plan on submitting the FINAL MAPS and HEC-2, profile and cross sections on 1 Oct 96. I revised the FW Method 4 in order to get the equal encroachment stations and ≤ 1.0' rise. This FW4 replaces the previous.

COPY TO Scott Ogden GVSCE

SIGNED Frank Edward Brown

— to file

# McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602)248-7702 Fax (602)248-7851

Geza E. Kmetty
Ronald C. McLaughlin
Leo M. Eisel
Halford E. Erickson
Ralph L. Toren
Terrence P. Kenyon
Richard E. McLaughlin

1/4

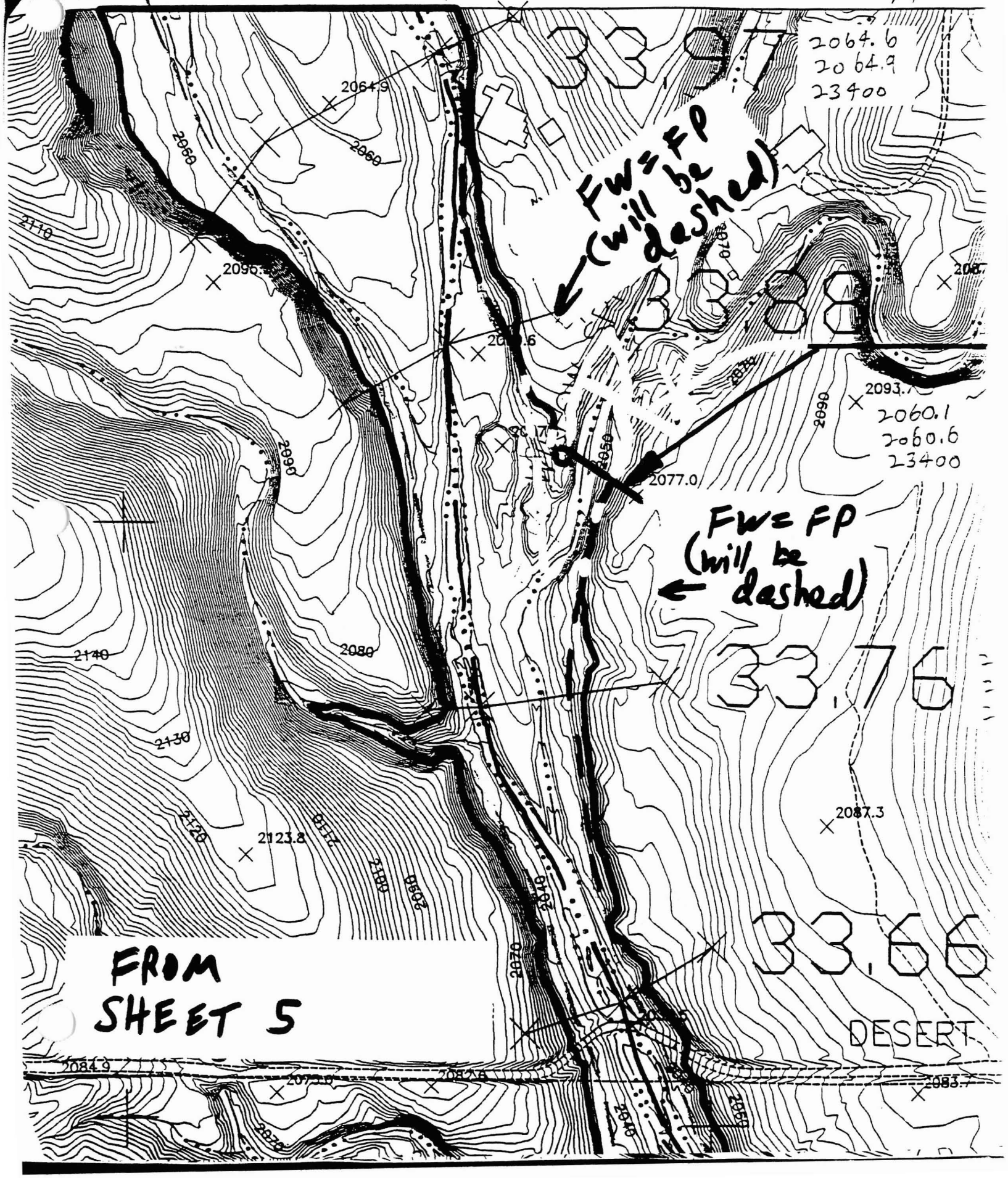
| | | |
|---|---|---|
| Date: 4 Oct 96 | Time Sent: 9:45 AM | Page 1 of 4 INCL. this page |
| From: | Frank Brown | |
| Transmitted to Fax Number: | 526-4601 | |
| To: | Kofi Awumah | |
| Company: | FCD of Mc | |
| Job # | 92-404.003 Cave Creek | |
| Comments: | | |

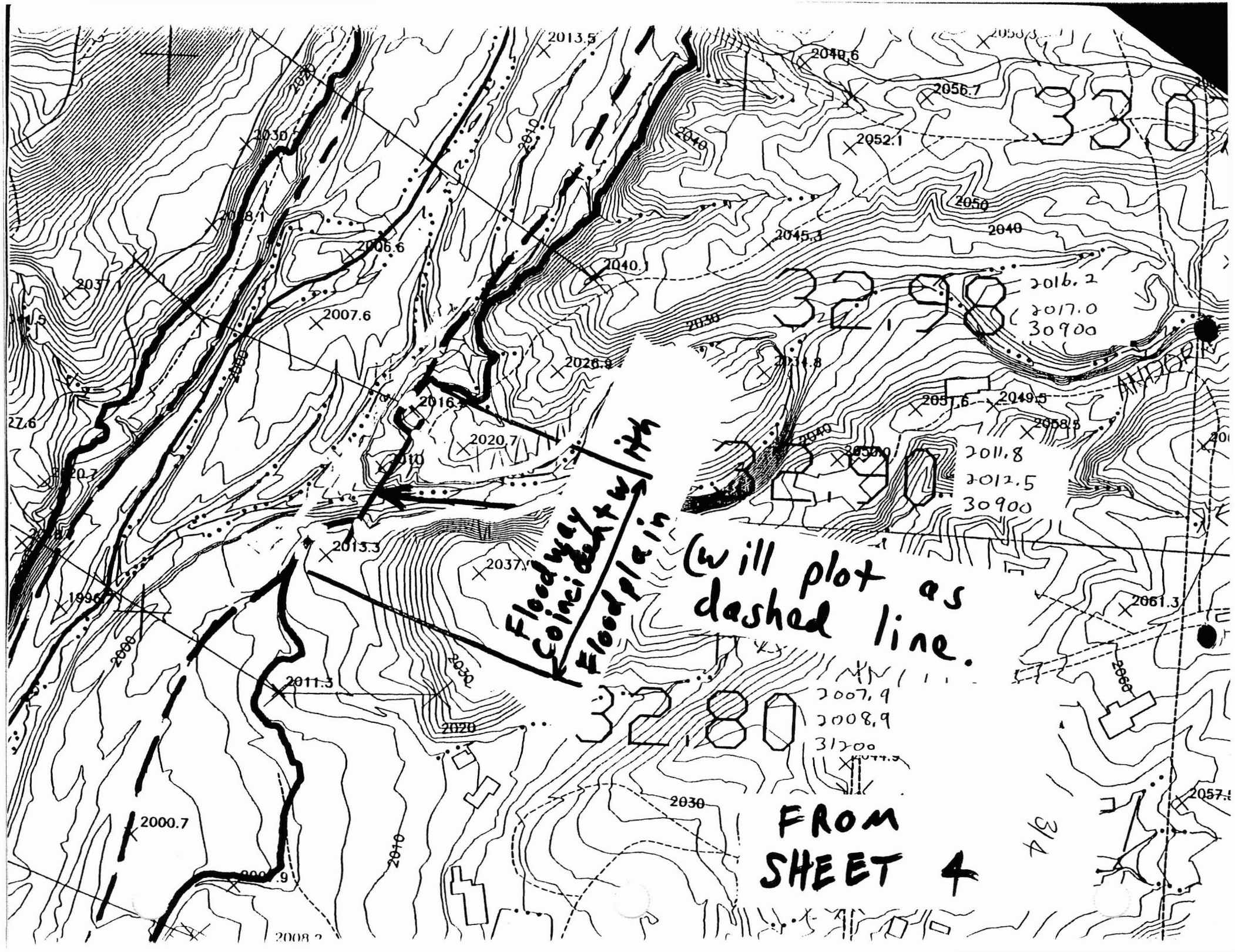
Kofi, here are the requested changes to the floodway at each of the 4 main tributaries delineated by FEMA. If any thing is hard to read, I can deliver originals to you, or I can make Final plots of these areas.

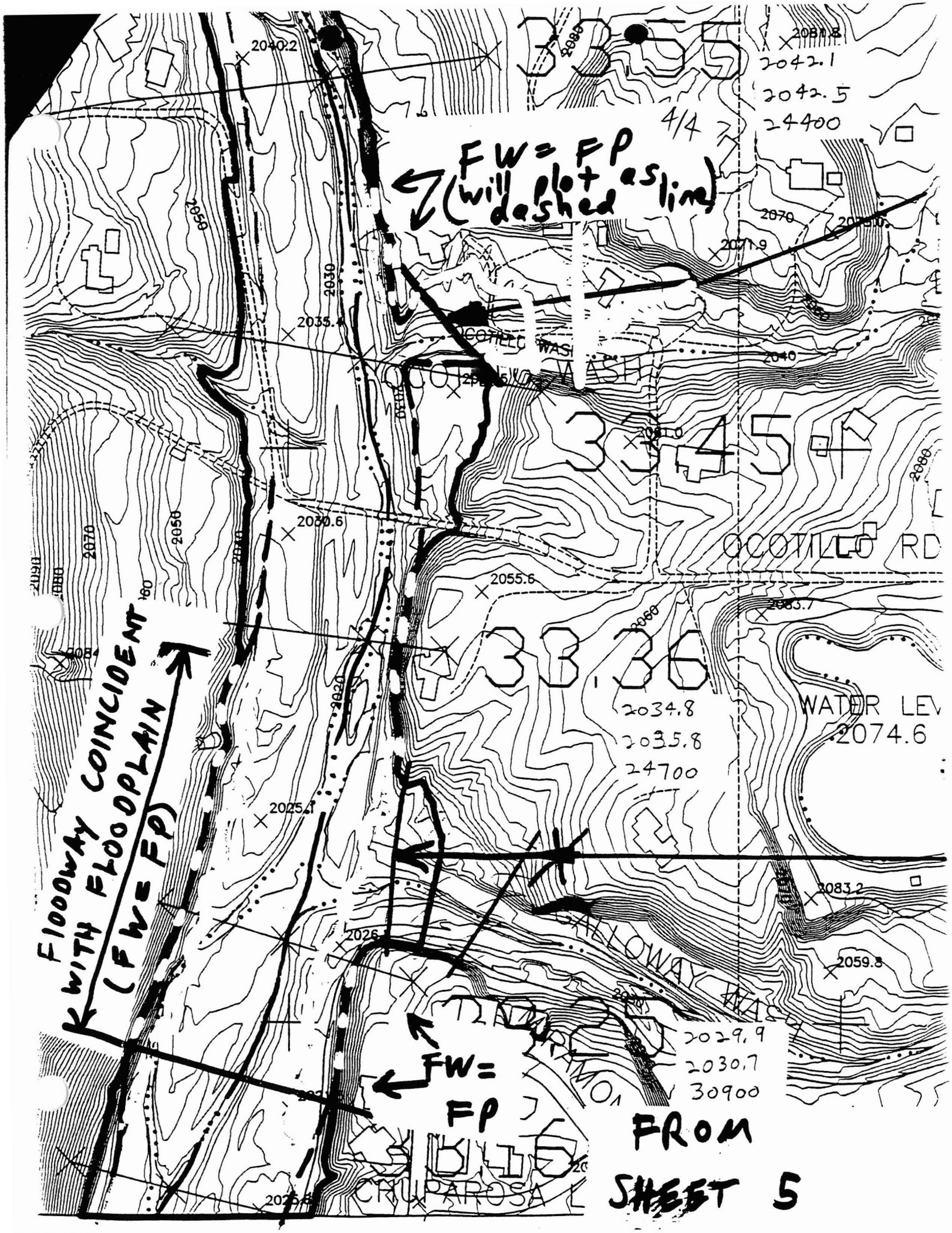
Frank

c: Mr. Scott Ogden, GVSCE, Inc

NOTE: If this transmission is incomplete, please call (602) 248-7702


33.97
2064.6
2064.9
23400
FW=FP
(will be
dashed)
2064.9
2060
2060
2110
2096.
2093.
2060.1
2060.6
23400
2077.0
FW=FP
(will be
dashed)
2140
2080
33.76
2130
2120
2123.8
2087.3
33.66
FROM
SHEET 5
DESERT
2084.9
2083.7


2013.5
2040.6
2056.7
2052.1
2050
2040
2045.3
2040.1
2006.6
2007.6
2026.9
2016.2
2017.0
30900
2051.6
2049.5
2058.5
2020.7
2011.8
2012.5
30900
2013.3
2037.9
Floodway coincident w/ Floodplain
(will plot as dashed line.
2061.3
2011.3
2007.9
2008.9
31200
2020
2030
2000.7
2010
FROM SHEET 4
2008.2


4/4
FW = FP
(will plot as dashed line)
FLOODWAY COINCIDENT WITH FLOODPLAIN (FW = FP)
FW = FP
FROM SHEET 5
OCOTILLO WASH
OCOTILLO RD
WATER LEV
2074.6
2040.2
2042.1
2042.5
24400
2071.9
2035.4
2030.6
2055.6
2034.8
2035.8
24700
2025.1
2083.2
2059.8
2029.9
2030.7
30900
2070
2050
2030
2020
2060
2080
2084

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

21 October 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
Calibration Summary Report

Dear Kofi:

Enclosed is a copy of the summary report for the calibration effort that was performed based on the December 1992 - February 1993 storm in the Cave Creek watershed. The report documents the calibration results presented by GVSCE and John Henz (Henz Meteorological Service) to the District and others on 5 June 1996. The report is for inclusion into the District's files and is supplied for information and reference purposes only. It is not our intent to include this as part of the Hydrology TDN per our previous discussions.

We trust that you will find the information and recommendations useful, and that they will facilitate the District's efforts in using the gage data currently being collected at Cave Buttes Dam and within the Cave Creek Watershed. As always, if you have any questions, please do not hesitate to call Scott Ogden or me.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol, PhD, PE

FLOOD CONTROL DISTRICT
of
Maricopa County
2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859

BOARD OF DIRECTORS
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Don Stapley
Mary Rose Garrido Wilcox

RECEIVED OCT 24 1996

1/1

October 22, 1996

Frank Brown
McLaughlin Kmetty Engineers, Inc.
3501 N 16th Street
Phoenix, Arizona 85016

Dear Frank:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28 Floodway Delineation- HEC-2 Encroachment Methods 4 and 1**

I have reviewed your HEC-2 models for the floodway delineation using encroachment methods 1 and 4. I have also reviewed the floodplain and floodway boundaries drawn on the topographic base maps.

I have found no other problems, therefore you may go ahead with plotting the final floodplain maps.

Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

28 October 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek Above Carefree Highway Floodplain Delineation Study
FCD 95-28
Survey Notes

Dear Kofi:

Enclosed are three bound copies of the complete survey notes by Alcocer Land Surveyors, Inc (ALS). Those notes include the GPS surveying performed and sealed by Project Engineering Consultants, Ltd. to bring in the NAD 1983 horizontal datum, and all traverse and level loop notes by ALS. This submittal satisfies Task 8.1.6 of the Scope of Work.

If you have any questions, please do not hesitate to call Scott Ogden or me.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

George V. Sabol, PhD, PE
President

Enclosures

**FLOOD CONTROL DISTRICT**
**OF MARICOPA COUNTY**
2801 West Durango Street
Phoenix, Arizona 85009

(602) 506-1501

# LETTER OF TRANSMITTAL

DATE 10/29/96 JOB NO.

ATTENTION Scott Ogden

RE: Cave Creek Wash

TO George V. Sabol Consulting Engrs
7950 E. Acoma Dr, Ste 211
Scottsdale AZ 85260

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ _____

| COPIES | DATE | NO. | DESCRIPTION |
|---|---|---|---|
| | 10/29/96 | 1 | Evaluation Form on Disk |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☑ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 19 _____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS Please fill out and mail a hard copy to me.
Thanks,

COPY TO _____

SIGNED: Kofi Ahmah

6910-009 R8-93

*If enclosures are not as noted, kindly notify us at once.*

SFC Engineering Company
~~George V. Sabol Consulting Engineers, Inc.~~
7950 East Acoma Drive, Suite 211
Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

# TELECOPY TRANSMITTAL

Date: 11/5/96 Time:

Send To: FAX No. FCDMC

Attn: Kofi Awumah

From: Scott Ogden

Project No./Name: 1204102 / Cave Creek Above Carefree Hwy FDS

Remarks:

Copy of memo sent to Frank at MKE

Total number pages including this Transmittal: 2

*SFC Engineering Company*

**MEMORANDUM**

**TO:** Frank Brown, PE (MKE)

**FROM:** W. Scott Ogden, ~~PE~~ (SFC) W. Scott Ogden

**DATE:** 5 November 1996

**SUBJECT:** Cave Creek Above Carefree Highway FDS
Floodway Method 1 Delineations

Per our discussion, the following are cross sections that I feel may warrant further review with the District in regard to the location of the floodway. These determinations are based on the 27 September HEC-2 model (CAVEFW1.*). Keep me apprised of any changes.

| Section ID | Comment |
|---|---|
| 30.10 | Move RFW to slope intercept and adjust LFW accordingly |
| 30.19 | Move RFW to slope intercept and adjust LFW accordingly |
| 30.27 | Move RFW to defined TOB and adjust LFW accordingly |
| 30.65 | Move RFW to defined TOB and adjust LFW accordingly |
| 30.74 | Move RFW to defined TOB and adjust LFW accordingly |
| 31.13 | Move RFW to slope intercept and adjust LFW accordingly |
| 31.16 | Move RFW to slope intercept and adjust LFW accordingly |
| 31.24 | Move RFW to slope intercept and adjust LFW accordingly |
| 31.45 | Move LFW to slope intercept and adjust RFW accordingly |
| 31.54 | Move LFW to defined TOB and adjust RFW accordingly |
| 32.69 | Move RFW to slope intercept and adjust LFW accordingly |
| 32.80 | Move RFW to slope intercept and adjust LFW accordingly |
| 33.55 | Move LFW to defined TOB and adjust RFW accordingly |
| 35.24 | Move LFW to slope intercept and adjust RFW accordingly |
| 35.27 | Move LFW to slope intercept and adjust RFW accordingly |
| 35.36 | Move LFW to slope intercept and adjust RFW accordingly |

Note: RFW - Right Floodway Line
LFW - Left Floodway Line
TOB - Top of Bank

CC: Kofi Awumah, PhD, PE (FCDMC)

MKE

# McLaughlin Kmetty Engineers, Ltd

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 Fax (602) 248-785

## MEMORANDUM

GEZA E. KMETT
RONALD C. McLAUGHLI
LEO M. EISE
FRANK E. BROW
ROBERT E. CONSOI
ROBERT J. STAVE
CHARLES L. JC
RONALD E. HAUGH

TO: W. Scott Ogden, P.E. (SFC)

FROM: Frank Brown, P.E. (MKE) Frank Edward Brown

DATE: 11 November 1996

SUBJECT: Cave Creek Above Carefree Highway FDS, Floodway Method 1 Delineations

Per discussions with Kofi in a meeting on Nov. 6th, the following changes were made to the floodway delineations. Kofi has also been advised that most cross section numbers have been revised by 0.01 according to changes in the river mile stationing. Changes will be shown on future HEC-2 analyses. The cross section IDs below have not been revised and correspond to cross section IDs in your Nov. 5th Memo. Bolded section IDs are cross sections which were not in your memo, but revised according to discussions with Kofi.

| Section ID | Comment |
|---|---|
| 30.10 | Moved RFW to floodplain intercept, LFW not adjusted |
| 30.19 | Moved RFW to floodplain intercept, LFW not adjusted |
| 30.27 | Moved RFW to floodplain intercept, LFW not adjusted |
| 30.65 | Moved RFW to floodplain intercept, LFW not adjusted |
| 30.74 | Kept as previously delineated |
| 31.13 | Kept as previously delineated |
| 31.16 | Kept as previously delineated |
| 31.24 | Kept as previously delineated |
| 31.45 | Kept as previously delineated |
| 31.54 | Kept as previously delineated |
| 32.69 | Kept as previously delineated |
| 32.80 | Kept as previously delineated |
| **32.90** | Moved LFW to floodplain intercept, RFW not adjusted |
| **33.26** | Moved LFW to floodplain intercept, RFW not adjusted |
| **33.36** | Moved LFW to floodplain intercept, RFW not adjusted |
| **33.45** | Moved LFW to match tributary, RFW not adjusted |
| 33.55 | Kept as previously delineated |
| 35.24 | Moved LFW to floodplain intercept, RFW not adjusted |
| 35.27 | Moved LFW to floodplain intercept, RFW not adjusted |
| 35.36 | Moved LFW to floodplain intercept, RFW not adjusted |

Note: RFW - Right Floodway Line LFW - Left Floodway Line

CC: Kofi Awumah, PhD, PE (FCDMC)

g:/p/92404003/wp/memo6nov.wpd

450

# McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602)248-7702 Fax (602)248-7[illegible]

Geza E. Kmetty
Ronald C. McLaughlin
Leo M. Eisel
Halford E. Erickson
Ralph L. Toren
Terrence P. Kenyon
Richard E. McLaughlin

| LETTER OF TRANSMITTAL | Date: 2/26/97 | Job No.: 92.404.003 |
|---|---|---|
| To: | Attention: Kofi Awumah | |
| FCD of MC | Re: Cave Creek | |
| | | |
| | | |
| | | |
| | | |

WE ARE SENDING YOU x ATTACHED x VIA hand delivered

| Original: | Copies | Date | Description |
|---|---|---|---|
| 1 set | | | FEMA Map Overlay: cover sheet and seven (7) sheets. 200 Scale. 24"x36" |
| 1 ea. | | | FEMA Map Overlay: one (1) sheet on vellum. 1000 Scale. 24"x36" |
| et | | 1/8/97 | Semi Rectified Aerial Photograph showing floodplain and floodways: seven (7) sheets. |
| | 1 set | 2/25/97 | FEMA Flood Profiles: six (6) sheets. 11"x17" overlay showing thalweg change. |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Remarks:

These are your originals to make as many copies as you need.

COPY TO Scott Ogden, GVSCE

SIGNED Frank Edward Ryan

SFC

4 March 1997
File: 1204102

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

**Attention:** **Dr. Kofi Awumah, P.E.**

Dear Kofi:

**Reference:** **Cave Creek Above Carefree Highway**
**FCD 95-28**
**FEMA Submittal Review Package**

Enclosed are the following documents:

- Two (2) final and sealed copies of the Hydrology TDN (Books 1 and 2) for submittal to FEMA,
- One (1) final copy of the Hydraulics TDN for review and comment, and
- One (1) set of completed FEMA forms (MT-2's) without the accompanying revised FIRM Panel, for review and comment.

It is my understanding that MKE has delivered a vellum of the FIRM Panel overlay to the District on 26 February 1997. That map is intended to be used for the FEMA submittal requirement, therefore, please review it with the FEMA forms.

With regard to the FEMA forms, the following notations are made to facilitate your review:

1. We took the liberty to fill out Form 1 to the extent possible. It is my understanding that the District will need to fill out the items on page 4 regarding the review fees and the "Revision Requestor" and "Community Official" signature blocks.

2. Please check the information filled in on Form 1, page 4 regarding the impacted communities. Do we need a letter from the Town of Cave Creek acknowledging the revision request?

3. On Form 5, Item 5a, we have marked "yes" to the question, assuming that the public meeting announcement and mailers meet this requirement. FEMA then requests letters from the affected property owners stating they have no objections. Does the District need to obtain these since the changes are minimal and no additional insurable structures have been included in the floodplain?

Upon receipt of your review comments, we will make any revisions and supply you with a full FEMA ready submittal package. We request that you return the redlined review copy of the

4 March 1997

Hydraulics TDN so that we may use as much of the unchanged material as possible in the final reports. Any redline marks or comments made in the document will be saved and returned to you with the final FEMA submittal. Thank you for your cooperation in this, and if you have any questions please do not hesitate to call.

Sincerely,

**SFC ENGINEERING COMPANY**

W. Scott Ogden

W. Scott Ogden, P.E.
Project Engineer

Enclosures

cc: Joyce Sabol, GVSCE (without enclosures)

wso/\\phxserv01\sabproj\p\1204102\word-docs\fema_rvw_trnsltr.doc

# FLOOD CONTROL DISTRICT
## of
## Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Jan Brewer
Fulton Brock
Don Stapley
Mary Rose Garrido Wilcox


March 7, 1997

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
c/o SFC Engineering Company
7776 Pointe Parkway W. Suite 290
Phoenix, AZ 85044-5403

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28 Technical Data Notebook and Floodplain Maps**

After reviewing the final report, the following are my comments that need attention.

General:

The floodplain and floodway boundaries expanded or shifted at various locations when compared to the effective maps, although the discharges reduced and the channel bed is lower for the existing conditions. This may be partly due to changes to channel bed form and configuration, and of course better topographic mapping. However, can you check the results again and see if the floodway delineation can be further optimized to reduce its width. Also investigate the possibility of adjusting the Manning's n values slightly at the southern portions of the study reach to reduce the floodplain width.

FEMA FORMS

1. FEMA Forms, MT-2 Form 1
   Page 1, Section 5, include data for Cave Creek Town as well.

2. FEMA Forms, MT-2 Form 3.
   Page 1, item 3, Approval not required by State or Federal Agency
   Page 2, item 4, fill out table on "Comparison of 100 -year Discharges
   Page 3, items 5 and 6, include 'Historical Data for flooding Source' and give gage data

TECHNICAL DATA NOTEBOOK

1.Include the FEMA forms in the TDN

2. Section 1: General Information Summary Sheet, page 3. Line 1J. delete State Reviewer

3. Section 4. Paragraph 4.4.1 . Revise text to indicate the existence of gage data, but give other explanations why no calibration was done

4. Appendix F, Section 4, line 4, correct [FEMA, 1993] to [FEMA 1995]

After these minor corrections are taken care of, the report can be considered to be approved. Please feel free to give me a phone call if you have any questions.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

McLaughlin Kmetty Engineers, L

3501 North 16th Street Phoenix, Arizona 85016-6419 (602) 248-7702 Fax (602) 248-7

March 17, 1997

GEZA E. K
RONALD C. McLAU
LEO M.

FRANK E. B

ROBERT E. CO
ROBERT J. S

RONALD E. HA

Mr. Scott Ogden
George V. Sabol Consulting Engineers, Inc.
c/o SFC Engineering Company
7776 Pointe Parkway West, Suite 290
Phoenix, Arizona 85044

**Re: Cave Creek FDS**
**FCD No. 95-29**
**MKE Job No. 92-404.003**

Dear Scott:

We have addressed the review comments contained in the District's 7 March 1997 letter addressed to you, and the comments we received at a meeting held on 11 March 1997. Our response letter follows the format of the District's letter.

General: (Floodway)

We have optimized the floodway analysis at the requested cross sections. When we limited the floodway to the FEMA Effective location, surcharges ranging from 1.1 feet to 1.5 feet were obtained.

We then relaxed the floodway to a new location that is in between the two floodways, and in some cases is exactly the same as shown in the Revised model contained in the TDN. We must point out that this new floodway is based upon unequal conveyance, meaning that property on one bank is favored over that on another bank. The Revised floodway in the TDN is based upon an Encroachment Method 4 analysis, with no further refinements made for the final Encroachment Method 1 analysis.

The FEMA 37 document *Guidelines and Specifications for Study Contractors,* January 1995, addresses the above floodway situation. In Chapter 5, "Detailed Hydraulic Analysis," B. Initial Flood Insurance Study Methodology, 2. Floodway Determination, (Page 5-3), it states "Normally, the floodway shall be determined using equal reduction of conveyance on opposite sides of the stream." Under C. Considerations for Flood Insurance Restudies, 1. Floodway Determination, (Page 5-5), FEMA 37 states "The existing floodway configuration should be retained wherever possible." and on Page 5-6 states "However, floodway revisions are justifiable and necessary if restudy data indicate an increase in surcharge above the maximum limit, or if, as a result of improved data, the width or configuration of the floodway necessitates a change from that shown on the effective map." I think too many changes have occurred in Cave Creek to justify retaining the existing floodway.

G:\P\92404003\WP\Review.#2

General: (Floodplain)

Concerning the n values, FEMA 37 states in Chapter 5, Detailed Hydraulic Analysis, C. Considerations for Flood Insurance Restudies, 1. Flood Elevation Determination, (Page 5-5), "Roughness coefficients in the model should reflect existing conditions and should be verified by field reconnaissance . . ." The n values are appropriate for the existing conditions. As requested, we investigated floodplain differences near River Mile 30.48. The following table presents the results of that investigation. The information contained in the table is taken from the flood profiles and/or the HEC-2 analysis. Care was taken to use the Corrected Effective model, which reflects the results of the datum change documented in the TDN.

Comparison Table of Revised Model to Effective Model at River Mile 30.475

| | Effective | Revised | Difference: |
|---|---|---|---|
| Bed Elevation | 1890.2 | 1891.9 | 1.7 feet higher today |
| Water Surface | 1900.0 | 1902.0 | 2.0 feet higher today |
| Flow Rate, cfs | 35,900 | 33,800 | 2,100 cfs lower today |
| n value, Left Overbank | 0.050 | 0.055 | 0.005 higher today |
| n value, Main Channel | 0.042 | 0.050 | 0.008 higher today |
| n value, Right Overbank | 0.050 | 0.055 | 0.005 higher today |

As stated in the FEMA forms, this is a complete restudy of the wash. Many changes have occurred over the last twenty years. The 1.7 foot rise in the bed elevation seems to have the most impact to the higher water surface today. This is a substantial topographic change that is reelected in the revised flood elevation. I think the floodplain shown with this study is appropriate.

FEMA FORMS

1. and 2. As agreed, we provided you with the WordPerfect files for you to make the minor revisions to the FEMA forms.

TECHNICAL DATA NOTEBOOK

1. We will provide a tab for you to insert the contents of Appendix H.

2. GVSCE will address this comment.

3. Revision to the text is not necessary since it is a true statement. GVSCE will investigate Kofi's comment on the yellow tag.

4. We will revise the text as requested.

Clear direction is needed concerning revisions to the floodway. Please call me to advise.

Very truly yours,
McLAUGHLIN KMETTY ENGINEERS, Ltd.

Frank Edward Brown

Frank Edward Brown, P.E.
Project Manager

G:\P\92404003\WP\Review.#2

SFC

# FAX TRANSMITTAL

| | | | |
|---|---|---|---|
| **To:** | FCDMC | **Fax No.** | 506-4601 |
| **Attention:** | Dr. Kofi Awumah, P.E. | **Date:** | 21 March 1997 |
| **Reference:** | **CAVE CREEK ABOVE CAREFREE HIGHWAY FDS - FLOODWAY REVISIONS FILE: 1204102** | 4 page(s) total including cover sheet. Original will **NOT** follow by mail. | |
| **Sender:** | W. Scott Ogden | | |

The content of this Fax Transmittal is Confidential. If the reader is not the intended recipient or its agent, be advised that any dissemination, distribution, or copying of the content of this Transmittal is prohibited. If you have received this Transmittal in error, please notify the sender immediately and return the original to us by mail at our expense. Thank you.

MESSAGE:

The following is MKE's response letter addressing the review comments contained in your letter dated 7 March 1997. Please review these and we will discuss them at our meeting on Monday (24 March). Frank will also have a redlined set of the 200-scale workmaps to show the resultant floodway alignments.

Also, I would like to reschedule our 11:00 am meeting to 1:30 pm if possible. Please call to confirm.

Thanks Kofi

W. Scott Ogden

W. Scott Ogden, P.E.
Project Engineer

Attachment

cc:

wso/k:\p\1204102\word-docs\kofi_fax.doc

SFC Engineering Company 7776 Pointe Parkway West Phoenix AZ 85044 Ph: (602) 438-2200 Fax: (602) 431-9562

SFC

4 April 1997
File: 1204102

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

**Attention:** **Dr. Kofi Awumah, P.E.**

Dear Kofi:

**Reference:** **Cave Creek Above Carefree Highway**
**FCD 95-28**
**FEMA Submittal Package**

Enclosed are the following documents:

- Two (2) final and sealed copies of the Hydraulics TDN for submittal to FEMA. One copy has the floodplain delineation maps folded and included in map pockets. The other copy has map pockets provided, but the maps are submitted rolled per your request.
- Two (2) sets of completed FEMA forms (MT-2's) with accompanying FIRM Panel overlay maps folded and inserted in pockets.
- One (1) vellum FIRM Panel overlay map (rolled).
- One (1) copy of the Digital Terrain Model (DTM) per District specifications on QIC80 format tape.
- Corrected abstract inserts for the Hydrology TDNs previously delivered.
- Returned copy of Willdan's TDN.

Please call if we can be of further assistance in making the FEMA submittal.

Sincerely,

**SFC ENGINEERING COMPANY**

W. Scott Ogden

W. Scott Ogden, P.E.
Project Engineer

Enclosures

cc: Joyce Sabol, GVSCE (without enclosures)

# McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602)248-7702 Fax (602)248-7851

Geza E. Kmetty
Ronald C. McLaughlin
Leo M. Eisel
Halford E. Erickson
Ralph L. Toren
Terrence P. Kenyon
Richard E. McLaughlin


| LETTER OF TRANSMITTAL | Date: 04-15-97 | Job No.: 92-404.003 |
|---|---|---|
| To: George V. Sabol Engineering Co., Inc. | Attention: W. Scott Ogden | |
| c/o SFC Engineering Company | Re: Cave Creek Wash Above Highway | |
| Southwest Regional Office | | |
| 7776 Pointe Parkway West, Suite 290 | | |
| Phoenix, Arizona 85044 | | |
| | | |

WE ARE SENDING YOU X ATTACHED X VIA Pick up or Hand Delivery

| Original: | Copies | Date | Description |
|---|---|---|---|
| 8 | | 01-12-96 | 9" x 9" Photographs, 1:8000, 95143, 1 (1-8) |
| 8 | | 01-12-96 | 9" x 9" Photographs, 1:8000, 95143, 2 (1-8) |
| 7 | | 12-05-96 & | |
| | | 01-08-97 | 9"x 9" Photographs, 1:10500, 95143, 1-7 Spots |
| | | | Cave Creek Wash Above Highway photographs for semi-rectified aerial |
| | | | photo sheets |
| | | | |

Remarks:

COPY TO

SIGNED Frank Edward Brown

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
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Mary Rose Garrido Wilcox


April 15, 1997

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
c/o SFC Engineering Company
7776 Pointe Parkway W., Suite 290
Phoenix, Arizona 85044

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**Digital Terrain Model - AMC Inc.**

The HIS department has the following comments for the DTM tape you submitted as part of the required submittal.

1. We could not copy off any files from the submitted tape. The error is unrecognizable data.

2. In looking at the transmittal sent along with the tape, the files sent would not pass the review . You are required to use DTM Specs 1.0. We are currently using DTM Specs 1.1, which is easier. You may therefore choose either specs version.

3. The PRJ_RID number for this project will be 1028. You will need this number to name the files correctly.

I have enclosed a copy of the DTM Specs Version 1.1 for your use. Please forward the comments to AMC for the necessary revision and re-submittal.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



APR 1997

BOARD OF DIRECTORS
Betsey Bayless
Jan Brewer
Fulton Brock
Don Stapley
Mary Rose Garrido Wilcox


April 16, 1997

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
c/o SFC Engineering Company
7776 Pointe Parkway W., Suite 290
Phoenix, Arizona 85044

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28**
**H.I.S Conversion**

This is to notify you to commence work on the H.I.S conversion tasks contained in the Scope of Works for this contract. Contrary to the original schedule of performing this task after FEMA review and approval, the District would prefer that this work be done now so as to end this contract quickly. If any changes should become necessary after the completion of your contract, it would be the responsibility of Flood Control District.

I have enclosed a summary sheet of the latest revision to the HIS Specifications. The original Scope of Work called for Version 2.0 of the Specifications but we now have Version 2.1. This latest version is easier to use and you have the option of using either of them. You may request a copy of the new specs.If you need to discuss any items on the specs, please call so that we can set up a meeting with our G.I.S Department as soon as possible.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

# GIS COVERAGES

His Data:

Digital data will be prepared in conformance with the district's HIS data Delivery Specifications, Rev 2.1 from Feb.14 1996 for the following themes:

| Name | Page No. | Description |
|---|---|---|
| NDXPRJ | LP-40 | Shows the map sheet boundaries of the project. |
| PRJ | LP-60 | Defines the boundary of the project |
| CARTO | LP-110 | Planimetric features captured but not used by HIS. (Fences, tree lines, etc)(If any) |
| CORNERS | LP-210 | Section corners as defined by the PLSS.(Public land surcey System) |
| CTRL | LP-215 | Other control points that are not corners |
| AGRCLTR | LP-305 | Dairy and Agricultural Areas |
| STRCT | LP-360 | Structures like building footprints, culverts, bridges. (If any) |
| DQ | LP-410 | Data Quality of Data: Scale, date, Vertical Datum, Projection |
| PRJ.REL | LP-430 | Contractor name, Project Name, Project Id |
| FPBLN | LP-520 | Floodway center line |
| FPCTLFCD | LP-523 | Elevation Reference Marks |
| FPSRFFCD | LP-535 | Surface Water Elevation |
| FPXFCD | LP-540 | Cross sections used in Hec 2 |
| FPZNFCD | LP-550 | Floodplain Zones |
| FPZNHZ | LP-560 | Floodplain Hazard Zones |
| CNL | LP-610 | Canals (If any) |
| FLTY | LP-620 | FCD Project in the area. (If any) |
| RR | LP-650 | Railroads in the area. (If any) |
| STRTCLN | LP-655 | Street Centerlines |
| STRTDTL | LP-660 | Edge of Pavement (if any) |
| UTLTY | LP-670 | Utilities, Power poles, etc (If any) |
| ELV | LP-710 | Contours and spot elevations |
| VEG | LP-775 | Areas of similar vegetative mix |
| DRNBSN | LP-920 | Drainage basins |
| DRNPTH | LP-930 | Drainage Path |
| LAKE | LP-950 | Lakes are in the area (If any) |
| RIVER | LP-960 | Washes or streams in the area. (If any) |

This is a comprehensive listing of possible features. If there are no features collected under one of the categories mentioned, then the theme does not need to be delivered.

Mapping should be done according to the DTM manual: "Digital Terrain Model Mapping - Data Collection & Delivery Specifications" Rev 1.0 / May 1994. This book is available at the front desk.

SFC

18 April 1997
File: 1204102

Aerial Mapping Company, Inc.
3141 West Clarendon Avenue
Phoenix, Arizona 85017

**Attention: Mr. Robert Parks**

Dear Bob:

**Reference: Cave Creek Above Carefree Highway FDS**
**FCD 95-28**
**DTM Delivery and H.I.S. Conversion**

I have received two (2) letters from Dr. Kofi Awumah, our project manager at FCDMC, regarding the subject project. Copies of both letters are attached hereto for your reference.

The first letter dated 15 April 1997 is the response comments by the HIS department regarding the DTM data that was submitted with the FEMA package. I created a copy of the tape you supplied and delivered it to the District. Apparently the information provided is not what they are expecting. I suspect that part of the problem was with the tape we supplied, as it was written by a Jumbo drive (3020) on a QIC-80 tape. That is probably the reason why FCDMC could not copy off any of the files (See comment 1). I did, however, supply a hard copy of the README.DOC file and according to comments 2 and 3, it appears that the files were not what FCDMC expects. Please respond to comments 2 and 3 and either inform me that the data you submitted is correct or supply the revised data. With regard to comment 1, I will make sure that the data is submitted to FCDMC is in the correct format and readable. I will leave it to your discretion as to which version of DTM specifications you want to use (see letter). I only ask that you inform me of your decision.

The second letter dated 16 April 1997 authorizes us to commence work on the H.I.S. conversions as outlined in Task 7 of the Scope of Work, even though we as yet do not have FEMA approval. As you may or may not know, our contract with FCDMC expires 30 June 1997, therefore, we need to have the conversions completed and approved by the HIS Department and the final submittal to Kofi by no later than 16 May 1997. Any further delay will jeopardize the on time completion of the contract. In this regard, please call me when you receive this letter so that we may discuss scheduling and data requirements, as well as any needs regarding meeting with the HIS department at FCDMC or the use of either Version 2.0 and 2.1.

18 April 1997

By copy of this letter, I am also informing Mr. Frank Bown of MKE about this information to make him aware that coordination will be required as far as delivering the digital files for the floodplain maps. I look forward to wrapping this project up and I thank you in advance for your attention to this matter. Please call me when you receive this letter so that we may discuss these items further.

Sincerely,

**SFC ENGINEERING COMPANY**

W. Scott Ogden

W. Scott Ogden, P.E.
Project Engineer

cc: Joyce Sabol (GVSCE)
Frank Brown, P.E. (MKE)
Kofi Awumah, Ph.D., P.E. (FCDMC) (without attachments)

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# McLaughlin Kmetty Engineers, Ltd.

3501 North 16th Street Phoenix, Arizona 85016-6419 (602)248-7702 Fax (602)248-7

Geza E. Kmetty
Ronald C. McLaughlin
Leo M. Eisel
Halford E. Erickson
Ralph L. Toren
Terrence P. Kenyon
Richard E. McLaughlin


| LETTER OF TRANSMITTAL | Date: 04-23-97 | Job No.: 92-404.003 |
|---|---|---|
| To: Flood Control District of Maricopa County | Attention: Mr. Kofi Awumah, Ph.D., P.E. | |
| 2801 West Durango Street | Re: Cave Creek Above Carefree Delineation Study | |
| Phoenix, Arizona 85009-6399 | FCD No. 95-28 | |
| | | |
| | | |
| | | |

WE ARE SENDING YOU X ATTACHED ___ VIA_____

| Original: | Copies | Date | Description |
|---|---|---|---|
| | 3 | | Updated Survey Field Notes from Alcocer Land Surveyors |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Remarks:

COPY TO W. Scott Ogden, SFC

SIGNED Geza Kmetty

SFC

21 April 1997
File: 1204102

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

**Attention:** **Dr. Kofi Awumah, P.E.**

Dear Kofi:

**Reference:** **Cave Creek Above Carefree Highway FDS**
**FCD 95-28**
**Stereo Photography 9"x 9" Contact Prints**

Enclosed, please find the following:

- One (1) set of original 9"x 9" stereo photographs (2 flight paths, 8 prints each) sequentially numbered and cataloged,
- One (1) set of original 9"x 9" spot aerial photography used for generation of semi-rectified orthophotos, and
- One (1) copy of a map referencing the flight paths.

This submittal satisfies Task 8.2.4 of the Scope of Work. If you have any questions or require further information, please do not hesitate to call.

Sincerely,

**SFC ENGINEERING COMPANY**

W. Scott Ogden

W. Scott Ogden, P.E.
Project Engineer

Enclosures

cc: Joyce Sabol, GVSCE (without enclosures)

**wso/k:\p\1204102\word-docs\9x9_photos_trnsltr.doc**

SFC

# FAX TRANSMITTAL

| | | | |
|---|---|---|---|
| **To:** | FCDMC | **Fax No.** | 506-4601 |
| **Attention:** | Dr. Kofi Awumah, P.E. | **Date:** | 14 May 1997 |
| **Reference:** | **CAVE CREEK ABOVE CAREFREE HIGHWAY FDS FILE: 28900031** | 1 page(s) total including cover sheet. Original will **NOT** follow by mail. | |
| **Sender:** | W. Scott Ogden | | |

The content of this Fax Transmittal is Confidential. If the reader is not the intended recipient or its agent, be advised that any dissemination, distribution, or copying of the content of this Transmittal is prohibited. If you have received this Transmittal in error, please notify the sender immediately and return the original to us by mail at our expense. Thank you.

MESSAGE:

George received a call from a Mr. Mike Conaboy of Michael Baker Jr., Inc. in Princeton, NJ on 14 May 1997, regarding our Cave Creek FEMA submittal. Apparently the Hydraulics TDN sent to him did not have the folded 24"x 36" (full size) floodplain and floodway maps in it. If you remember, one of the two copies we submitted to you had folded maps included in the folders and the other copy was delivered with the maps in a separate roll per your request. I am speculating that the wrong copy was sent to FEMA. Please send the folded (or rolled..your choice) set of maps from the other TDN to:

Michael Baker Jr., Inc.
Attn: Sheila Norlin
3601 Eisenhower Ave
Suite 600
Alexandria, Virginia 22304

Apparently, Mr. Conaboy was just starting to look the package over, so.....we'll see.

Thanks Kofi

W. Scott Ogden

W. Scott Ogden, P.E.
Project Engineer

wso/p:\sabproj\p\1204102\word-docs\kofi_fax.doc

SFC Engineering Company 7776 Pointe Parkway West Phoenix AZ 85044 Ph: (602) 438-2200 Fax: (602) 431-9562

# FLOOD CONTROL DISTRICT
## of
## Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTORS
Betsey Bayless
Jan Brewer
Fulton Brock
Don Stapley
Mary Rose Garrido Wilcox


February 7, 1997

Scott Ogden, Project Manager
George V. Sabol Consulting Engineers, Inc.
c/o SFC Engineering Company
7776 Pointe Parkway W., Suite 290
Phoenix, Arizona 85044

Dear Scott:

**SUBJECT: Cave Creek Above Carefree Floodplain Delineation Study - FCD 95-28 Resumption of Work**

This is to inform you that Wildan and Associates have progressed enough in their delineation of the downstream segment of the Cave Creek to permit you to finalized your work. You may therefore notify McLaughlin Kmetty Engineers to resume their portion of the Study. I have informed Wildan and Associates to end their delineation at Cross Section 30.2 , therefore your portion of the work starts at this location with their water surface elevation becoming your starting water surface elevation.

Please finalize the Technical Data Notebooks and incorporate the necessary changes for my final review. Also prepare the FEMA forms and the FEMA FIRM Panels with the effective floodplain boundaries overlaid with your new boundaries.

Also, we are in the process of planning a Public Meeting to present the results of the study to the property owners affected. We are looking at end of February to first week of March time frame and I will let you inform you as soon as the date is finalized,

Please feel free to give me a phone call if you have any questions.

Yours Sincerely,

Kofi Awumah

Kofi Awumah, Ph.D., P.E.
Project Manager

# 1.3.4 FEMA REGIONAL OFFICES

# 1.3.5 FEMA WASHINGTON

# Federal Emergency Management Agency

Washington, D.C. 20472

April 25, 1997

Kofi Awumah, Ph.D., P.E.
Engineering Division
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

IN REPLY REFER TO:
Case No.: 97-09-706P
Communities: Town of Cave Creek, City of Phoenix, and Maricopa County, Arizona
Community Nos.: 040129, 040051, and 040037

316-ACK.FEX

Dear Dr. Awumah:

This responds to your request dated April 15, 1997, that the Federal Emergency Management Agency (FEMA) issue a revision to the Flood Insurance Rate Map (FIRM) for Maricopa County, Arizona and Incorporated Areas, which is the effective FIRM for the above-referenced communities. Pertinent information about the request is listed below.

| | |
|---|---|
| Identifier: | Cave Creek above and below Carefree Highway |
| Flooding Source: | Cave Creek |
| FIRM Panel(s) Affected: | 04013C0795 F, 0802 F, 0805 F, 0815 G, and 1210 E |

As you may know, FEMA has implemented a procedure to recover costs associated with reviewing and processing requests for modifications to published flood information and maps. However, because your request is based on a detailed hydrologic or hydraulic study conducted by a Federal, State, or local agency to replace an approximate study conducted by FEMA, no fees will be assessed for our review.

We have completed an inventory of the items you submitted. We have received the required data to begin a detailed technical review of your request. If additional data are required, we will inform you within 30 days of the date of this letter.

Please direct all questions concerning your request to our Technical Evaluation Contractor at the following address:

Michael Baker Jr., Inc.
3601 Eisenhower Avenue, Suite 600
Alexandria, Virginia 22304

Attention: Mr. Massoud Rezakhani
(703) 317-6239

When you write us about your request, you must include the case number referenced above in your letter.

# Federal Emergency Management Agency

Washington, D.C. 20472

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 97-09-706P

The Honorable Don Stapley
Chairman, Maricopa County Board of Supervisors
301 West Jefferson Street
Phoenix, Arizona 85003

Community: Maricopa County, Arizona
Community No.: 040037
Panels Affected: 04013C0414 E, 0415 E, 0805 F, and 0815 G
Effective Date of This Revision: AUG 0 5 1997

102-I-A-C

Dear Mr. Stapley:

This responds to a request that the Federal Emergency Management Agency (FEMA) revise the effective Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) report for Maricopa County, Arizona and
the effective FIRM and FIS report for your community), in accordance with Part 65 of
Insurance Program (NFIP) regulations. In a letter dated April 15, 1997, Mr. Kofi
E., Engineering Division, Flood Control District of Maricopa County, requested that
RM and FIS report to show the effects of revised hydrologic and hydraulic analyses and
aphic information along Cave Creek Wash from Cave Buttes Dam to Morning Star Road.

:omplete our review of this request were submitted with Mr. Awumah's letter. Because
:evision (LOMR) is based on a detailed hydrologic or hydraulic study conducted by a
:al agency to replace an approximate study conducted by FEMA, fees were not assessed

ıur review of the submitted data and the flood data shown on the effective FIRM and FIS
sed the FIRM and FIS report to modify the elevations, floodplain and floodway boundary
: designations of the flood having a 1-percent chance of being equaled or exceeded in any
d) along Cave Creek Wash. As a result of the modifications, the base flood elevations
:k Wash increased in some areas and decreased in other areas; the width of the Special
SFHA), the area that would be inundated by the base flood, increased in some areas and
:as; and the width of the regulatory floodway increased in some areas and decreased in
Panels 71P, 387P, 388P, and 389P in the effective FIS report have been deleted. The
own on the enclosed copies of FIRM Panels 04013C0414 E, 04013C0415 E, and
ıted December 3, 1993, and 04013C0815 G dated September 30, 1995; Profile Panels
gh 878P; and affected portions of the Summary of Discharges Table and Floodway Data
hereby revises the above-referenced panels of the effective FIRM and the affected
:port dated September 30, 1995.

request also affects the Town of Cave Creek and the City of Phoenix, separate LOMRs
s were issued on the same date as this LOMR.

effective as of the date shown above. The map panels as listed above and as modified
ısed for all flood insurance policies and renewals issued for your community.

Incorporated Areas (
the National Flood
Awumah, Ph.D., P.
FEMA revise the FI
more detailed topogr.

All data required to
this Letter of Map F
Federal, State, or loc
for the review.

We have completed
report. We have revi
delineations, and zon
given year (base floo
(BFEs) for Cave Cre
Flood Hazard Area (
decreased in other ar
other areas. Profile
modifications are sh
04013C0805 F, all da
870P and 875P throu
Table. This LOMR
portions of the FIS r

Because this revision
for those communitie

The modifications are
by this letter will be

CHANGES ARE MADE IN DETERMINATIONS OF BASE FLOOD ELEVATIONS FOR THE TOWN OF CAVE CREEK, THE CITY OF PHOENIX, AND THE UNINCORPORATED AREAS OF MARICOPA COUNTY, ARIZONA, UNDER THE NATIONAL FLOOD INSURANCE PROGRAM

On September 30, 1995, the Federal Emergency Management Agency identified Special Flood Hazard Areas (SFHAs) in the Town of Cave Creek, the City of Phoenix, and the unincorporated areas of Maricopa County, Arizona, through issuance of a Flood Insurance Rate Map (FIRM). The Mitigation Directorate has determined that modification of the elevations of the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood) for certain locations in these communities is appropriate. The modified base flood elevations (BFEs) revise the FIRM for the communities.

The changes are being made pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (Public Law 93-234) and are in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, Public Law 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65.

A hydraulic analysis was performed to incorporate revised hydrologic analyses and more detailed topographic information and has resulted in a revised delineation of the regulatory floodway and SFHA boundaries and revised BFEs for Cave Creek Wash from Cave Buttes Dam to Morning Star Road. The table below indicates existing and modified BFEs for selected locations along the affected lengths of the flooding source(s) cited above.

| Location | Existing BFE (feet)* | Modified BFE (feet)* |
|---|---|---|
| Approximately 3,000 feet upstream of Cave Buttes Dam | None[1] | 1,660[1] |
| At Carefree Highway | 1,869[2] | 1,866[2] |
| Approximately 300 feet upstream of Cahava Ranch Road | 2,137[3] | 2,138[3] |
| Approximately 1,700 feet upstream of Cahava Ranch Road | 2,149[4] | 2,151[4] |

[1]Within the unincorporated areas of Maricopa County
[2]Within the Town of Cave Creek and the unincorporated areas of Maricopa County
[3]Within the Town of Cave Creek and the City of Phoenix
[4]Within the City of Phoenix

*National Geodetic Vertical Datum, rounded to nearest whole foot

Under the above-mentioned Acts of 1968 and 1973, the Mitigation Directorate must develop criteria for floodplain management. To participate in the National Flood Insurance Program (NFIP), the community must use the modified BFEs to administer the floodplain management measures of the NFIP. These modified BFEs will also be used to calculate the appropriate flood insurance premium rates for new buildings and their contents and for the second layer of insurance on existing buildings and contents.

Upon the second publication of notice of these changes in this newspaper, any person has 90 days in which he or she can request, through the Chief Executive Officer of the community, that the Mitigation Directorate reconsider the determination. Any request for reconsideration must be based on knowledge of changed conditions or new scientific or technical data. All interested parties are on notice that until the 90-day period elapses, the Mitigation Directorate's determination to modify the BFEs may itself be changed.

exceed minimum NFIP criteria. These criteria are the minimum and do not supersede any State or local requirements of a more stringent nature. This includes adoption of the effective FIRM to which the regulations apply and the modifications described in this LOMR. Our records show that your community has met this requirement.

A Consultation Coordination Officer (CCO) has been designated to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Dorothy M. Lacey
Director, Mitigation Division
Federal Emergency Management Agency, Region IX
The Presidio of San Francisco, Building 105
San Francisco, California 94129-1250
(415) 923-7177

If you have any questions regarding floodplain management regulations for your community or the NFIP in general, please contact the CCO for your community at the telephone number cited above. If you have any technical questions regarding this LOMR, please contact Mr. John Magnotti of our staff in Washington, DC, either by telephone at (202) 646-3932 or by facsimile at (202) 646-4596.

Sincerely,

For Frederick H. Sharrocks, Jr., Chief
Hazard Identification Branch
Mitigation Directorate

Enclosures

cc: The Honorable Tom Aukerton
Mayor, Town of Cave Creek

The Honorable Skip Rimsza
Mayor, City of Phoenix

Mr. Kofi Awumah, Ph.D., P.E.
Engineering Division
Flood Control District of Maricopa County

Mr. George V. Sabol, Ph.D., P.E.
George V. Sabol Consulting Engineers, Inc.

Ms. Eileen Abbott, P.E.
Willdan Associates

# 1.3.6 FEMA TECHNICAL CONSULTANT

# 1.3.7 COPY OF PUBLIC NOTICES

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211
Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

# TELECOPY TRANSMITTAL

**Date:** 3 January 1996 **Time:** _____

**Send To:** **FAX No.** 506-4601

Kofi Awumah

**From:** Scott Ogden

**Project No./Name:** 84 / Cave Creek FDS

**Remarks:** Here is a copy of the legal advertisement that will be placed in the newspapers per Task 1.5 of the Scope of Work. We will run this add unless I here something different from you by Noon 4 January 1996.

Thanks

**Total number pages including this Transmittal:** 2

## ANNOUNCEMENT OF FLOOD HAZARD STUDY

The Flood Control District of Maricopa County, under authority of the National Flood Insurance Act of 1968 (P.L. 90-448), as amended, and the Flood Disaster Protection Act of 1973 (P.L. 93-234), is funding a detailed study of flood hazard areas near the community of Cave Creek, Arizona, along a 5.5 river mile reach of Cave Creek bordered by Morning Star Road on the north and Carefree Highway on the south. The study is being performed for the Flood Control District by George V. Sabol Consulting Engineers.

The purpose of this study is to examine and evaluate flood hazard areas which are developed or which are likely to be developed and to determine flood elevations for those areas. Flood elevations will be used by Maricopa County to carry out floodplain management objectives of the National Flood Insurance Program. They will also be used as the basis for determining appropriate flood insurance premium rates applicable for buildings and their contents.

This announcement is intended to notify all interested persons of the commencement of this study so that they may have an opportunity to bring any relevant facts and technical data concerning local flood hazards to the attention of the Flood Control District for consideration in the course of this study. Such information should be addressed to Mr. Kofi Awumah or Ms. Valerie Swick, Flood Control District of Maricopa County, 2801 W. Durango Street, Phoenix, Arizona 85009, telephone (602) 506-1501.

Published: Arizona Republic, January 1996

*George V. Sabol Consulting Engineers, Inc.*
7950 East Acoma Drive, Suite 211, Scottsdale, Arizona 85260-6962
(602) 483-3368 FAX (602) 483-3990

19 February 1996

Kofi Awumah, PhD, PE
Flood Control District of Maricopa County
2801 West Durango
Phoenix, AZ 85009

Subject: Cave Creek FDS - Affidavits of Publication

Dear Kofi:

As required in Task 1, item 1.5 of Contract FCD 95-28, we are enclosing the original affidavits of publication announcing the commencement of the flood hazard study near the community of Cave Creek.

Please contact me if you have questions.

Sincerely yours,
George V. Sabol Consulting Engineers, Inc.

W. Scott Ogden

W. Scott Ogden, PE

Enclosures: Affidavits from Arizona Business Gazette and Tribune

AFFIDAVIT OF PUBLICATION

FLOOD HAZARD STUDY CAVE CREEK

19

# ARIZONA BUSINESS GAZETTE

P.O. Box 1950
Phoenix, Arizona 85001
(602) 271-7300

STATE OF ARIZONA
COUNTY OF MARICOPA } SS.

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

ARIZONA BUSINESS GAZETTE

2/ 1/1996
2/ 8/1996

Tom Bianco

Sworn to before me this
EIGHTH day of
FEBRUARY A.D. 19 96

OFFICIAL SEAL
MARY LEE BOOHER
Notary Public - State of Arizona
MARICOPA COUNTY
My Comm. Expires March 17, 1999

Mary Lee Booher
Notary Public

**ANNOUNCEMENT OF FLOOD HAZARD STUDY**

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Published: February 1, 8, 1996

**Tribune**
NEWSPAPERS

P.O. BOX 1547 • MESA, ARIZONA 85211

P.O. Number: _____

Invoice Number: 851850

STATE OF ARIZONA
County of Maricopa

I, MARIE GERZ, Legal Clerk, acknowledge that the attached hereto was published in a newspaper of general circulation at Mesa, Arizona, County of Maricopa on the following dates:

01/10,17 1996

S

M-Mesa T-Tempe C-Chandler G-Gilbert S-Scottsdale

LEGAL CLERK

Subscribed and sworn to before me this date: 17 JAN 96

NOTARY PUBLIC

OFFICIAL SEAL
JULIE P. NICEL
NOTARY PUBLIC-ARIZONA
MARICOPA COUNTY
My Comm. Expires July 27, 1999

## AFFIDAVIT OF PUBLICATION

**ANNOUNCEMENT OF FLOOD HAZARD STUDY**

The Flood Control District of Maricopa County, under authority of the National Flood Insurance Act of 1968 (P.L. 90-448), as amended, and the Flood Disaster Protection Act of 1973 (P.L. 93-234), is funding a detailed study of flood hazard areas near the community of Cave Creek, Arizona, along a 5.5 river mile reach of Cave Creek bordered by Morning Star Road on the north and Carefree Highway on the south. The study is being performed for the Flood Control District by George V. Sabol Consulting Engineers.

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Pub Jan 10, 17, 1996 S-851850

MESA TRIBUNE LEGAL ADS ARE ALSO PUBLISHED IN THE GILBERT TRIBUNE

# FLOOD CONTROL DISTRICT
of
**Maricopa County**

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859



BOARD OF DIRECTC
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox


## ▸ *Public Meeting Announcement* ◂
## Cave Creek Floodplain Delineation Study

The Flood Control District of Maricopa County invites interested people to attend a public open house meeting introducing a floodplain delineation study along Cave Creek Wash:

March 7, 1996
Thursday
5:00 - 7:30 pm

**Desert Sun Elementary School** (Library/Media Center)
33606 N. 60th Street
Approx. a mile east of Cave Creek Rd, south of Carefree Hwy; Turn rt at *Fine Arts Ctr & Desert Sun School* signs

Maps of the creek and study area will be displayed. Representatives from the Flood Control District and the engineering consulting firms will be available to discuss the study process and answer questions.

Floodplain delineation involves developing detailed topographic maps to determine where water goes, while incorporating the results of studying rainfall patterns to determine typical and peak amounts of runoff. The studies will be used to better manage the floodplain to reduce or prevent flood damage. Some areas may be designated for further analysis.

The Flood Control District is also currently conducting floodplain delineations for north Skunk Creek, Granite Reef Wash, Indian Bend Wash, Rio Verde, White Tanks Wash, Eastern Canal - Mesa, RWCD Canal-Mesa, RID Canal-Tolleson, Fountain Hills, and the Salt River.

**Additional information may be obtained by contacting:**

**Sandy Walchuk**, Public Involvement Coordinator,
**Ning Mao**, South Project Manager, or
**Kofi Awumah**, North Project Manager, at the Flood Control District, 506-1501

A sign language interpreter will be made available upon request with 72 hours' notice. Alternative format materials or FM or Infra-Red Listening Devices are also available upon request with 72 hours' notice. Additional reasonable accomodations will be made available to the extent possible within the time frame of the request. Please contact David A. Brozovsky, Flood Control District ADA Coordinator, at 506-1501, if any of these services are required.

# OPEN • HOUSE

Don't Miss The Cave Creek Wash Open House
on Wednesday, March 12th at Desert Sun School.




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

## Public Meeting Notice

OPEN HOUSE

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

# Public Meeting Announcement
# Cave Creek Floodplain Delineation Study

## OPEN HOUSE

## Wednesday, March 12, 1997

## Desert Sun Elementary School Cafeteria

## 33606 N. 60th Street

## 6:00pm to 7:30pm

Parking available in the NORTH parking lot

You are invited to attend an open house meeting which will present the results from the floodplain delineation study along Cave Creek Wash. Representatives from the Flood Control District and consultants will be on hand to discuss the study and answer any questions you may have.

For further information contact:
Perry Baker, Public Involvement Coordinator, or
Kofi Awumah and Ning Mao, Project Managers
Flood Control District of Maricopa County, 506-1501

A sign language interpreter will be made available upon request with 72 hours notice. Additional reasonable accommodations will be made to the extent possible. Please contact David Brozovsky, ADA Coordinator, at 506-1501 if any special services are required.

OPEN HOUSE

# 1.4 CONTRACT DOCUMENTS

# SCOPE OF WORK
# FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
# FLOODPLAIN DELINEATION AND TOPOGRAPHIC MAPPING FOR CAVE CREEK WASH FROM TONTO NATIONAL FOREST TO CAREFREE HIGHWAY
# FCD 95-28

## GENERAL

The project consists of approximately nine (5.5) river miles of floodplain delineations for Cave Creek Wash from the Tonto National Forest in the north to Carefree Highway in the south, as shown on Exhibit "1." This will require the development of the necessary topographic data and approximately 120 square miles of watershed hydrology. The consultant will develop the hydrology using the Corps of Engineer's HEC-1 computer model, and the floodplain and floodway delineations using primarily the HEC-1 computer model and the HEC-2 computer model if appropriate. The consultant must use sound engineering judgement in the development of the hydrologic and hydraulic models. The results of the models must be analyzed carefully and refinements made to the input parameters in order to obtain the most realistic results. All work must meet Arizona Department of Water Resources (ADWR) and Federal Emergency Management Agency (FEMA) requirements for floodplain delineations. The results of this study must be reviewed and accepted by FEMA prior to the finalization of this contract. All work under this Scope will be completed within 300 calendar days from the date of Notice to Proceed, including 60 days for District reviews.

## TASK 1 - COORDINATION

1.1 The consultant shall submit a project schedule showing coordination meetings and completion dates for each of the tasks in the scope within 14 days of Notice To Proceed. The consultant shall update this project schedule when appropriate.

1.2 The consultant shall participate in regular coordination meetings (at least once every four weeks) with the District's Project Manager and in milestone coordination meetings in the development of the hydrologic and hydraulic analyses. The consultant is responsible for the minutes of any meetings. Whenever possible, coordination and milestone meetings should be combined. Meetings will be held at Consultant's office.

1.3 The consultant shall submit a quarterly estimation of the projected billing within 14 days of Notice to Proceed. Thereafter, this estimation will be updated and submitted to the District's project manager at least 10 days prior to the end of each quarter.

1.4 The consultant shall submit monthly progress reports at least 5 days before submittal of monthly invoices. The report shall be brief and should be no longer than two typed pages. At a minimum, the monthly report shall contain the following:

a. A description of the work accomplished by task during the reporting month.

b. Percent (%) completed for the month and percent (%) cumulative completed for each task.

c. A brief description of the work to be accomplished the following month.

d. A description of any problems encountered.

1.5 The consultant is responsible for placing the legal advertising at the beginning of the study, notifying the public of the study. The ad will be run in a widely circulated newspaper two times, with approximately one week between runs. The ad must also be run two times in a local newspaper that serves the area being studied. After the ad is run the consultant will supply the District with the original affidavit of publication from each of the newspapers for each day that the ad ran.

1.6 The consultant shall notify all property owners and obtain any necessary Rights of Entry for the study area. The District shall furnish the Consultant with a list of all the relevant property owners notified and a sample Right of Entry letter.

1.7 The District shall plan and conduct two public meetings in conjunction with this study. The first meeting will be to inform the public of the purpose and scope of the study. The second meeting will be to inform the public and obtain public comment on the study results, and shall take place prior to the submittal of the final report to FEMA. The consultant/District shall be responsible for the preparation of the graphic displays for these meetings. One representative from the consultant shall attend one of the meetings. The consultant shall respond to the public's comments and make revisions to the study if necessary.

1.8 Consultant/District Performance Evaluations will be performed. An informal evaluation will be performed at the completion of the hydrologic analysis. A formal evaluation will be performed at the completion of the project upon receipt of all deliverables.

## TASK 2 - DATA COLLECTION

2.1 The consultant shall collect and review pertinent data from the District and other outside sources. Data to be collected will include previous flood hazard reports and hydrology for the study area; existing topographic mapping; historical flooding information; as-built plans for existing structures; FEMA Flood Hazard Boundary Maps and any Letters of Map Amendment and/or Revisions, and other pertinent information.

2.2 A written report summarizing the data collected shall be submitted to the District for information purposes. A preliminary draft of this report is due within 90 days of Notice to Proceed.

## TASK 3 - TOPOGRAPHIC MAPPING

3.1 An aerial survey subcontractor shall be retained by the consultant as part of this contract. Mapping would be about 6.0 linear miles. The topographic mapping would be strip mapping of Cave Creek Wash only, from southern boundary of the 1990 study to Carefree Highway. Topographic mapping for the tributaries of Cave Creek Wash would be limited to the extend that would permit the tie-in of the new delineation with the 1990 study of the tributaries.

3.2 The consultant shall coordinate all the aerial surveying work with the aerial surveying subcontractor to ensure that the specifications of the aerial surveying work are met. The consultant is responsible for ensuring that the topographic mapping covers the area of delineation. Quality control on surveys will be per FEMA Document 37, Flood Insurance Study Guidelines and Specifications for Study Contractors, January 1995.

3.3 Digital contour and planimetric data developed for this study shall be delivered according to the District's HIS specifications.

3.4 Digital Terrain Models shall be delivered following the guidelines stated in Digital Terrain Model Mapping, Data Collection & Delivery Specifications, Release 1.0 May 1994.

3.5 Prepare topographic mapping to a 2-foot contour interval, with a scale of 1 inch = 200 feet, with spot elevations and/or 1-foot contours on all section line and mid-section line roads.

3.6 Ground Control:

a. The consultant shall provide all survey control using 1983 NAD.

b. The consultant shall systematically set panel points and establish horizontal and vertical control throughout the areas to be mapped for use in compilation by the aerial survey contractor. Where readily available, surveys will tie into the State Plane Coordinate System. Field control shall be sufficient to readily allow for compilation of maps by the aerial survey contractor at the desired map scale and contour interval, and will be based on the National Geodetic Vertical Data of 1929 (NGVD). A conversion factor, including documentation of how it was derived, will be provided by the consultant to allow comparison of NGVD 29 elevations to NAVD 88 elevations and will be included in the Technical Data Notebook.

c. The horizontal and vertical control points shall be located and marked by the consultant. The controls for the aerial mapping shall be in sufficient numbers and shall be in locations which will be compatible with the accuracy of the mapping requirements. The controls shall be of at least third order accuracy. Section corners, quarter corners, and mid-section points shall be used for control points wherever possible.

3.7 The consultant shall provide permanent non-erasable topographic mylars of the work study drawings. The drawings shall be 24" X 36" in size, with a scale of 1 inch = 200 feet and a contour interval of 2 foot for all mapping with the exception of section line roads which will have a contour interval of 1 foot. A cover sheet will be provided with the project title, date of topographic mapping, and a location map showing geographic range covered by each specific mapping sheet. Each drawing shall include the floodplain and floodway delineations and a minimum of a north arrow, scale, section corners and quarter corners, current and proposed streets and highway names, State Plane Coordinate System, major drainage features, corporate boundaries, cross section lines, channel station center line, index map, and description and elevation of elevation reference marks (ERMs). A note explaining the proper means to convert the NGVD 29 elevations to NAVD 88 elevations shall be included in "NOTES" in the map border. The mapping will have an accuracy such that ninety percent (90%) of all contours shall be within one-half contour of the true elevations and the remaining ten percent (10%) of the contours shall not be in error by more than one contour interval.

## TASK 4 - FIELD SURVEY

4.1 Prepare topographic mapping to a 2 foot contour interval with a scale of 1 inch = 200 feet, with spot elevations or 1 foot contours on all section line and mid-section line roads, for floodplain/floodway delineation areas as identified in Task 6 or FEMA criteria, whichever is more stringent.

4.2 Ground Control for Floodplain Delineations:

4.2.1 All topographic mapping and survey work shall meet or exceed Federal Emergency Management Agency (FEMA) minimum criteria as defined in FEMA Document 37, Flood

Insurance Study Guidelines and Specifications for Study Contractors, January 1995. This would include, but is not limited to: the establishment of "permanent" elevation reference marks (ERMs); field control; and verification of profiles by the ground survey profile procedure.

4.2.2 Horizontal and Vertical Control: Systematically set panel points and establish horizontal and vertical control throughout the area to be mapped for use in compilation by the aerial survey contractor. Where readily available, surveys will tie into State Plane Coordinate System 1983 NAD. Field control shall be sufficient, at least one "permanent" point per mile, such point(s) being used as Elevation Reference Marks (ERMs). Surveys will be based on National Geodetic Vertical Datum (NGVD) 1929, per FEMA guidelines. A conversion factor, including documentation of how it was derived, will be provided by the consultant to allow comparison of NGVD 29 elevations to NAVD 88 elevations and will be included in the Technical Data Notebook. "Permanent" survey points shall consist of existing monumentation, such as brass caps or similar survey monuments. Where additional monumentation is needed, survey markers conforming to Maricopa Association of Governments (MAG) Uniform Standard Detail for Public Works Construction, detail 120-1, Type C, shall be placed 2" +/- above grade, and topped with a brass cap. Elevation Reference Marks will be labelled on available maps and described in a manner which allow them to be readily located in the field.

4.2.3 All aerial targets are to be removed following completion of the topographic mapping.

4.3 The consultant shall verify the accuracy of the mapping by the procedures called for in FEMA Document 37 or other methods approved by FEMA. This shall include the verification of cross sections used in the floodplain delineation.

4.4 Field surveys of bridges, culverts, and hydraulic structures are to be obtained by the consultant when as-built plans are not available or when changes significant to the HEC-2 modeling, such as sedimentation, have occurred since the date of as-built. This information should be reduced and compiled into an 11"x 17" (maximum size) drawing for inclusion in the final report. The information presented in the drawing should be in a format appropriate for use in the HEC-2 model. Field surveys of bridges, culverts, hydraulic structures, and routing reaches must also be obtained where necessary for proper hydrologic modeling. It may be necessary to field survey some structures since the as-built plans may not be on 1929 NGVD.

## TASK 5 - HYDROLOGY

5.1 The hydrologic study of the watershed shall be delivered to the District under separate cover from the hydraulic analysis. The consultant shall use the U.S. Army Corps of Engineers computer program HEC-1, 1990 Version 4.0, to develop a hydrologic model for the area. Using appropriate hydrologic judgement, sub-basins are to be identified that provide reasonable depiction of the watershed condition. The sub-basins must be as homogeneous as possible, using watershed area, watershed type (mountainous and flat lands or urban and undeveloped areas), and time of concentration as criteria. Sub-basin break-downs will be done in sufficient detail to provide peak discharges at structures, major road crossings, confluences, and at boundary lines. An appropriate time step and number of ordinates is to be selected that allows for complete calculation of the flood hydrograph without sacrificing resolution of the flood peak. All calculations, or assumptions used in developing sub-basin and routing parameters shall be documented and made a part of the appendix for the hydrology report. Field surveys may need to be taken for HEC-1 modeling purposes.

5.2 Four meetings associated with four tasks, and two field trips shall be held with the Flood Control District staff at the following milestones:

a. One field trip at the start of the project to scope out the critical points of the watershed and problem areas.

b. Meeting number 1: as soon as basic data are gathered and the sub-basins have been delineated. Sample HEC-1 parameter estimations should also be presented and discussed at this meeting. A copy of the draft maps of the sub-basins must be delivered to the District at this meeting.

c. Meeting number 2: after all the parameters have been estimated. A draft copy of the parameters must be delivered to the District at least one week prior to this meeting.

d. Meeting number 3: after the preliminary HEC-1 results have been obtained and a draft report has been prepared. A copy of the draft report and the copy of the HEC-1 on a floppy disc, compatible with the Districts computer, must be delivered two weeks prior to the meeting.

e. Meeting number 4: to review comments by the District. A second field trip may be scheduled for the same day so the results obtained could be discussed.

5.3 The specific hydrologic techniques to be used in this study are:

a. Rainfall Depth: Point precipitation values shall be determined using the information and procedures described in the Drainage Design Manual for Maricopa County, Arizona: Volume I - Hydrology.

Rainfall Distribution: Peak discharges and peak volumes for the 100-year 6-hour storm shall be estimated using the District's Distribution(s). Peak discharges and peak volumes for the 100-year 24-hour storm shall be estimated using the SCS Type II rainfall distribution.

b. Areal Reduction: The point precipitation values shall be areally reduced for critical concentration points. Areal reduction for the 6 hour rainfall duration shall be applied using the curves in the Drainage Design Manual for Maricopa County, Arizona: Volume I - Hydrology. NOAA HYDRO-40 shall be used with the 24 hour rainfall reduction. Copies can be obtained from the District.

c. Rainfall Excess: The Green and Ampt methodology shall be utilized for estimation of rainfall losses. The Lotus spreadsheet and procedures, provided by the District, shall be used to determine composite parameter values for each sub-basin.

d. Unit Hydrograph: The Clark and S-Graph method shall be used following the procedures outlined in the Drainage Design Manual for Maricopa County, Arizona: Volume I - Hydrology. The choices in methodology shall be at the discretion of the consultant, with consent from the District.

e. Time of Concentration and S-Graph Lag Equation: The Papadakis method shall be used with the Clark unit hydrograph, along with the MCUHP1 computer program, to determine the time of concentration. If this method results in unsuitable times of concentration, other method(s) must be used and compared for the most realistic result. The S-graph lag equation, along with

the MCUHP2 computer program, shall be used with the appropriate S-graph (Phoenix mountain or Phoenix Valley).

f. Channel Routing: Channel routing shall be accomplished using either the Muskingum-Cunge or the Normal-Depth option of HEC-1. The choice of methodology shall be at the discretion of the consultant, with consent from the District. Average cross sections shall be developed utilizing available mapping and field reconnaissance data. Sufficient field cross sections shall be taken to ensure that routing reaches are reasonable and representative of field conditions.

The HEC-1 routing parameters for the reaches modeled using HEC-2 shall be adjusted after the HEC-2 cross sections are available. The resulting velocities and depths, for all reaches, must be assessed for realistic values.

g. Reservoir Routing: Detailed analysis of structures and ponding areas shall be accomplished using the Modified Puls reservoir routing option of HEC-1. Stage versus discharge tables for hydraulic structures shall be estimated using appropriate hydraulic methodology.

h. Channel Transmission Losses: Attempts shall be made to estimate infiltration losses through channel bottoms based on existing field data or literature. If sufficient data is not available, the final report must acknowledge so and explain how the peaks and volumes of flow are affected by not including the transmission losses.

5.4 The District shall provide appropriate references to facilitate parameter estimation.

5.5 Output of the computer model shall be reviewed to see if the peak flows and volumes are realistic. Adjustments to input for obtaining the most realistic results is normal to the scope.

5.6 Every attempt must be made to recover historic stream gage data and use it to compare with the results obtained by the hydrologic model. Major differences must be discussed in the final report.

5.7 It is required that the consultant obtain the approval of the District at each of the following steps:

a. Soil maps, watershed boundary maps, and land use maps.

b. HEC-1 parameter estimation.

c. HEC-1 flow diagram and input parameters.

d. HEC-1 results.

5.8 The Hydrologic Report

5.8.1 The findings of the hydrologic study shall be presented in Section 3 of the Technical Data Notebook and shall be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The report shall be organized as specified by the District, following SSA 1-90 format.

5.8.2 Tables and Figures for the appendices:

a. Topographic base map(s) showing the sub-basins, routing reaches, Tc flow paths or lag

flow paths, major man-made structures, and references (i.e. street names, Township, Range, Section, etc.) at a scale of 1 inch = 2000 feet.

b. Soils map(s) at the same scale as the base map.

c. Land use map(s) at the same scale as above.

d. Schematic map for the HEC-1 showing the sub-basins (area, Tc), the flow paths, the routing reaches (length, slope, friction, width, velocities, transmission losses, etc.), order of combining the hydrographs, channel, pipe or culvert dimensions (where appropriate).

e. Pertinent data on all the structures in the watershed (such as spillway elevation, rating curves, etc.).

f. One set of study maps (i.e. sub-basin boundary maps, flow path maps, soils maps, land use maps) to be folded and delivered in a binder.

Specific deviations from this hydrologic scope shall not be undertaken without the specific written concurrence from the Flood Control District.

## TASK 6 - FLOODPLAIN DELINEATION

6.1 Floodplain delineations must be obtained using the U.S. Army Corps of Engineers HEC-2 Water Surface Profiles computer model, version 4.6.2, May 1991, and methodology acceptable to FEMA. This model will simulate the effects of floodplain geomorphology, flow changes, bridges, culverts, hydraulic roughness factors, effective flow limitations, split-flows, and other considerations. The consultant shall prepare the study using the guidelines established in FEMA Document 37, Flood Insurance Study Guidelines and Specification for Study Contractors, January 1995, and FIA Document 12, Appeals, Revisions, and Amendments to Flood Insurance Maps, January 1990.

6.2 The delineation work shall meet requirements for floodplain and floodway delineations as prescribed by FEMA and the Arizona Department of Water Resources.

6.3 The delineation study shall be based on the final results of the hydrologic study as directed by the District.

6.4 The consultant is to make refinements to the HEC-2 model based on review of the model results by the District, ADWR, FEMA, and the Technical Evaluation Contractor. The consultant shall review the HEC-2 model results for reasonableness. Adjustments to the input parameters for obtaining the most realistic results is normal to the scope.

6.5 Floodways are to be determined using equal conveyance encroachment method 4 to start with, but only encroachment method 1 will be used in the final analysis. The floodway encroachment is to be as near the one foot maximum rise in elevation as possible.

6.6 The consultant must obtain District approval at each of the following steps:

a. Field reconnaissance report and estimation of Manning's "n" values.

b. Proposed location and alignment of the cross sections and channel centerline.

c. Floodplain (natural) delineation.

d. Floodway delineation using equal conveyance encroachment.

e. Floodway delineation using encroachment method 1.

f. Final Hydraulics Report.

6.7 Field Reconnaissance

6.7.1 The consultant shall conduct a field reconnaissance of the full study reach. This will include observation of channel and floodplain conditions for estimation of Manning's "n" values; photographic documentation of floodplain characteristics; determination of channel bank stations; observation of possible overflow areas; inspection of levees or other flood control structures; and measurement of bridge dimensions.

6.7.2 Mannings "n" values are to be determined using the methodology in the USGS report, Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona, April 1991. Copies of the report are available through the District.

6.7.3 A draft report on the field reconnaissance shall be submitted to the District for review and approval prior to beginning the HEC-2 modeling. The report shall present the determination of channel and overbank "n" values using captioned color photographs or color photocopies. The report shall also discuss floodplain conditions affecting the delineation, describe structures and obstructions, and provide color photos or photocopies of major hydraulic structures. Photo locations, structures, and "n" values shall be displayed on reduced scale mapping and included in the Final Report.

6.8 Cross Sections

6.8.1 The location and alignment of cross sections and channel centerline shall be submitted for the District's review and approval prior to digitizing the cross section data. Cross section stationing shall be from left to right looking downstream with the thalweg as station 10,000. Cross sections will be spaced approximately every 500 feet, unless geographic or structural constraints dictate otherwise, and shall extend the full width of the area inundated by 100-year flood waters. Identification of cross sections shall be in river miles, increasing upstream. The stationing shall tie into the specified river mile of the existing FEMA studies. Cross section orientation may need to be altered after running of HEC-2 model to ensure that sections are perpendicular to flow per FEMA criteria.

6.8.2 All cross sections shall be plotted using a pen, laser, or electrostatic plotter. The cross section plots shall show water surface profiles, ineffective flow areas, "n" values, encroachments, channel stationing and other pertinent information. All plots are to be accompanied by a legend. These plots are to be available at all reviews.

6.8.3 Cross section plots are limited to one plot at the following three stages of work: (a.) a plot of digitized "GR", STCHL, STCHR, centerline (station 10,000) to be used as a check of input data and for working sections during compilation of the floodplain model; (b.) a plot of the cross section for the completed floodplain run which shows the floodplain water surface

elevation, ineffective flow areas, "n" factor, and encroachments to be used as working sections for development of the floodway model; (c.) a plot of the final floodway model cross sections which will show Type 1 encroachments and encroached water surface, in addition to data covered in items (a.) and (b.). These cross sections, generated under (c.), will be submitted as part of the Final Report.

6.9 Bridges and culverts must be modeled in compliance with HEC-2 modeling requirements for the selected routine. Where multiple bridges occur, each bridge shall be modeled separately. The HEC-2 modeling results for bridges, culverts, and other hydraulic structures must be checked by using an independent method approved by the District to analyze these structures.

6.10 For floodplains identified as ponding areas, it is preferable to analyze the area by using the HEC-2 model, which shall provide the District with water surface elevations. If appropriate, the consultant shall identify in the ponded floodplains a floodway. The purpose of this floodway is to allow the pond to seek a constant stage throughout the areal extent of the ponds, versus the creation of two independent ponds.

6.11 Flood zones must be determined according to FEMA criteria and clearly labelled on the final drawings.

6.12 The total area of the floodplain and floodway must be determined for each reach in square miles and acres.

6.13 The findings of the floodplain/floodway delineation study shall be presented in Section 4 of the Technical Data Notebook and shall be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The report shall be organized as specified by the District standards, following SSA 1-90 format.

## TASK 7 - HIS DATA

7.1 Digital data shall prepared in conformance with the District's HIS Data Delivery Specifications, Revision 2.0, June 20, 1995, for the following themes:

a. Floodplain Baseline Route System (LP-520 /fpbln)

b. FEMA Control Survey Points (LP-525 / fpctrl)

c. Floodplain FCD Water Surface Elevation (LP-535 / fpsrffcd)

d. Floodplain Cross Sections (LP-540 / fpxfcd)

e. Floodplain FCD Zone (LP-550 / fpznfcd)

f. FCD Project Map Index (LP-40 / ndxprj)

g. FCD Project Boundary (LP-60 / prj)

7.2 Topographic mapping related digital data shall prepared in conformance with the District's HIS Data Delivery Specifications, Revision 2.0, June 20, 1995, for the following themes:

a. Miscellaneous Control Survey Points (LP-215 / ctrl )

b. Structures (LP-360 /strct)

c. Cartographic Arc and Point Coverage (LP-110 / carto)

d. Elevation (LP-710 / elv)

e. Canal System (LP-610 /cnl)

f. FCD Project Facilities (LP-620 / flty)

g. Railroad System (LP-650 /rr)

h. Street Detail (LP-660 / strtdtl)

i. Utility (LP-670 / utlty)

j. Lakes (LP-950 / lake)

7.3 Separate check plots shall be produced from either Arc-Info or Arc-CAD from the digital database(s) of each theme in 7.1. The check plots shall be prepared with a minimum of annotation and shall serve only to verify the information in the data base. If the hydrologic and delineation maps have not derived directly from the digital data delivered to the District, then the consultant shall certify that the check plots have been examined and that the check plots faithfully represent the data and maps used in the report and /or work maps.

## TASK 8 - DELIVERABLES

8.1 FEMA Submittal: The consultant will submit the following items to the District for review by FEMA and any other appropriate governmental agency. All of the following products are considered deliverables for the FEMA submittal:

8.1.1 Original Affidavits of Publication.

8.1.2 Two (2) complete sets of blueline topographic base maps with the floodplain/floodway delineations shown. All drawings shall be signed and sealed by persons of appropriate professional registration(s). Each registrant shall provide a specific statement as to what service they performed.

8.1.3 Two (2) complete copies of the Technical Data Notebook, including HEC-1 and HEC-2 input/output files on diskettes. The Technical Data Notebook shall be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The notebook shall be organized as specified by the District, following SSA 1-90 format.

8.1.4 Two (2) sets of completed FEMA forms shall be submitted in a notebook separate from the Final Report.

8.1.5 One (1) copy of the Digital Terrain Model (DTM) shall be submitted following the guidelines stated in the Digital Terrain Model Mapping, Data Collection & Delivery Specifications, Release 1.0, May 1994.

8.1.6 Three (3) sets of complete survey notes shall be submitted in a notebook separate from the Final Report.

8.1.7 Two (2) copies of the current FIRM panels showing the proposed delineation.

8.2 Final Submittal: The following products are considered deliverables for the final submittal to the District after FEMA approval is issued:

8.2.1 One (1) complete set of non-erasable topographic mylars of the work study drawings. Sheets shall be 24" X 36" in size and numbered to correspond to the delineation maps.

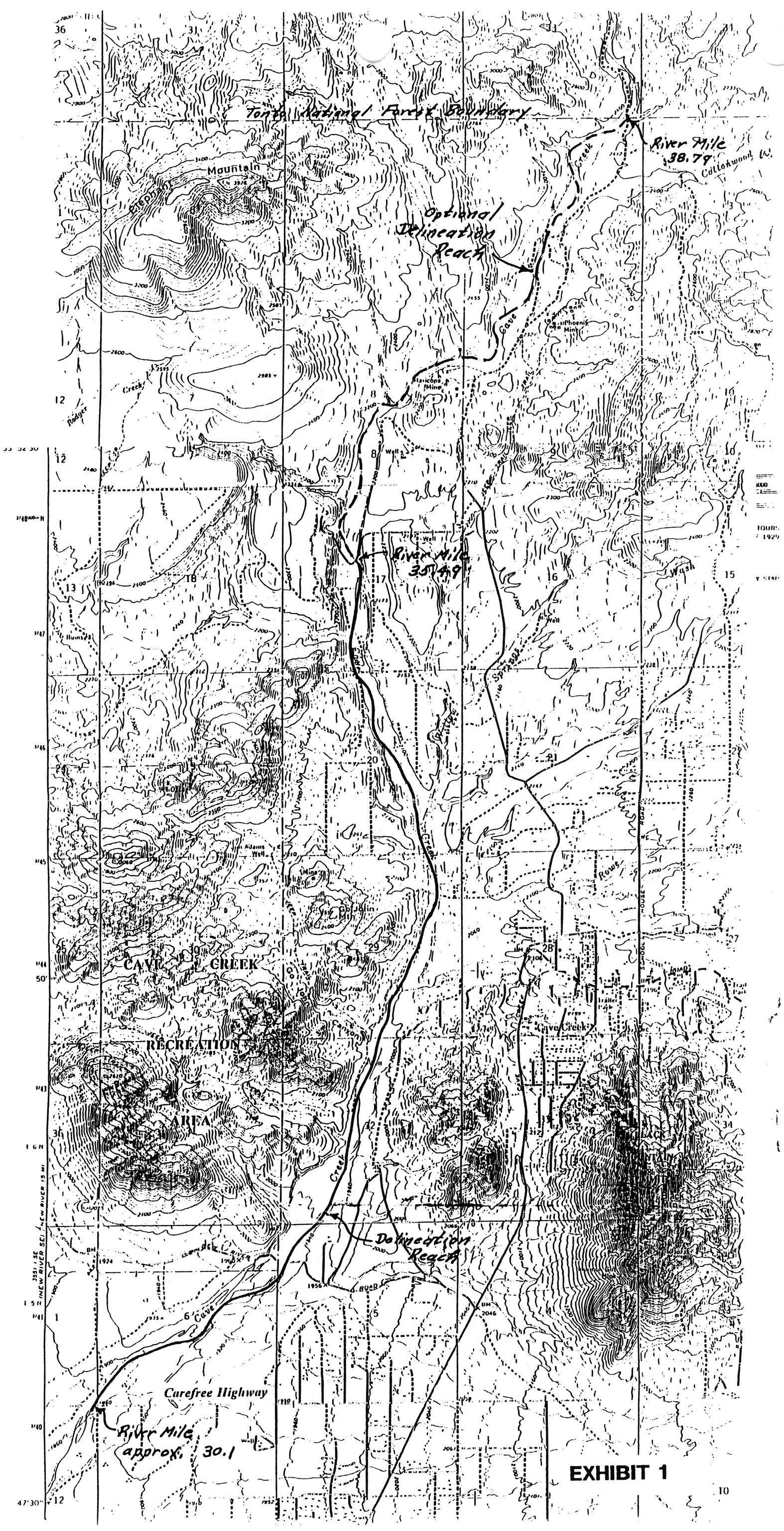
8.2.2 One (1) complete sets of mylars and four (4) complete sets of sealed blueline topographic base maps with the floodplain/floodway delineations shown. All drawings shall be signed and sealed by persons of appropriate professional registration(s). Each registrant will provide a specific statement as to what service they performed.

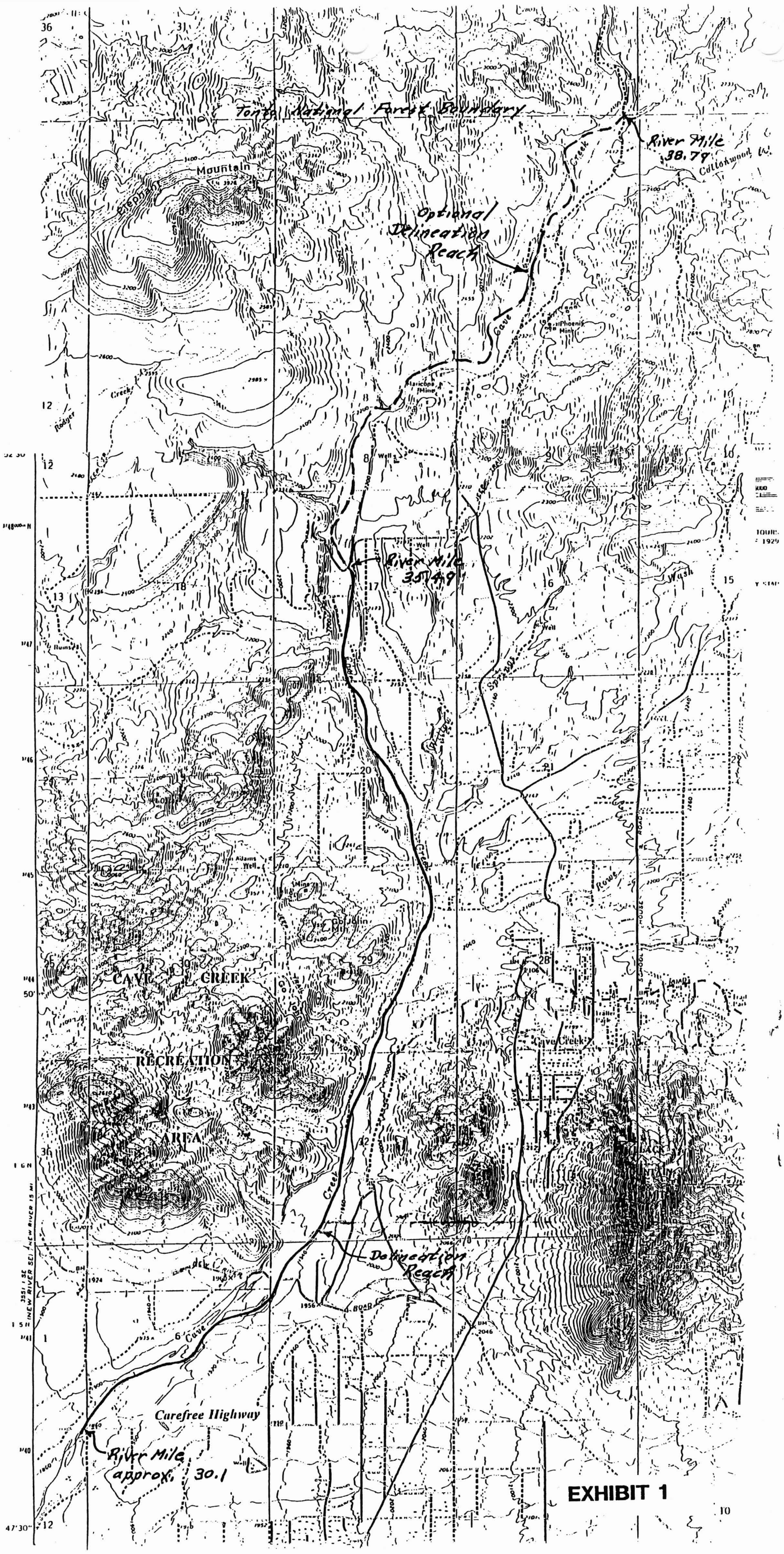
8.2.3 One (1) complete set of transparent overlays of photo-mylars. Sheet size, numbering, and layout shall correspond to the delineation work maps.

8.2.4 One (1) complete set of 9" X 9" contact prints of the aerial stereo photographs sequentially numbered and catalogued.

8.2.5 Digitized topographic data and floodplain/floodway boundaries in conformance with the District's HIS Specifications.

8.2.6 Four (4) complete copies of the Technical Data Notebook including HEC-1 and HEC-2 input/output files on diskettes. The Technical Data Notebook shall be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The notebook shall be organized as specified by the District, following SSA 1-90 format. This submittal of the Technical Data Notebook shall include any correspondence and/or meeting minutes with the reviewing agencies and shall reflect any revisions required by those reviewing agencies. Revisions may include, but are not limited to, modifications to the delineation maps, the HEC-1 model, the HEC-2 model, and/or the Final Report.


Tonto National Forest Boundary
River Mile 38.79
Cottonwood Wash
Elephant Mountain
Optional Delineation Reach
Cave Creek
Phoenix Mine
Maricopa Mine
Badger Creek
River Mile 35.49
Spring Creek
Adams Well
Mine
Goblin Mt.
CAVE CREEK
RECREATION
AREA
Cave Creek
Delineation Reach
Carefree Highway
River Mile approx. 30.1
EXHIBIT 1


Tonto National Forest Boundary
River Mile 38.79
Cottonwood
Elephant Mountain
Optional Delineation Reach
Phoenix Mine
Maricopa Mine
Creek
Rodger
River Mile 35.49
Adams Well
CAVE CREEK
RECREATION
AREA
Cave Creek
Delineation Reach
Carefree Highway
River Mile approx. 30.1
EXHIBIT 1

## SECTION 2: MAPPING AND SURVEY INFORMATION

### 2.1 Description of Mapping

The base mapping data used to produce workmaps and resulting hydrology exhibits for the hydrologic portion of this study are summarized by exhibit map as follows:

**Hydrology Exhibit A** - The base mapping used for Hydrology Exhibit A comprises a mosaic of the following United States Geological Survey (USGS) 7.5 minute quadrangle maps:

| | |
|---|---|
| Cave Creek: | 1965 mapping from 1962 photography, photo revised in 1978, 20-foot contour interval (CI), National Geodetic Vertical Datum (NGVD) of 1929. |
| Wildcat Hill: | 1965 mapping from 1962 photography, photo revised in 1978, 20-foot CI, NGVD of 1929. |
| New River Mesa: | 1964 mapping from 1962 photography, photo inspected in 1978, 40-foot CI, 20-foot supplementary CI (SCI), NGVD of 1929. |
| Humboldt Mountain: | 1964 mapping from 1962 photography, photo inspected in 1978, 40-foot CI, NGVD of 1929. |
| Cooks Mesa: | 1967 mapping from 1965 photography, 40-foot CI, 20-foot SCI, Datum is Mean Sea Level. |
| Rover Peak: | 1967 mapping from 1965 photography, 40-foot CI, NGVD of 1929. |

The USGS quadrangle maps were photographically spliced and reproduced on a thin mylar sheet at a scale of 1 inch = 2,000 feet. That mylar was used for a base workmap and is also used as an overlay to produce Hydrology Exhibit A.

**Hydrology Exhibit B** - The base mapping data for Hydrology Exhibit B is derived from the following three sources:

1. Soils Conservation Service, 1986, Soil Survey of Augila-Carefree, Parts of Maricopa and Pinal Counties, Arizona (herein called SCS Survey),

2. USFS, Tonto National Forest, 1989, General Ecosystem Survey (herein called USFS General Survey), 1:250,000 soils boundary map scale, and

3. USFS, Tonto National Forest, 1995, Terrestrial Ecosystem Survey of the Cartwright Allotment (herein called Cartwright Allotment Survey), 1:24,000 soils boundary map scale.

Digital files of the SCS Survey soils boundaries were provided by the District in AutoCAD format. Soils boundaries and orientation information were traced from the USFS maps at their original scale. Those tracings were then raster scanned, vectorized into an AutoCAD format, scaled to the project coordinate system and plotted. The plot was overlayed onto the base quadrangle mapping and visually inspected for correct orientation. The final plotting scale for Hydrology Exhibit B is 1 inch = 2,000 feet.

**Hydrology Exhibit C** - Base land use and cadastral information were supplied by the District in digital AutoCAD format. Land use boundaries were checked against current aerial photographs and revised as necessary. Field reconnaissance checking was also done for areas not covered by current aerial photography. Final plotting scale for Hydrology Exhibit C is 1 inch = 2,000 feet.

## 2.2 Index of Maps

Each hydrology exhibit is a single sheet map, and therefore, does not require a mapping index. Refer to Section 2 of the "Cave Creek Above Carefree Highway Floodplain Delineation Study, Technical Data Notebook, Hydraulics," herein called the Hydraulics TDN, for an index of the floodplain delineation maps.

## 2.3 Survey Field Notes

No survey information was used in the hydrologic analysis for this project. Refer to Section 2 of the Hydraulics TDN for a discussion and summary of the survey information used for floodplain topographical mapping and control.

## 2.4 Watershed Maps, Hydrologic Analysis Maps

Hydrology Exhibits A, B, and C represent the three maps used for the hydrologic analyses summarized in this report. Folded copies of each map are provided in pockets at the back of this report.

Hydrology Exhibit A is a map of the study watereshed showing subbasin delineation to a location in Cave Creek, just below the Carefree Highway bridge. That map contains subbasin boundaries, concentration points, time of concentration or basin lag flow paths, reach route flow paths with special indication of HEC-2 study reaches, upstream and downstream flowpath or reach route elevations, subbasin centroid locations, and cadastral boundaries. The cadastral information includes Township and Range lines and text, sectional lines and text, and municipal boundaries. All of this information overlays the base USGS quadrangle mylar discussed in Section 2.1.

Hydrology Exhibit B is a soils map for the study watershed. In addition to the base information discussed in Section 2.1, Hydrology Exhibit C contains subbasin and cadastral boundaries.

Hydrology Exhibit C is a land use map for the study watershed and contains delineations of land use area as defined in Section 3.2.2.3. Also shown are the subbasin and cadastral boundaries.

## 2.5 Hydraulic Analysis Maps

Refer to Section 2 of the Hydraulics TDN.

## 2.6 FIRM, FHBM Draft Maps

Refer to Section 2 of the Hydraulics TDN.

## 2.7 Community Maps

General street and corporate information for the communities are shown on Hydrology Exhibits A through C as they apply to the hydrologic analyses. Refer to Section 2 of the Hydraulics TDN for street references and names as they relate to the specific floodplain delineation study area.

## 2.8 Miscellaneous Maps

Reference Sections 2.1 and 2.4 for discussions of the soils and land use mapping.

# SECTION 3: HYDROLOGIC ANALYSIS

## 3.1 Hydrologic Method Description

Watershed modeling is performed using the methodology set forth in the Drainage Design Manual for Maricopa County, Volume I, Hydrology (Flood Control District of Maricopa County (FCDMC), 1992), which is herein referred to as the Design Manual. The US Army Corps of Engineers (COE) HEC-1 Computer Program, version 4.0.1E, dated May 1991, as implemented by Dodson & Associates, Inc., is used for modeling. Three separate HEC-1 models are developed for this study. The first is an existing condition 100-year, 24-hour storm duration model of the overall Cave Creek watershed, with a 5-minute time increment. The second and third are existing condition 100-year, 6-hour and 24-hour storm duration models of the Andora Hills Wash watershed, with 2-minute time increments. The last two models are developed to better estimate peak discharges along Andora Hills Wash for the relative size of contributing watershed and subbasins. The rainfall depth-duration-frequency statistics are obtained from the NOAA Atlas II, Arizona, and the rainfall distributions used are the SCS Type II for the 24-hour storm and the 6-hour storm patterns suggested in the Design Manual. Rainfall losses are estimated by the Green and Ampt infiltration equation with additional consideration for surface retention. The Clark unit hydrograph is used to generate hydrographs for the small, urban subbasins of the Andora Hills Wash watershed. The S-graph method is used for hydrograph generation of all other modeling subbasins. Hydrographs are routed through the watershed using Modified Puls channel storage routing.

The purpose in undertaking this study is to estimate 100-year recurrence interval peak discharges at designated locations along Cave Creek and Andora Hills Wash. Those locations were discussed and mutually agreed upon between the Flood Control District of Maricopa County (FCDMC) and George V. Sabol Consulting Engineers, Inc. (GVSCE). In general, those locations are:

1. Major wash confluences along Cave Creek and other hydrologically significant locations within the study watershed,

2. The beginning and ending floodplain delineation reach locations on Cave Creek, and

3. Sufficient locations along Andora Hills Wash to provide discharges for future floodplain modeling and delineation.

The study watershed in relationship to the State of Arizona is shown on the Location Map, Figure 3-1. The study watershed in relationship to the City of Phoenix corporate limits and Maricopa County is shown on the Vicinity Map, Figure 3-2.

## 3.2 Parameter Estimation

### 3.2.1 Drainage Area Boundaries

The study watershed is approximately 120 square miles in size and is shown and delineated on Hydrology Exhibit A. The upper western boundaries of the study watershed are contiguous with the New River watershed and the northern and eastern study watershed boundaries are contiguous with the Verde River watershed. Black Mesa, Elephant Mountain, and the mountains of the Cave Creek Recreation Area define the lower western watershed boundary. The northern and eastern boundaries are defined by Rover Peak, Humboldt Mountain, Willow Spring Mountain, Maverick Butte, Bronco Butte, Butte Peak, and Apache Peak. The southern portion of the study watershed generally follows Cave Creek Road until it diverges southwesterly at a location approximately one mile east of the Cave Creek Road and Pima Road intersection. At that point, the southern boundary leaves Cave Creek Road and follows the terrain southwesterly to the Carefree Highway Bridge.

The overall watershed is divided into major subbasins of tributary areas draining to the locations designated for peak discharge estimation. Several of the subbasins are drained by major washes such as Seven Springs Wash, Bronco Creek, Big Maggie May Wash, Skunk Tank Canyon Wash, Grays Gulch, Mattys Fork, Cottonwood Creek, Willow Springs Wash, Grapevine Wash, Galloway Wash, Andora Hills Wash, and several unnamed washes. For the areas not drained by a major wash, a subbasin size criteria of 3 to 5 square miles is used with 1 square mile as a minimum. Acronyms are used on Hydrology Exhibit A to label each subbasin relative to the major wash draining that area. A defined list of those acronyms is provided in Table A-10 of Appendix A.

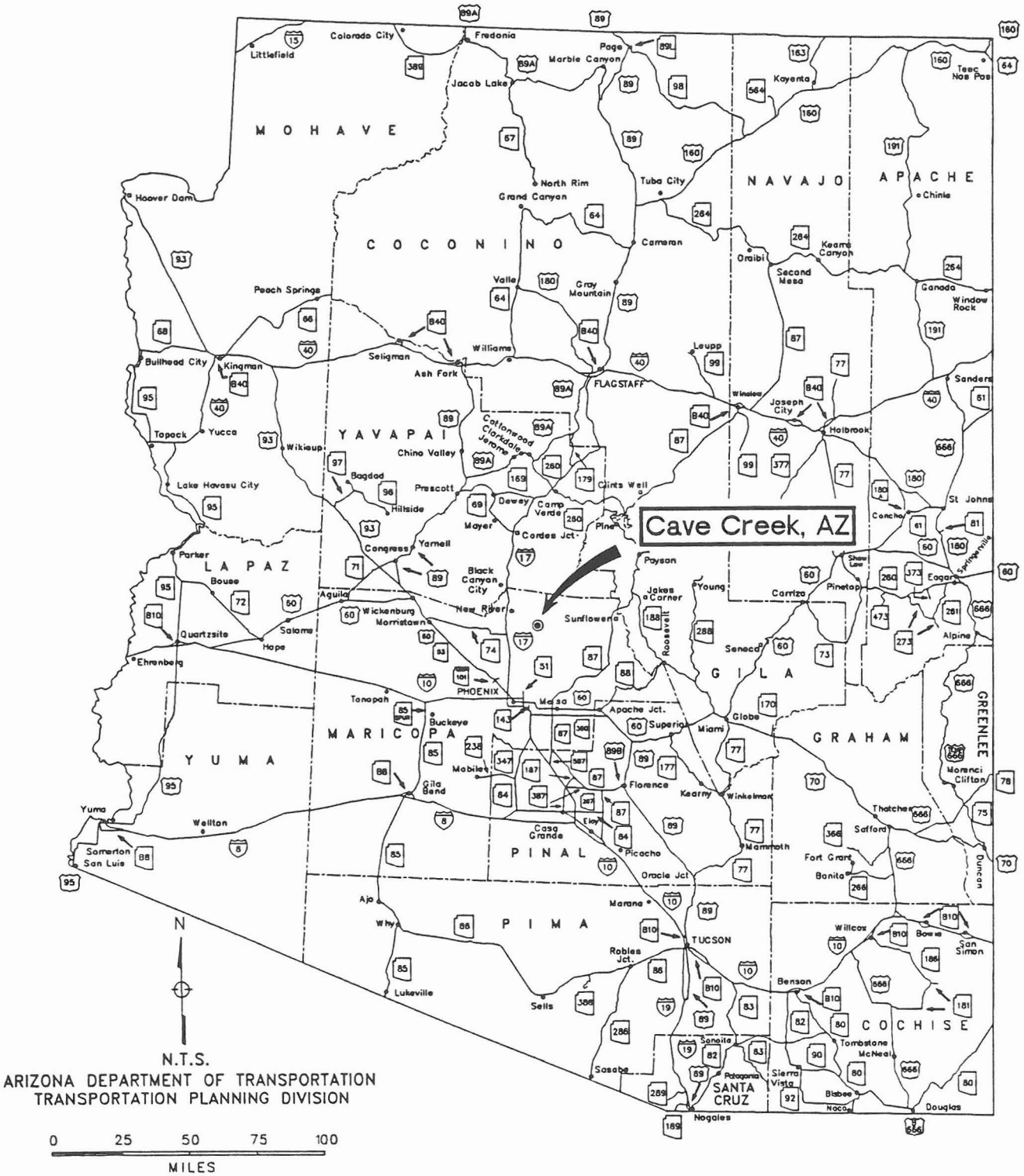



**FIGURE 3-1**

**Location Map**

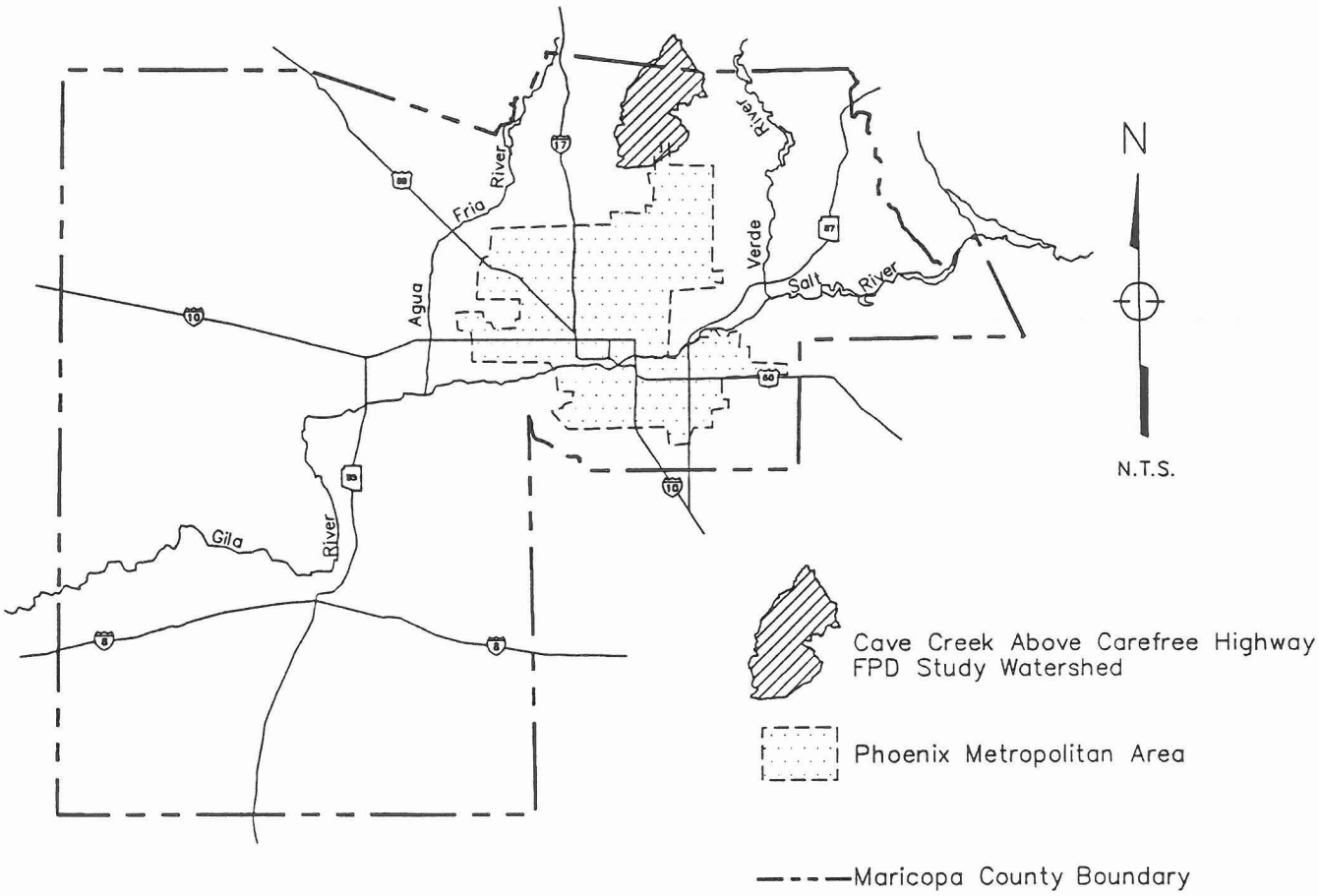



**FIGURE 3-2**

**Vicinity Map**

The Andora Hills Wash major subbasin is further divided into nine minor subbasins (refer to Hydrology Exhibit A) in order to provide more detailed peak discharge estimates along that watercourse. The combined area of the nine minor subbasins is approximately 2.8 square miles and the majority of that area consists of the downtown portions of Cave Creek and Carefree, and the approximate northern half of Black Mountain.

In general, the study watershed is situated within the rectangular region defined by the northern portion of Township 5 North, Townships 6, 7, and 8 North, and Ranges 4 and 5 East. The study watershed extends across several corporate and jurisdictional boundaries including the City of Phoenix, the City of Scottsdale, the unincorporated communities of Cave Creek and Carefree, unincorporated Maricopa County, and the Tonto National Forest. The extreme northern headwater area of the Cave Creek watershed penetrates into Yavapai County, with the remaining watershed situated within Maricopa County.

The majority of the watershed is characterized by rugged desert mountain and hillslope terrain, with a small portion in the extreme southern region transitioning to steep desert rangeland with braided flow patterns. The watershed elevations range from a low of 1,860 feet at the Carefree Highway Bridge to a high of 5,340 feet at Blackjack Point in the northern limit. The soils on the watershed range from clay loam to sandy loam and are interspersed throughout the area. Higher concentrations of more mature and finer textured soils tend to coincide with southern migration through the watershed.

### 3.2.2 Physical Parameters

#### 3.2.2.1 General

Physically based hydrologic parameters for the watershed and modeling subbasins are estimated in conformance with the Design Manual. The procedures used for estimation of those parameters are discussed in the following sections. Pertinent supporting data and calculations are provided in the technical appendices as noted.

#### 3.2.2.2 Watershed Subbasin Delineation and Area Parameters

The watershed and subbasin boundaries are delineated using Hydrology Exhibit A as discussed in Section 2. Reconnaissance trips to the watershed served

as guidance for delineation of urbanized areas and other locations found to be lacking sufficient topographical detail for boundary determination. A tracing of the resultant subbasin delineations was produced and scanned into an AutoCAD format for overlay onto Hydrology Exhibit A. Known vertical and horizontal alignments such as township and range lines were also traced and scanned with the subbasin delineations in order to provide a reference for general positioning of the digital file entities to the coordinate system used for the project (NAD 1983). The positioning was done by aligning the scanned reference lines with digital township and range lines supplied by the District. The final watershed and subbasin boundaries are plotted on all hydrology exhibits and centroid locations are shown on Hydrology Exhibit A for all subbasins which require that data.

Subbasin areas and centroid locations were determined by converting the finalized AutoCAD basin boundary polylines into GIS format and using that software application to perform the necessary data retrieval. Data results were spot-checked for errors, as well as cross-checked with soil and land use polygon data obtained by the same software, for each subbasin (soils and land use data retrieval discussed later in Section 3).

#### 3.2.2.3 Rainfall Loss Parameters

General

Rainfall losses for the watershed are estimated using the Green and Ampt infiltration equation method of HEC-1. The variable XKSAT (hydraulic conductivity at natural saturation) is estimated by evaluating natural condition soil properties and textures as they occur on the watershed and assigning values to those soils using the methods in the Design Manual. Both variables PSIF (wetting front capillary suction) and DTHETA (antecedent volumetric soil moisture deficit) are functions of soil texture, and therefore, XKSAT. The variable DTHETA is additionally related to the moisture condition of the soil and is categorized as either dry, normal, or saturated. Dry DTHETA is considered typical for natural land and normal DTHETA is considered typical for developed areas where irrigation and other factors tend to maintain a higher moisture content in the soil. Saturated DTHETA conditions are not considered to exist on the watershed for this study. Table A-1 of Appendix A is a tabular summary of PSIF and DTHETA values for a corresponding value of XKSAT. Effective

imperviousness, RTIMP, is attributed to rock outcrop in natural areas. Roofs, paving, lake surfaces, and compaction associated with gravel roads and equestrian arenas and pens contribute to RTIMP in developed areas. Surface retention, IA, is an estimate of the initial surface storage that occurs during a storm event.

With the exception of bare ground XKSAT and PSIF, separate composite rainfall loss parameters are calculated for natural and developed land areas within each subbasin. The two composite values are then area averaged to obtain final subbasin Green and Ampt method parameters. The bare ground value of XKSAT is estimated using the soils data and applies to the pervious portion of the entire subbasin for both natural and developed areas. Values for PSIF, DTHETA (dry) and DTHETA (normal) are directly related to the bare ground XKSAT value and are obtained from Table A-1 of Appendix A. Values of PSIF corresponding to the bare ground XKSAT remain constant for all pervious areas in the subbasin, and DTHETA (dry) and DTHETA (normal) are estimated for natural and developed areas respectively. As a final step, the bare ground XKSAT value is adjusted for vegetation per the Design Manual using the subbasin average vegetative cover percentage.

Soil Parameters

**General** - Soil properties and texture classifications are used to estimate the bare ground XKSAT variable of the Green and Ampt method. Typically, soils information and studies also identify the presence of rock outcrop and often provide percentage estimates as part of the study.

**Data Sources** - Three sources of information are used in this study to estimate the type and location of soils occurring on the watershed. They are:

1. Soils Conservation Service, 1986, Soil Survey of Augila-Carefree, Parts of Maricopa and Pinal Counties, Arizona (herein referred to as SCS Survey),

2. USFS, Tonto National Forest, 1989, General Ecosystem Survey (herein referred to as USFS General Survey), and

3. USFS, Tonto National Forest, 1995, Terrestrial Ecosystem Survey of the Cartwright Allotment (herein referred to as Cartwright Allotment Survey).

The limits of the SCS Survey are generally within the boundaries of Maricopa County. The USFS General Survey provides general soils information and mapping units for the entire Tonto National Forest. The Cartwright Allotment Survey is a more detailed terrestrial ecosystem survey of the Cartwright Ranch grazing allotment in Tonto National Forest. Each source provides mapped soil unit boundaries with soil type and layer depth estimates. Rock outcrop percentages are also provided for map units in which they are significant. Hydrology Exhibit B is a composite map of all three soils sources as they occur on the watershed, with map units for each source delineated and general source boundary limits provided. The watershed and subbasin boundaries and labels are included for reference.

**USFS General Survey XKSAT and Rock Outcrop** - Table 3-1 summarizes the composition of soil types and characteristics, rock outcrop, and the final log average bare ground XKSAT value for each of the USFS General Survey map units occurring on the watershed. It should be noted that where the Cartwright Allotment Survey boundary overlays the USFS General Survey (See Exhibit B), the Cartwright Allotment Survey soils data are used. The bare ground XKSAT and rock outcrop percentage values for each USFS General Survey soil map unit occurring on the watershed are summarized in Table 3-2 and Table A-2 of Appendix A.

**Cartwright Allotment Survey XKSAT and Rock Outcrop** - The main objective of the Cartwright Allotment Survey was to provide an assessment of the range conditions for the area and the impacts that cattle grazing has had on the soil and vegetation conditions. Soil map units are more densely defined than the USFS General Survey, but soil characteristics, component percentages and rock outcrop percentage estimates are not as detailed. In general, soil types for each map unit are summarized as surface soils and underlying subsoils. Some map units are divided into .1 and .2 components, but no percentage estimates are provided. Descriptions of the soils present within each map unit are provided in Table 6 of the survey (USFS, 1995) and excerpts from that table are provided in Appendix A for reference. Discussions with the Tonto National Forest soil scientist revealed that "surface soils" can be expected to average 3 inches in depth or less. That assessment was visually verified at several locations throughout the watershed during field reconnaissance trips. Typically, the surface soils are classified as loams to sandy loams with rocky,

## TABLE 3-1

### Summary of USFS General Survey soil unit characteristics

| Map Unit (1) | Component (2) | Composition % (3) | Soil Description (4) | Assigned Soil Texture (5) | Bare Ground XKSAT in/hr (6) | Log Avg XKSAT in/hr (7) |
|---|---|---|---|---|---|---|
| 103 | .1 | 50 | Deep clay loam | Clay loam | 0.04 | 0.12 |
| | .2 | 40 | Deep very cobbly loam | Sandy loam | 0.40 | |
| | .5 | 10 | Deep loam | Loam | 0.25 | |
| 121 | .1 | 50 | Deep very cobbly clay loam | Sandy clay loam | 0.06 | 0.12 |
| | .2 | 30 | Deep very stoney loam | Sandy loam | 0.40 | |
| | .5 | 10 | Deep very cobbly loam | Sandy loam | 0.40 | |
| | .6 | 10 | Shallow very stoney loam | Sandy loam | 0.40 | |
| 126 | .1 | 30 | Deep extremely stoney loam | Sandy loam | 0.40 | 0.40 |
| | .2 | 30 | Deep extremely cobbly loam | Sandy loam | 0.40 | |
| | .3 | 15 | Rock outcrop | ---- | | |
| | .4 | 15 | Rock outcrop | ---- | | |
| | .5 | 10 | Shallow extremely stoney loam | Sandy loam | 0.40 | |
| 301 | .1 | 50 | Deep gravelly sandy loam | Sandy loam | 0.40 | 0.40 |
| | .2 | 40 | Shallow very gravelly sandy loam | Sandy loam | 0.40 | |
| | .5 | 10 | Deep very gravelly sandy loam | Sandy loam | 0.40 | |
| 303 | .1 | 30 | Shallow extremely cobbly sandy loam | Sandy loam | 0.40 | 0.40 |
| | .2 | 30 | Mod. deep extremely cobbly sandy loam | Sandy loam | 0.40 | |
| | .3 | 15 | Rock outcrop | ---- | | |
| | .4 | 15 | Rock outcrop | ---- | | |
| | .5 | 10 | Shallow extremely cobbly sandy loam | Sandy loam | 0.40 | |

TABLE 3-2

**Summary of assigned XKSAT and RTIMP values for USFS General Survey soil map units**

| Soil Map Unit (1) | Bare Ground XKSAT in/hr (2) | Natural Rock Outcrop % (3) | Assigned RTIMP % (4) |
|---|---|---|---|
| 103 | 0.12 | 0 | 0 |
| TES121 | 0.12 | 0 | 0 |
| 126 | 0.40 | 30 | 15 |
| TES301 | 0.40 | 0 | 0 |
| 303 | 0.40 | 30 | 15 |

stony or cobbly descriptors. The subsoils below the surface soils are generally finer textured soils such as clay loams and clays with some rocky, stony or cobbly descriptors. It is therefore assumed that for a 100-year storm, the soil horizon that controls the value of XKSAT in map units with shallow surface soils is the subsoil. The soil texture and corresponding bare ground XKSAT values for each Cartwright Allotment Survey soil map unit occurring on the watershed, are assigned accordingly and summarized in Table 3-3. Rock outcrop percentages are estimated by a comparison of the Cartwright Allotment Survey soil map units to the USFS General Survey map units with respect to location, inspection of the Cartwright Allotment Survey map unit locations with respect to the watershed topography, observations noted during field reconnaissance, and judgement. The rock outcrop percentage values for each Cartwright Allotment Survey soil map unit occurring on the watershed are summarized in Table A-3 of Appendix A.

**SCS Survey XKSAT and Rock Outcrop** - The SCS Survey soil unit mapping was supplied in digital format by the District. The composite bare ground XKSAT values and rock outcrop percentages for all SCS map units occurring on the watershed are taken directly from the Design Manual and summarized in Table 3-4 and Table A-4 of Appendix A.

**Soil Map Unit Polygon Areas by Subbasin** - Areas of soil map unit polygons as they exist within a subbasin were obtained by converting the finalized soil map unit

TABLE 3-3

**Summary of assigned soil textures and XKSAT values for Cartwright Allotment Survey soil map units**

| Map Unit | Assigned Soil Texture | Bare Ground XKSAT in/hr | Assigned Rock Outcrop % |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| 12 | Sandy loam | 0.40 | 0 |
| 73 | Sandy loam | 0.40 | 0 |
| 239 | Sandy loam | 0.40 | 30 |
| 292 | Sandy loam | 0.40 | 30 |
| 300 | Sandy clay loam | 0.06 | 0 |
| 301 | Sandy clay loam | 0.06 | 0 |
| 352 | Sandy loam | 0.40 | 10 |
| 381 | Sandy loam | 0.40 | 0 |
| 382 | Sandy loam | 0.40 | 15 |
| 390 | Sandy clay loam | 0.06 | 0 |
| 391 | Sandy clay loam | 0.06 | 0 |
| 400 | Sandy clay loam | 0.06 | 0 |
| 401 | Sandy clay loam | 0.06 | 0 |
| 402 | Sandy loam | 0.40 | 10 |
| 415 | Sandy loam | 0.40 | 0 |
| 416 | Sandy clay loam | 0.06 | 0 |
| 417 | Loam | 0.25 | 20 |
| 418 | Sandy loam | 0.40 | 0 |
| 451 | Loam | 0.25 | 0 |
| 452 | Loam | 0.25 | 20 |

TABLE 3-4

Summary of assigned XKSAT and RTIMP values for SCS Survey soil map units

| Soil Map Unit (1) | Bare Ground XKSAT in/hr (2) | Natural Rock Outcrop % (3) | Assinged RTIMP % (4) |
|---|---|---|---|
| 3 | 0.58 | 0 | 0 |
| 6 | 0.62 | 0 | 0 |
| 8 | 0.96 | 0 | 0 |
| 12 | 0.01 | 0 | 0 |
| 24 | 0.02 | 0 | 0 |
| 26 | 0.01 | 0 | 0 |
| 28 | 0.02 | 0 | 0 |
| 31 | 0.33 | 35 | 15 |
| 33 | 0.23 | 0 | 0 |
| 34 | 0.23 | 0 | 0 |
| 40 | 0.17 | 0 | 0 |
| 41 | 0.17 | 0 | 0 |
| 44 | 0.03 | 0 | 0 |
| 61 | 0.15 | 0 | 0 |
| 63 | 0.14 | 25 | 10 |
| 66 | 0.23 | 0 | 0 |
| 72 | 0.09 | 30 | 15 |
| 93 | 0.33 | 0 | 0 |
| 95 | 0.04 | 0 | 0 |
| 96 | 0.07 | 0 | 0 |
| 98 | 0.37 | 0 | 0 |
| 104 | 0.14 | 60 | 30 |
| 110 | 0.13 | 0 | 0 |
| 112 | 0.39 | 0 | 0 |
| 121 | 0.12 | 0 | 0 |

AutoCAD drawing into GIS format and using GIS based software to perform the necessary data retrieval. Data results for each subbasin were spot-checked for errors and cross-checked with subbasin and land use classification polygon area data obtained by the same software.

Natural Area Parameters for each Subbasin

**XKSAT, PSIF, DTHETA (dry) and RTIMP** - Composite value calculations for natural area XKSAT, PSIF, DTHETA (dry) and RTIMP are summarized in the worksheets of Table A-6, Appendix A. The assigned natural area (effective rock outcrop) RTIMP values for each of the soil map units described previously are summarized in Tables A-2, A-3 and A-4 of Appendix A. Example step-by-step calculations for Subbasin S290 are provided in Appendix A for tracking of the spreadsheet calculation procedure.

**IA** - Using the Design Manual for guidance, natural area surface retention values are assigned to each subbasin based on inspection of the topographical mapping and observations of the surface terrain characteristics noted during field reconnaissance trips. Those assignments are summarized by subbasin in Table A-5 of Appendix A.

**Vegetative Cover Density** - Six vegetation transects were taken at various locations throughout the watershed and are used to provide a basis for the estimation of natural condition vegetative cover densities (VCD's) for each subbasin. The transect field notes are provided in Appendix B, along with a map showing the general location of each transect in relation to the watershed subbasins. Photographs taken at each transect location were submitted to the District in a separate notebook, and are available for review upon request. Additional observations of the natural vegetation conditions were made during both aerial and ground reconnaissance trips to the watershed. Based on those observations and the transect data in Appendix B, natural condition VCD values are assigned to each subbasin. Those assignments are summarized by subbasin in Table A-5 of Appendix A.

Land Use Parameters

**General** - The watershed is subdivided into polygons of common land use elements. Those elements are lumped into two general categories of either "natural" or "developed," with sub-categories labeled as classifications. The natural category includes all undeveloped or generally natural condition land use classifications. All other land use classifications are included in the developed category.

**Land Use Mapping** - A digital map of land use polygons was supplied by the District. That map was then supplemented and revised as necessary to include and reflect recent development activity that has occurred on the watershed since the last update of District files. The revisions and supplements were made based on inspection of 19 February 1995 aerial photography provided by Landiscor, 23 June 1995 aerial photography by Rupp Aerial, and photographs and observations made during aerial and ground reconnaissance trips. The resultant land use classification polygons are shown on Hydrology Exhibit C.

**Land Use Classifications** - Each land use classification polygon indicated on Hydrology Exhibit C is labeled with a land use classification identifier. A summary listing of those identifiers and their descriptions are provided in Table 3-5. Two classes of LDR; LDR-15 and LDR-25, are used in this study. The LDR-15 classification is for light density residential areas with little or no natural rock outcrop. The LDR-25 classification is used for light density residential areas around Black Mountain and the Boulders community, that are characterized by significant amounts of rock outcrop.

**Composite IA and VCD Values by Land Use Classification** - Composite values of IA and VCD are calculated for each land use classification by first assigning values to the pervious and impervious portions of that land use element. VCD and IA values for the pervious portions are summarized in columns 3 and 4 of Table 3-5. Impervious portion values of 0.05 inches for IA and 0 percent for VCD are used for all developed category land use classifications. Composite values are then calculated by area weighting the pervious and impervious IA and VCD values. The resulting composite values calculated for each developed land use classification, are summarized in columns 5 and 6 of Table 3-5.

TABLE 3-5

**Rainfall loss characteristics and corresponding composite values for each land use classification**

| Land use Class (1) | RTIMP % (2) | Pervious Area Open Space Values Veg. Cover % (3) | Pervious Area Open Space Values IA in (4) | Composite Values Veg. Cover % (5) | Composite Values IA in (6) |
|---|---|---|---|---|---|
| LDR-15 | 15 | 40 | 0.20 | 34 | 0.18 |
| LDR-25 | 25 | 40 | 0.20 | 30 | 0.16 |
| MDR | 30 | 40 | 0.20 | 28 | 0.16 |
| HDR | 45 | 40 | 0.20 | 22 | 0.13 |
| C | 80 | 50 | 0.15 | 10 | 0.07 |
| RSRT | 60 | 80 | 0.20 | 32 | 0.11 |
| AP | 85 | 50 | 0.15 | 8 | 0.07 |
| GC* | 10 | 90 | 0.20 | 81 | 0.19 |
| EF | 5 | 40 | 0.15 | 20 | 0.10 |
| N | ** | ** | ** | ** | ** |
| F | ** | ** | ** | ** | ** |
| L | 100 | 0 | 0.00 | 0 | 0.00 |
| PARK | ** | ** | ** | ** | ** |
| P | 100 | --- | --- | 0 | 0.05 |

| Land Use Class | Description |
|---|---|
| LDR | Light Density Residential |
| MDR | Medium Density Residential |
| HDR | High Density Residential |
| C | Commercial, incl. Light and Medium Intensity |
| RSRT | Hotel or Resort |
| AP | Airport |
| GC | Golf Course |
| EF | Equestrian Facility |
| N | Natural, includes vacant landuse |
| F | Forest |
| L | Lake |
| PARK | Park |
| P | Pavement |

* The golf course vegetation cover accounts for natural desert out-of-bounds areas included in the land use polygons.

** Land use class is considered as natural condition and does not contribute to the developed area composite values.

**Land Use Classification Polygon Areas by Subbasin** - Areas of land use classification polygons as they exist within a subbasin were obtained by converting the finalized land use AutoCAD drawing into GIS format and using GIS based software to perform the necessary data retrieval. Data results for each subbasin were spot-checked for errors and cross-checked with subbasin and soil polygon area data obtained by the same software.

Developed Area Parameters for each Subbasin

**XKSAT, PSIF and DTHETA (normal)** - The bare ground XKSAT and PSIF values remain the same as the natural area values for each subbasin. DTHETA(normal) values for developed areas are taken from Table A-1 of Appendix A.

**RTIMP** - RTIMP values for each land use classification are summarized in Table 3-3. Assignments of those values are made with guidance from the Design Manual, inspection of aerial photography, and observations made during field reconnaissance trips. Composite developed area RTIMP values are calculated for each subbasin in the worksheets of Table A-8, Appendix A. Example step-by-step calculations for Subbasin S290 are provided in Appendix A for tracking of the spreadsheet calculation procedure.

**IA and VCD** - Developed area composite IA and VCD value calculations for each subbasin are summarized in the worksheets of Table A-8, Appendix A. Example step-by-step calculations for Subbasin S290 are provided in Appendix A for tracking of the spreadsheet calculation procedure.

Area Weighted Rainfall Loss Parameters for each Subbasin

Table A-9 of Appendix A summarizes the final area weighting calculations of rainfall loss parameters for each subbasin in the watershed. Table 3-6 is a summary of the final Green and Ampt HEC-1 input parameters for each subbasin. Reference Section 3.5 for a description of the HEC-1 operators.

### 3.2.2.4 Unit Hydrograph Parameters

General

The S-graph method and Clark unit hydrograph are both used for this study.

## TABLE 3-6

**Summary of basin area and Green and Ampt method HEC-1 input parameters for each subbasin**

| Subbasin ID | HEC-1 ID | Area sq. mi. | Green and Ampt Method Loss Parameters IA inches | DTHETA | PSIF inches | XKSAT in/hr | RTIMP % |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| SSW1 | S110L | 10.597 | 0.20 | 0.40 | 6.00 | 0.19 | 3 |
| CC1 | S110R | 17.935 | 0.20 | 0.37 | 5.20 | 0.28 | 6 |
| BC1 | S120 | 4.774 | 0.25 | 0.35 | 4.55 | 0.39 | 6 |
| CC2 | S130 | 2.878 | 0.25 | 0.37 | 5.30 | 0.27 | 6 |
| BMM1 | S140 | 1.837 | 0.20 | 0.35 | 4.45 | 0.36 | 4 |
| CC3 | S150 | 1.065 | 0.20 | 0.35 | 4.35 | 0.42 | 12 |
| UNT1 | S150R | 1.995 | 0.20 | 0.35 | 4.30 | 0.40 | 9 |
| STC1 | S160 | 1.294 | 0.25 | 0.35 | 4.80 | 0.33 | 5 |
| CC4 | S170 | 0.913 | 0.20 | 0.39 | 5.80 | 0.20 | 7 |
| GG1 | S170R | 3.417 | 0.20 | 0.35 | 4.60 | 0.33 | 9 |
| MF1 | S180 | 3.803 | 0.25 | 0.39 | 5.80 | 0.20 | 5 |
| CC6 | S190L | 2.814 | 0.20 | 0.38 | 6.40 | 0.16 | 2 |
| CC5 | S190R | 4.370 | 0.25 | 0.38 | 5.40 | 0.23 | 7 |
| CC7 | S200 | 3.949 | 0.20 | 0.35 | 4.90 | 0.31 | 9 |
| CWC1 | S210 | 10.345 | 0.20 | 0.35 | 4.65 | 0.35 | 14 |
| CC8 | S220 | 3.635 | 0.20 | 0.37 | 5.30 | 0.24 | 14 |
| CC9 | S230 | 1.839 | 0.20 | 0.36 | 6.80 | 0.13 | 11 |
| CC10 | S240 | 2.627 | 0.20 | 0.35 | 6.80 | 0.14 | 6 |
| WSW1 | S250 | 5.887 | 0.19 | 0.32 | 6.60 | 0.15 | 10 |
| UNT2 | S260L | 3.781 | 0.19 | 0.35 | 5.70 | 0.22 | 13 |
| CC11 | S260R | 1.648 | 0.20 | 0.34 | 7.00 | 0.12 | 12 |
| GVW1 | S270 | 4.863 | 0.25 | 0.39 | 5.80 | 0.20 | 16 |
| GVW2 | S280 | 5.933 | 0.19 | 0.32 | 4.65 | 0.34 | 9 |
| GWW1 | S290 | 7.639 | 0.17 | 0.29 | 5.00 | 0.29 | 12 |
| GVW3 | S310 | 2.387 | 0.16 | 0.34 | 5.40 | 0.24 | 4 |
| AHW1 | S320 | 0.454 | 0.16 | 0.27 | 6.00 | 0.19 | 22 |
| AHW4 | S330 | 0.164 | 0.14 | 0.16 | 8.00 | 0.08 | 36 |
| AHW3 | S340L | 0.240 | 0.18 | 0.32 | 6.20 | 0.18 | 15 |
| AHW2 | S340R | 0.065 | 0.13 | 0.19 | 6.60 | 0.14 | 43 |
| AHW5 | S350 | 0.161 | 0.16 | 0.28 | 6.00 | 0.18 | 23 |
| AHW6 | S360 | 0.578 | 0.18 | 0.32 | 6.40 | 0.16 | 15 |
| AHW7 | S370 | 0.341 | 0.11 | 0.21 | 7.00 | 0.11 | 49 |
| AHW8 | S380 | 0.415 | 0.18 | 0.21 | 7.00 | 0.12 | 15 |
| AHW9 | S390 | 0.347 | 0.15 | 0.28 | 6.60 | 0.15 | 15 |
| UNT3 | S400L | 5.026 | 0.18 | 0.32 | 6.00 | 0.19 | 13 |
| CC12 | S400 | 3.059 | 0.20 | 0.35 | 6.80 | 0.13 | 11 |
| CC13 | S410 | 1.308 | 0.16 | 0.28 | 7.60 | 0.10 | 4 |

The S-graph method is used to model a majority of the study watershed subbasins, with the only exceptions being the minor subbasins draining to Andora Hills Wash. Those subbasins are modeled using the Clark unit hydrograph due to the extent of urbanization in the that area and their small size.

S-graph Method

**S-graphs** - The Phoenix Mountain and Desert/Rangeland S-graphs, as defined in the Design Manual, are used for this study. The Phoenix Mountain S-graph is used to model the mountainous and hillslope areas of the upper and central portion of the watershed. The Desert/Rangeland S-graph is used for the southern areas characterized by distributary flow patterns. The conversion of the S-graphs to unit hydrographs is accomplished using the MCUHP2 program supplied by the District with the Design Manual.

**Lag Parameter** - The basin lag parameter ($T_L$) is estimated using equation 5.11 of the Design Manual. That equation, using the COE exponents, is:

$$T_L = 24\,K_n \left[\frac{L L_{ca}}{S^{0.5}}\right]^{0.38}$$

where: $T_L$ = basin lag in hours;

$L$ = length of the hydraulically longest flow path in miles;

$L_{ca}$ = length along the watercourse used to define L from the subbasin concentration point to a point opposite the subbasin centroid in miles;

$S$ = watercourse slope in feet per mile; and

$K_n$ = estimated mean Manning's n for all the channels in the subbasin.

Subbasin estimates of the equation variables $K_n$, L, $L_{ca}$ and S are summarized in Table C-1 of Appendix C. Estimates of $K_n$ for each subbasin are selected using the Design Manual (Table 5-4) for guidance, and a combination of field reconnaissance observations of hydraulic roughness, inspection of topographical maps, estimates of

vegetative cover, and assessment of the degree of urbanization within the subbasin. Estimates of L, $L_{ca}$ and S are measured from Hydrology Exhibit A. The type of S-graph and lag parameter estimate for the subbasins modeled by the S-graph method is summarized in Table 3-7.

Clark Unit Hydrograph

**Time of Concentration** - The time of concentration ($T_c$) for use with the Clark unit hydrograph is estimated using Equation 5.5 (Papadakis and Kazan empirical equation) of the Design Manual:

$$T_c = 11.4\ L^{0.50}\ K_b^{\ 0.52}\ S^{-0.31}\ i^{-0.38}$$

where: $T_c$ = subbasin time of concentration in hours;

L = length of hydraulically longest flow path in miles;

S = watercourse slope in feet per mile;

$K_b$ = representative watershed resistance coefficient; and

i = average rainfall excess intensity, during the time $T_c$, in inches/hour.

Solution of the $T_c$ equation is an iterative process dependent on *i*, and is accomplished using a modified version of the MCUHP1 computer program provided by the District with the Design Manual.

Table C-1 in Appendix C, summarizes the parameter values used to calculate $T_c$ for each Clark unit hydrograph subbasin. The length, L, is listed for each subbasin in column 6. The slope, S, is calculated using top and bottom elevations of the Tc path, listed in columns 4 and 5 respectively, and L. The calculated slope is shown in column 7. Steep watercourse slopes are adjusted using Figure 5.4 of the Design Manual. The following expressions are mathematical approximations of the curve plotted on that figure and are used to calculate the adjusted slope.

TABLE 3-7

Summary of S-graph type and lag estimate for each S-graph modeled subbasin

| Subbasin ID (1) | HEC-1 ID (2) | S-graph Type (3) | Subbasin Lag hours (4) |
|---|---|---|---|
| SSW1 | S110L | Mountain | 1.09 |
| CC1 | S110R | Mountain | 1.50 |
| BC1 | S120 | Mountain | 1.09 |
| CC2 | S130 | Mountain | 0.54 |
| BMM1 | S140 | Mountain | 0.65 |
| CC3 | S150 | Mountain | 0.45 |
| UNT1 | S150R | Mountain | 0.50 |
| STC1 | S160 | Mountain | 0.65 |
| CC4 | S170 | Mountain | 0.40 |
| GG1 | S170R | Mountain | 0.91 |
| MF1 | S180 | Mountain | 0.87 |
| CC6 | S190L | Mountain | 0.54 |
| CC5 | S190R | Mountain | 0.89 |
| CC7 | S200 | Mountain | 0.48 |
| CWC1 | S210 | Mountain | 1.39 |
| CC8 | S220 | Mountain | 0.60 |
| CC9 | S230 | Mountain | 0.55 |
| CC10 | S240 | Mountain | 0.66 |
| WSW1 | S250 | Mountain | 0.88 |
| UNT2 | S260L | Mountain | 0.93 |
| CC11 | S260R | Mountain | 0.47 |
| GVW1 | S270 | Mountain | 1.20 |
| GVW2 | S280 | Mountain | 1.01 |
| GWW1 | S290 | Desert/Rangeland | 0.99 |
| GVW3 | S310 | Desert/Rangeland | 0.66 |
| UNT3 | S400L | Desert/Rangeland | 0.99 |
| CC12 | S400 | Mountain | 0.65 |
| CC13 | S410 | Desert/Rangeland | 0.46 |

$$S_{adj} = b + m(\ln(S))$$

where: $S < 225$ no adjustment is necessary

and: $225 < S < 400$

$m = 133.8009$

$b = -500.865$

and: $S > 400$

$m = 61.54998$

$b = -74.6827$

The adjusted slopes are listed in column 8.

The estimation of $K_b$ for each Andora Hills Wash subbasin is made by classifying it into a category of surface roughness type. Seven categories of surface roughness are used for this study. The first four types; A, B, C and D, are taken directly from Table 5.1 of the Design Manual. Additional intermediate types A/B, B/C and C/D are interpolated to provide definitions for areas of mixed classifications. The interpolated values of m and b for use in the $K_b$ equation for each intermediate type, are summarized as follows:

| Type | m | b |
|---|---|---|
| A/B | -0.01000 | 0.060 |
| B/C | -0.01938 | 0.115 |
| C/D | -0.02750 | 0.175 |

Subbasin classifications are assigned by a combination of field reconnaissance observations of surface roughness elements, inspection of topographical maps, and assessment of the degree of urbanization within the subbasin. Column 10 of Table C-1 in Appendix C summarizes the roughness type assigned to each Andora Hills Wash subbasin. The corresponding value of $K_b$ is summarized in Table C-1, column 11.

The $T_c$ results of the iterative 100-year, 6- and 24-hour calculations are summarized by subbasin in Table 3-8, and Tables C-2 (100-year, 6-hour) and C-3 (100-year, 24-hour) of Appendix C. A key assumption upon which the Clark unit hydrograph is based is that the $T_c$ be less than the duration of the most intense

portion of rainfall excess. The validity of the calculated $T_c$ values, based on this assumption, can be verified by inspection of Tables C-2 and C-3. The rainfall excess values, listed in order by decreasing rank, for the most intense 90 minute period of each storm, are respectively shown in columns 3 through 20 of each table. The total excess rainfall for that 90 minute period and subbasin, is listed in column 21. The duration of time in which 90 percent of the total rainfall excess (column 21) occurs is listed in column 22. That time is assumed to be the most intense portion of rainfall excess for each storm and is to be compared to the calculated value of $T_c$.

**Storage Coefficient** - The Clark unit hydrograph storage coefficient, R, is estimated using the calculated $T_c$ values summarized in Table 3-8, and equation 5.6 of the Design Manual. The results of the R value calculations are summarized in Table 3-8 and in Tables C-2 and C-3 of Appendix C.

**Time-Area Relation** - A dimensionless time-area relation of contributing area versus travel time to subbasin outlet, is required for the Clark unit hydrograph procedure. It is impractical to develop individual time-area relations for each subbasin of a numerous subbasin model, therefore, synthetic time-area relations are used in this study. The minor subbasins of the Andora Hills Wash drainage are either urbanized or partially urbanized. The U-D time-area relation of Figure 5.6 in the Design Manual is used for subbasins categorized as urban. The HEC-1 default time-area relation is used for subbasins categorized as partially urban. Table 3-8 and Table C-1 of Appendix C summarize the time-area relations used for each Andora Hills Wash subbasin.

### 3.2.2.5 Reach Route Parameters

General

Routing of subbasin hydrographs are performed using the Modified Puls channel storage method of HEC-1. Routing reach paths are shown on Hydrology Exhibit A, with each route identified by a name that consists of the upper and lower concentration point numbers which define that reach. For example, Reach 110120 is the reach with concentration point 110 at the upstream and concentration point 120 at the downstream.

TABLE 3-8

**Summary of Clark Unit Hydrograph parameters for each subbasin of Andora Hills Wash**

| Subbasin ID | HEC-1 ID | 100-year, 6-hour | | 100-year, 24-hour | | Time-Area Relation |
|---|---|---|---|---|---|---|
| | | Tc hrs | R hrs | Tc hrs | R hrs | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| AHW1 | S320 | 0.229 | 0.109 | 0.271 | 0.131 | B |
| AHW4 | S330 | 0.275 | 0.288 | 0.321 | 0.342 | A |
| AHW3 | S340L | 0.288 | 0.204 | 0.333 | 0.241 | B |
| AHW2 | S340R | 0.196 | 0.201 | 0.233 | 0.244 | A |
| AHW5 | S350 | 0.238 | 0.152 | 0.279 | 0.182 | B |
| AHW6 | S360 | 0.550 | 0.377 | 0.550 | 0.377 | B |
| AHW7 | S370 | 0.292 | 0.241 | 0.333 | 0.279 | A |
| AHW8 | S380 | 0.179 | 0.089 | 0.213 | 0.108 | A |
| AHW9 | S390 | 0.283 | 0.233 | 0.329 | 0.275 | A |

The majority of routing reaches are analyzed using the normal depth option for the Modified Puls method of HEC-1. Channel geometries for those reaches are approximated by an eight point cross section. The last two routing reaches, Reach 390400 and Reach 400410, are characterized by multiple low flow channels creating a cross section geometry that is too complex to adequately be defined with eight points. Therefore, stage versus discharge versus storage volume relations are generated for those two reaches using the Army Corps of Engineer's HEC-RAS program, version 1.1.

Physical Parameters

**Cross Section Geometry** - Representative cross section geometry for each reach route is obtained by either field reconnaissance or from the 200 Scale Mapping. Section geometry obtained by field reconnaissance was measured using a hand level and graduated range pole, and a 100 foot measuring tape. Field reconnaissance measurements were taken for use with routing reaches located outside the limits of the 200 Scale Mapping and were performed on 22 and 25 March 1996. During the field reconnaissance, several routing reaches were found to have cross sections that are hydrologically similar, therefore, one representative cross section was surveyed

for each of those groupings. Section geometry for reaches within the limits of the 200 Scale Mapping are taken from that mapping and either reduced to an equivalent eight point cross section for normal depth option routing or used directly in the HEC-RAS model. Cross section plots with routing reaches listed, including the multiple HEC-RAS sections used for Reaches 390400 and 400410, are provided in Appendix D.

**Manning's n Estimates** - The Manning's n values developed for the floodplain delineation portion of this study (see Section 4 of the Hydraulic TDN) are used as a basis for estimation of channel and overbank n values for each routing reach. Averages of those values are used directly for the Cave Creek routing reaches coincident with designated floodplain delineation reaches. Manning's n values for all other routing reaches are selected based on observations and photographs obtained during field reconnaissance trips, and judgement. Field reconnaissance photographs taken of routing reach channels and overbanks are bound and cataloged in a separate notebook and are available at the District for review. Generally, reaches of Cave Creek upstream of concentration point 180 are characterized by a well defined main channel with large boulders and cobbles causing significant roughness. The overbank areas are typically steep with either dense vegetation or rocky abutments. Reaches of Cave Creek downstream of concentration point 180 typically consist of a broader, more shallow main channel, lined with large to medium cobble. Overbanks are less steeply sloped with moderately dense overbank vegetation and roughness. Major tributary washes such as Galloway Wash, Grapevine Wash, and Andora Hills Wash, typically consist of a level channel bed (side to side) lined with coarse sand to sandy gravel and thick vegetation on the channel banks. Overbanks along these reaches are typically flat with moderate vegetation thickness and roughness. The channel and overbank n values selected for use with each hydrologic routing reach cross section are shown on the cross section plots in Appendix D.

**Routing Reach Length and Slope** - The normal depth option parameters of reach length and energy slope (assumed to be the channel slope) are measured from either Hydrology Exhibit A or the 200 Scale Mapping. Table D-1 of Appendix D summarizes those values for each routing reach not modeled with HEC-RAS.

**HEC-RAS Generated Routing Parameters** - Due to the complexity of channel geometries within Reaches 390400 and 400410, a simple hydraulic backwater analysis of each reach is performed using the HEC-RAS. The resulting stage versus discharge versus accumulated storage volume relations from those analyses are coded directly into the HEC-1 model at each respective reach route operation. The number of cross sections used to model each reach are based on an assumed number of NSTPS expected to be input to the HEC-1 model. For example, Reach 390400 is approximately 10,400 feet in length and is estimated to have an NSTPS value of 4 based on a modeling time of 5 minutes (NMIN) and an assumed average reach discharge velocity of 8 feet per second. Based on that assumption, five cross sections with four subreaches that correspond to the estimated number of NSTPS were used to model Reach 390400. Cross section location selections were based on the Cave Creek topography and geometry data were taken from the 1 inch = 200 foot, 2-foot contour interval mapping that is produced for the floodplain delineation portion of this study. Reference Section 2 of the Hydraulics TDN for further information regarding that mapping. The approximate location of each HEC-RAS cross section is shown on Hydrology Exhibit A. Plots of each cross section geometry, as coded into HEC-RAS, are provided in Appendix D. The HEC-RAS model hydraulic and volume data results for Reach 390400 and Reach 400410 are respectively summarized in Tables D-2 and D-3 of Appendix D.

**Channel Infiltration Losses** - Channel infiltration losses are estimated for each routing reach using the steady state loss rate option of HEC-1. There is no reliable stream flow gage data available for this watershed to provide guidance in selection of loss rates; however, it is expected that some losses due to infiltration exist within the routing reaches. Steady state loss rates for each reach are estimated by examining Hydrology Exhibit B to identify the dominant soil type in the main channel and overbank areas, and then assigning the XKSAT value for that soil type. The steady state loss rate selections for each routing reach are summarized in Table D-4 of Appendix D.

Computational Parameters

**General** - Routing computations are accomplished using the Modified Puls channel storage routing option of HEC-1, with consideration for channel infiltration losses. The physical parameters for each reach are determined as described previously. Other parameters affecting the hydrologic routing computations are:

1. The computational time interval; and
2. The number of routing computation steps.

**Computational Time Interval** - The modeling computational time interval (NMIN) directly impacts the hydrologic routing of a flood hydrograph and the minimum allowable reach length. Values of NMIN are typically selected to provide adequate definition of the unit hydrograph and should lie within the range of 0.1 to 0.25 times the minimum $T_c$ or Lag time occurring in the watershed. For the overall Cave Creek 100-year, 24-hour watershed model, the smallest Lag time is 0.40 hours (24 minutes), resulting in a range of 2.4 to 6.0 minutes. The selected NMIN value for that model is 5 minutes. For the Andora Hills Wash 100-year, 6- and 24-hour models, the smallest $T_c$ is 0.179 hours (10.7 minutes), resulting in a range of 1.1 to 2.7 minutes. The selected NMIN for each of those models is 2 minutes.

Assuming an average travel velocity of 8 feet per second, the minimum length of routing reach required for the floodwave to travel one time step in the Cave Creek 100-year, 24-hour model (NMIN = 5 minutes) is:

$$L_{min} = (5 \text{ min})(60)(8 \text{ fps}) = 2{,}400 \text{ feet.}$$

Similarly the minimum reach length for the Andora Hills Wash 100-year, 6- and 24-hour models (NMIN = 2 minutes) is:

$$L_{min} = (2 \text{ min})(60)(8 \text{ fps}) = 960 \text{ feet.}$$

Initially, hydrologic routing was performed for all travel reaches in each of the three HEC-1 models regardless of reach length. Those reaches that did not lag the hydrograph one time step and provide attenuation, were subsequently removed from

the model and replaced with a KM record commenting that reach is too short to route. It should be noted that several reaches with lengths shorter than those calculated above did provide slight attenuation without lagging the hydrograph, and were therefore kept in the model.

**Reach Route Step Estimation** - Estimation of the number of routing steps for input to the HEC-1 models is an iterative process. The number of routing steps for each reach may vary with the storm duration being considered. The process for estimating the number of steps is as follows:

Step 1: An initial estimate of the number of steps (NSTPS) for each reach is made assuming an average velocity of 5 feet per second. The HEC-1 models are run using the assumed values.

Step 2: The reach travel time is calculated by subtracting the time-to-peak ($T_p$) at the beginning of the routing operation from the Tp at the end of the routing operation.

Step 3: The travel time from Step 2 is then divided by the computational time interval (NMIN), to obtain a check NSTPS value.

Step 4: The result from Step 3 is compared with the NSTPS value currently coded in HEC-1 model. If the two values are not equal, the check NSTPS value is re-coded into the HEC-1 model as the new NSTPS value and the model is rerun.

Step 5: Repeat Steps 2 through 5 until the current NSTPS value and the check NSTPS value are equal. Convergence normally occurs within three iterations.

**Summary of Routing Results** - Tables D-5, D-6 and D-7 of Appendix D, summarize reach route hydraulic data and checking calculations for the overall Cave Creek 100-year, 24-hour model, and the Andora Hills Wash 100-year, 6- and 24-hour models, respectively. Data presented in those tables include average physical parameters, normal depth or HEC-RAS calculation results, minimum and maximum check velocities that are based on the HEC-1 calculated wave celerity and numerics relating flood wave velocity to normal depth velocity, travel time through the reaches in increments of NMIN, and final NSTPS values. A summary describing the calculations performed to obtain those values for each column of Tables D-5, D-6 and D-7, is provided in Appendix D following the tables. Examination of the data

summarized in those tables provides confirmation of the reasonableness of each reach route.

3.2.2.6 Reservoir Route Parameters

There are no reservoir routing calculations performed in this study. There are existing lakes and detention areas within the various golf courses, as well as a few small stock tanks in the upper watershed, but none of those structures are considered to have a significant impact on the 100-year storm.

3.2.3 Statistical Parameters

3.2.3.1 Precipitation Statistics

There are no statistical data of significant record available for this watershed other than the regional precipitation data published by the National Oceanic and Atmospheric Administration (NOAA). The precipitation depth-duration-frequency statistics used for this study are derived from the NOAA Atlas 2 for Arizona. Deficiencies of the current atlas are recognized and a revised precipitation-frequency analysis is currently in progress at the NOAA. The results of the revised atlas may differ from the values used herein, but, until the revised atlas or an equally accepted presentation of precipitation statistics is available, the current precipitation-frequency statistics will be used.

3.2.3.2 Discharge Statistics

The only discharge measurement statistics that exist for the study watershed are published in the USGS report by Garrett and Gellenbeck titled; Basin Characteristics and Stream Flow Statistics in Arizona as of 1989, (USGS 1991). In that report, statistics for a single crest-stage gage that was located on Cave Creek approximately one mile south of the Carefree Highway Bridge are sited. As a reference, the Carefree Highway Bridge is also the lower limit of this study. The period of record for the gage is from 1958 through 1979 and 1981 through 1989, and peak annual discharges and their date of occurrence were recorded. Instantaneous peak flow magnitudes for various return periods were calculated from the observed record using the log-Pearson Type III frequency distribution. The guidelines of the U.S. Water Resources Council Bulletin 17B were also followed. The 100-year instantaneous peak discharge estimate from that analysis is flagged by the

report authors as unreliable since the 100-year recurrence interval is equal to more than twice the period of record. Accordingly, the Cave Creek gaging station statistics are only considered as reasonable for indirect comparison purposes are not used for direct comparison or calibration of the HEC-1 modeling results. Other gage statistics for watersheds similar to the study watershed, are included in the Garrett and Gellenbeck report and are used for indirect comparisons as well. See Section 3.3 for a summary of those gage data.

### 3.2.4 Precipitation Data

#### 3.2.4.1 Rainfall Distributions

The storm frequencies specified for analysis in this study are the 100-year, 6- and 24-hour duration storms. The rainfall distributions for the 6-hour duration storm are based on watershed area. Those distributions are listed in the Design Manual with each precipitation pattern valid for a certain watershed area. Three precipitation patterns with corresponding watershed areas and precipitation depths are input to the Andora Hills Wash HEC-1 model using the JD record option. The 24-hour rainfall distribution used for this study is the SCS Type II, in accordance with the requirements set forth in the Design Manual.

#### 3.2.4.2 Point Precipitation Data

Point precipitation values used for this study are derived from the isopluvial maps in the Design Manual. Refer to Figures 3-3 and 3-4 for a depiction of the study watershed overlaid by isopluvials for the 100-year, 6- and 24-hour storms, respectively. An average 100-year, 24-hour point precipitation value for the overall Cave Creek watershed model was developed using Figure 3-4 to estimate the percentage of watershed situated between each of the isopluvials, assigning an average point precipitation value to that area as determined from those isopluvials, then areally averaging the assigned values based on their respective percentages. Average 100-year, 6- and 24-hour point precipitation values for the Andora Hills Wash models were selected by visual inspection of Figures 3-3 and 3-4. Table 3-9 summarizes the point precipitation values used for this study.

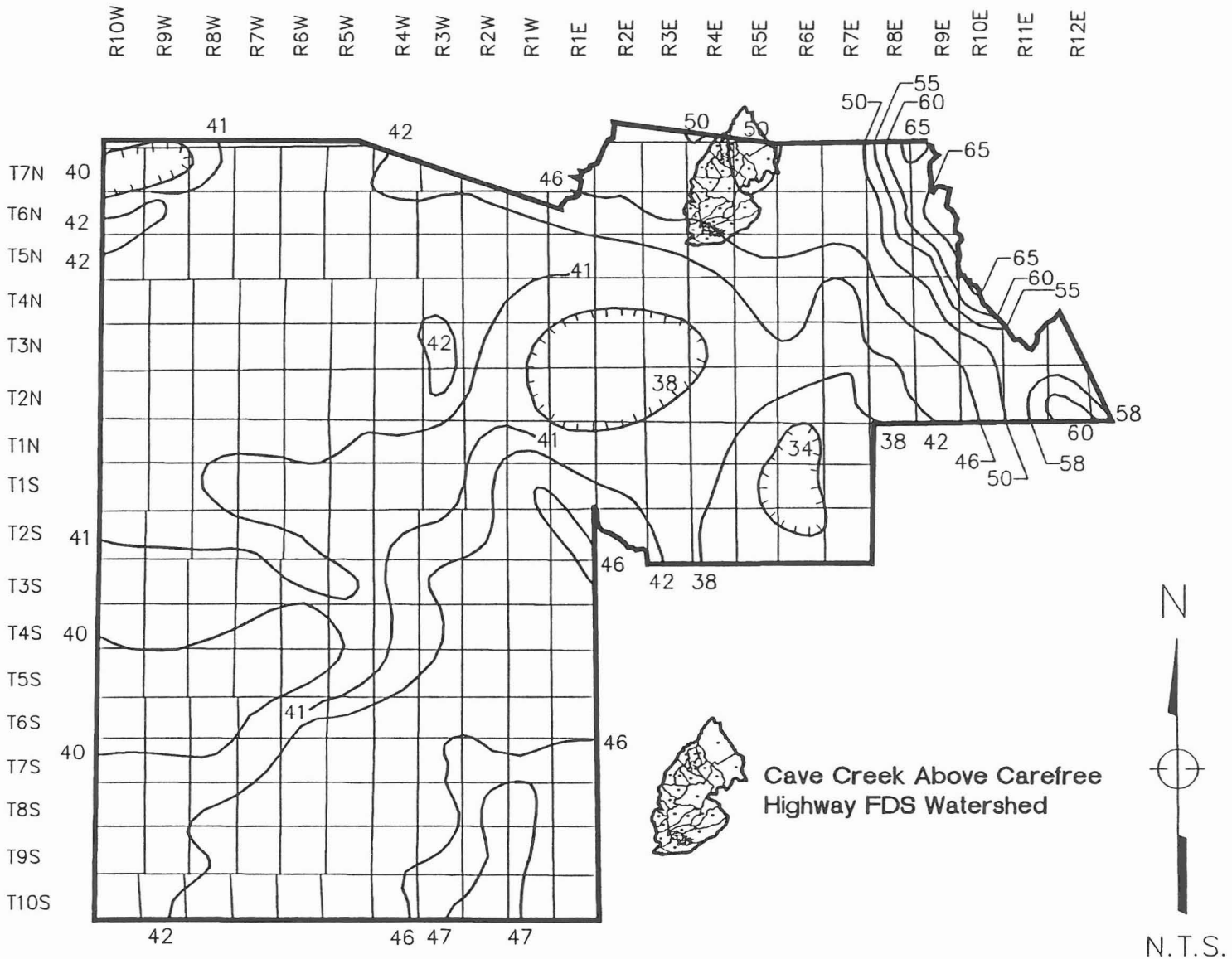



**FIGURE 3-4**

**Precipitation iopluvial map for Maricopa County for a 100-year, 24-hour storm**

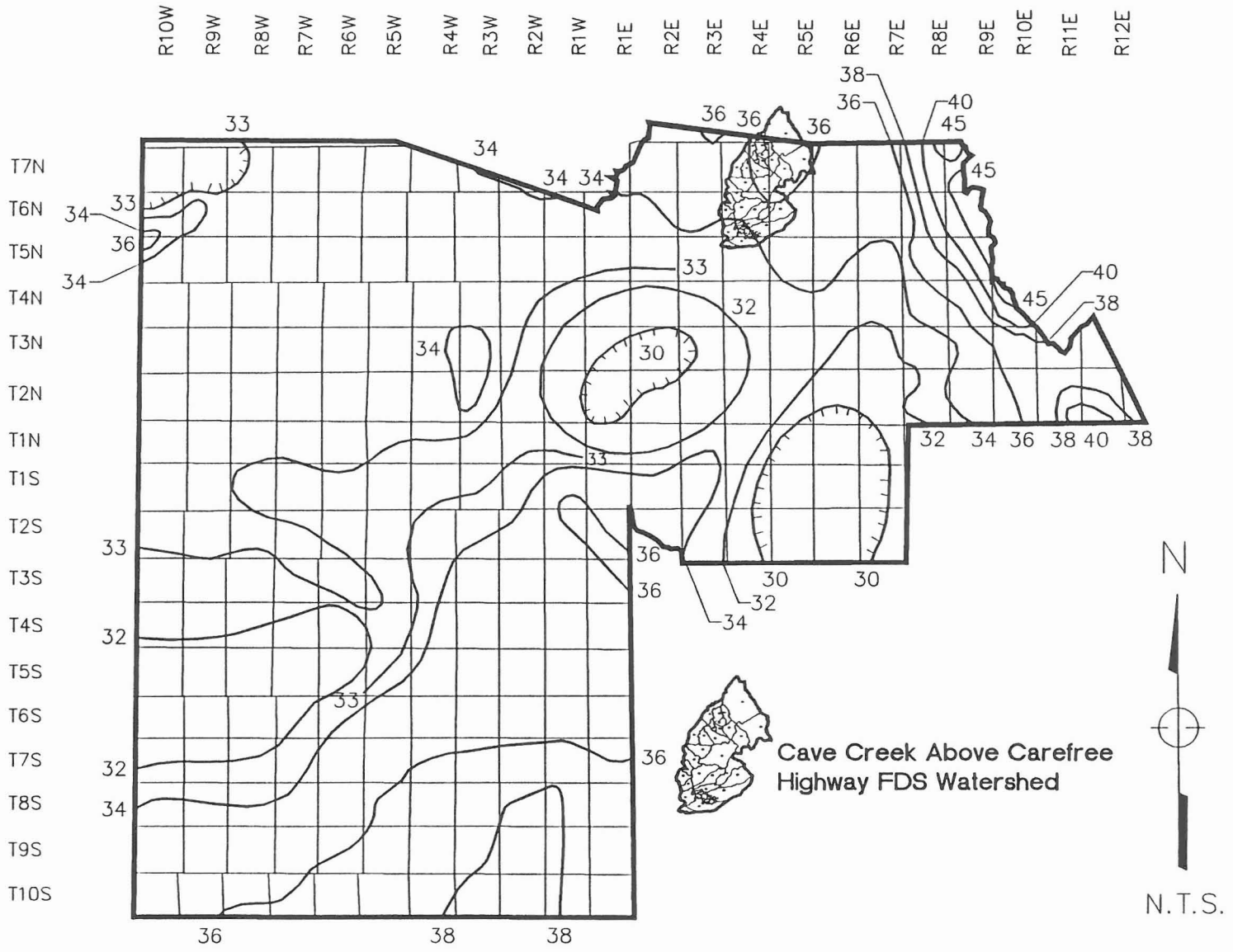



**FIGURE 3-3**

**Precipitation isopluvial map for Maricopa County, 100-year, 6-hour storm**

**TABLE 3-9**

**Point precipitation values for the Cave Creek and Andora Hills Wash watersheds**

| Storm Frequency and Duration (1) | Point Precipitation inches (2) |
|---|---|
| Cave Creek | |
| 100-year, 24-hour | 4.98 |
| Andora Hills Wash | |
| 100-year, 6-hour | 3.40 |
| 100-year, 24-hour | 4.60 |

3.2.4.3 Areal Precipitation Reduction

The precipitation reduction for the 6-hour storms are based upon the depth-area curve developed for the historic storm of 1954 over the Queen Creek, Arizona area, as developed by the U.S. Army Corps of Engineers in 1974. That depth-area curve is listed in the Design Manual. The precipitation reduction factors used for the 24-hour storms are listed in the Design Manual and those values were derived from information contained in the NOAA Technical Memorandum NWS HYDRO-40 (NWS, 1984). Appropriate depth-area reduction for all storms and accumulated drainage areas is simulated in HEC-1 using the JD record option. Table 3-10 summarizes the basin areas, reduction factors and areally reduced point precipitation values used in each of the three HEC-1 models.

3.2.5 Gage Data

3.2.5.1 Streamflow Gaging Stations

Two streamflow gages currently exist on Cave Creek in or near the study watershed. Both are owned, operated, and monitored by the District and their locations are as follows:

TABLE 3-10

**Summary of 100-year, 6- and 24-hour JD record areal reduction factors and corresponding basin areas**

| HEC-1 Model | Basin Area | Areal Reduction Factor | Areally Reduced Point Precipitation |
|---|---|---|---|
| | sm | | inches |
| (1) | (2) | (3) | (4) |
| **Cave Creek** | | | |
| 100-year, 24-hour | 0.01 | 1.000 | 4.98 |
| | 1 | 0.996 | 4.97 |
| | 10 | 0.940 | 4.68 |
| | 20 | 0.910 | 4.53 |
| | 70 | 0.856 | 4.26 |
| | 130 | 0.833 | 4.15 |
| **Andora Hills Wash** | | | |
| 100-year, 6-hour | 0.01 | 1.000 | 3.40 |
| | 1.0 | 0.987 | 3.38 |
| | 2.8 | 0.972 | 3.30 |
| **Andora Hills Wash** | | | |
| 100-year, 24-hour | 0.01 | 1.000 | 4.60 |
| | 1.0 | 0.996 | 4.57 |
| | 5.0 | 0.970 | 4.46 |

**Cave Creek at Spur Crossing:** A continuous measurement gage established 16 June 1993. Located 3.5 miles north of the Town of Cave Creek in Section 4, Township 6 N., Range 4 E., at Latitude 33° 53'05" and Longitude 111° 57'17". The gage is at elevation 2,280 feet.

**Cave Creek near Cave Creek:** A continuous measurement gage established 27 May 1994. Located along the 40th Street alignment, 0.75 miles southwest of the Carefree Highway, in the SW1/4 of Section 12, Township 5 N., Range 3 E., Latitude 33° 47'30" and Longitude 112° 00'36".

Both gages have an insignificant period of record for statistical analysis of a 100-year recurrence interval and a storm of near 100-year magnitude has not occurred on the

watershed during their time of operation. Data from these gages are therefore, not used in this study. It should be noted that the District's "Cave Creek near Cave Creek" gage is placed at essentially the same location as the previously mentioned USGS crest-stage gage station discussed in Section 3.2.3.2. The USGS gage was discontinued after 1989.

Additional streamflow gage data and statistics for watersheds in central and southern Arizona are published in the Garrett and Gellenbeck report (USGS, 1991). Results from selected watersheds that are considered hydrologically similar to the study watershed are used for indirect verification of the HEC-1 modeling results. The gage locations chosen are summarized in Section 3.3 of this report.

3.2.5.2 Precipitation Gages

There are four continuous recording precipitation gages located in or near the study watershed. All four gages are owned, operated, and monitored by the District and are located as follows:

**Cave Creek at Spur Crossing:** Established 16 June 1993. Located 3.5 miles north of the Town of Cave Creek in Section 4, Township 6 N., Range 4 E., at Latitude 33° 53'05" and Longitude 111° 57'17". The gage is at elevation 2,280 feet.

**Carefree Ranch:** Established 15 July 1985. Located 3.5 miles NE of Carefree Airport in Section 16, Township 6 N., Range 5 E., at Latitude 33° 52'03" and Longitude 111° 51'17". The gage is at elevation 3,200 feet.

**Humboldt Mountain:** Established 14 July 1981. Located 13 miles NE of the Town of Cave Creek in Section 1, Township 7 N., Range 5 E., at Latitude 33° 58'46" and Longitude 111° 47'56". The gage is at elevation 5,198 feet.

**Seven Springs:** Established 12 November 1981. Located 15 miles NNE of the Town of Cave Creek in Township 8 N., Range 5 E., at Latitude 34° 03'06" and Longitude 111° 51'17". The gage is at elevation 4,595 feet.

All four gages do not have a sufficient period of record for statistical analysis of a 100-year recurrence interval precipitation depth, therefore, data from these gages are not used in this study.

## 3.3 Calibration

### 3.3.1 General

Calibration of the HEC-1 models is not possible because of the lack of available physical data. In lieu of calibration, indirect methods of model verification are performed and compared to the modeling results. The indirect verification methods used are:

1. Comparison of HEC-1 results with USGS gage data for representative watersheds;

2. Comparison of HEC-1 results with estimates made using a USGS regional regression equation; and

3. Comparison of HEC-1 results with results from previous FIS studies completed in Maricopa County.

### 3.3.2 Comparison with USGS Gage Data

Representative watersheds and their corresponding gage data are selected from the Garrett and Gellenbeck report (USGS,1991) and summarized in Table E-1 of Appendix E. The HEC-1 modeling results selected for comparison are summarized in Table E-2 of Appendix E. Data from Tables E-1 and E-2 are plotted on Figure E-1 of Appendix E. The USGS gaged watersheds that are the most hydrologically similar to the study watershed, are identified as such in both Table E-1 and Figure E-1. The USGS gage data selected are for watersheds ranging in size from 1.8 to 144 square miles. Unit peak 100-year discharge estimates for those basins range from 136 to 1,789 cfs per square mile. The HEC-1 model results selected for comparison range in size from 1.3 to 124 square miles, with unit peak 100-year discharges ranging from 272 to 1,243 cfs per square mile. As can be seen on Figure E-1, the HEC-1 model data points plot favorably within the scatter limits of the USGS gage data. In summary, there is no reason to doubt the validity of the HEC-1 model results based on this comparison.

### 3.3.3 Comparison with USGS Regional Regression Equation.

Table E-3 provides a comparison of the HEC-1 modeling results to 100-year peak discharge estimates calculated using regional regression equations developed for Arizona,

and published in the USGS Open-File Report 93-419 by Thomas, Hjalmarson, and Waltemeyer titled; Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States, (USGS,1994). According to that report, Arizona is characterized by flood regions, with the study watershed being located in Flood Region 12. Applicable excerpts from that report for Flood Region 12, that are used for this comparison, are provided in Appendix E. Included in those excerpts are a map showing regional boundaries in Arizona with the approximate limit of the study watershed indicated (labelled as Figure E-2), a Region 12 scatter diagram of mean basin elevation versus drainage area for gaged sites used to perform regression analysis (labelled as Figure E-3), a tabulation of Region 12 regression equations for estimation of peak discharges and the corresponding error percentages (labelled as Table E-4), and a Region 12 scatter diagram and envelope curve of peak 100-year discharges versus drainage area for gaged sites used for regression analysis (labelled as Figure E-4). In summary, the regression equation results are very similar to the HEC-1 model results for all of the comparison points and there is no reason to doubt the validity of the HEC-1 model based on this comparison. In fact, this comparison strongly supports the HEC-1 results.

### 3.3.4 Comparison with Previous FIS Studies in Maricopa County

The Arizona Department of Water Resources (ADWR) has adopted State Standard SS-2 (ADWR,1991) which includes envelope curves of 100-year peak discharge estimates, by county, for flood insurance studies performed in Arizona. The curve developed for Maricopa County is included in Appendix E as Figure E-5. The 100-year HEC-1 model unit peak discharge results summarized in Table E-2 are plotted on Figure E-5 for comparison. In summary, all data points plot below the envelope curve and generally within the data points, and there is no reason to doubt the validity of the HEC-1 model based on this comparison.

## 3.4 Special Problems and Solutions

### 3.4.1 HEC-1 Warnings and Errors

The only warning messages encountered in any of the three models summarized in this report are as follows:

```
* 130140 *   *** WARNING *** MODIFIED PULS ROUTING MAY
BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN 19304.
TO 21669.
```

* 400410 * WARNING --- ROUTED OUTFLOW ( 44962.) IS GREATER THAN MAXIMUM OUTFLOW ( 44000. ) IN STORAGE-OUTFLOW TABLE

* S370 * WARNING EXCESS AT PONDING LESS THAN ZERO FOR PERIOD. EXCESS SET TO ZERO

The first warning listed above specifies a range of peak flows for which the routing numerics may be unstable. For example; in the first warning message above, the routed peak discharge for the reach is 17,396 cfs (see the 100-year, 24-hour HEC-1 model for the overall Cave Creek watershed). Note that the computed peak discharge is less than the range specified in the warning message. Each routing reach for which a warning message is issued was checked for the following:

1. The routed peak discharge was compared to the range listed in the warning message;
2. The routed peak discharge was compared with the inflow peak discharge to determine if an increase resulted due to the routing computations; and
3. The routed hydrograph was plotted and checked for oscillations if either item 1 or 2 above was a concern.

Hydrograph plots for the reaches which required analyzing by the third step are provided in Appendix F. Examination of those plots do not give any cause to suspect the routing calculations, therefore, the warning messages are considered inconsequential.

The second warning message listed above occurs only in the overall Cave Creek watershed 100-year, 24-hour model, and only for routing reach 400410. The message is self-explanatory and is issued only for the ordinates of the first index hydrograph (JD record option) that exceed 40,000 cfs for that reach route. This message is inconsequential to the desired modeling results since the subject index hydrograph for which the message is issued is not used to interpolate the final hydrograph for that operation. Accordingly, the message is ignored.

The third warning message listed above is in regard to the rainfall loss calculations performed by HEC-1 using the Green and Ampt methodology. After satisfying the surface retention loss requirement, HEC-1 then performs check calculations for each modeling time period to determine when a combination of accumulated rainfall and sufficient rainfall intensity occur to begin ponding (rainfall excess generation). All rainfall is infiltrated to that point and accounted for in the calculations. Once the program determines that ponding has occurred, an infiltration rate is then calculated for each time period and subtracted from the rainfall intensity for that same period to obtain the rate of rainfall excess. Due to imperfect numerics, it is possible to have a rainfall intensity for the modeling time period that results in the calculation of a ponding condition, yet is less than the calculated infiltration capacity of the soil for that time period. This results in a negative value for the rainfall excess calculation. HEC-1 issues its message and sets the loss to zero. Subbasin operation S370 in the Andora Hills Wash 100-year, 24-hour model is the only place where this message appears. This message is not an indication of model instability and can be disregarded.

## 3.5 Final Results

### 3.5.1 General

Three HEC-1 models are developed for this study. The first and primary model is of the Cave Creek watershed tributary to a point just below the Carefree Highway bridge and is for a 100-year, 24-hour storm. The two secondary models are of the Andora Hills Wash watershed, which is a major subbasin of the Cave Creek watershed, and are for 100-year, 6- and 24-hour storms. The difference in modeling of the Andora Hills Wash minor subbasins between the Cave Creek and Andora Hills Wash 100-year, 24-hour models, occurs in the computational time interval (NMIN) and point precipitation values. The Cave Creek model uses an NMIN of 5 minutes and the Andora Hills Wash model uses 2 minutes. Differences in the point precipitation values are summarized in Section 3.2.4.2.

The results for each model are summarized in Tables 3-11 through 3-14. Tables 3-11, 3-12, and 3-13 summarize HEC-1 model results for each of the three models. Table 3-14 compares the 100-year, 6-hour to 100-year, 24-hour results from the Andora Hills Wash models and summarizes the controlling storm duration for each HEC-1 operation. In summary, the 6-hour storm produces higher peak discharges and controls until

## TABLE 3-11

### Summary of 100-year, 24-hour HEC-1 model results for Cave Creek watershed

| Subbasin ID | HEC-1 ID | Peak Discharge cfs | Time to Peak hrs | Tributary Drainage Area sm | Unit Peak Discharge cfs/sm | Excess Rainfall Depth in | Excess Rainfall Volume ac-ft |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| SSW1 | S110L | 7,509 | 12.67 | 10.6 | 708 | 1.679 | 949 |
| CC1 | S110R | 9,212 | 12.92 | 17.9 | 514 | 1.585 | 1,516 |
| BC1 | S120 | 3,123 | 12.58 | 4.8 | 655 | 1.584 | 403 |
| CC2 | S130 | 3,342 | 12.25 | 2.9 | 1,160 | 1.743 | 268 |
| BMM1 | S140 | 1,846 | 12.25 | 1.8 | 1,003 | 1.622 | 159 |
| CC3 | S150 | 1,381 | 12.17 | 1.1 | 1,291 | 1.871 | 107 |
| UNT1 | S150R | 2,361 | 12.17 | 2.0 | 1,181 | 1.744 | 186 |
| STC1 | S160 | 1,334 | 12.25 | 1.3 | 1,034 | 1.697 | 117 |
| CC4 | S170 | 1,378 | 12.17 | 0.9 | 1,514 | 1.962 | 95 |
| GG1 | S170R | 2,742 | 12.50 | 3.4 | 802 | 1.788 | 326 |
| MF1 | S180 | 3,283 | 12.50 | 3.8 | 864 | 1.796 | 364 |
| CC6 | S190L | 3,503 | 12.25 | 2.8 | 1,247 | 1.805 | 271 |
| CC5 | S190R | 3,666 | 12.50 | 4.4 | 839 | 1.813 | 423 |
| CC7 | S200 | 4,911 | 12.17 | 4.0 | 1,243 | 1.792 | 378 |
| CWC1 | S210 | 5,895 | 12.83 | 10.4 | 570 | 1.845 | 1,018 |
| CC8 | S220 | 4,131 | 12.25 | 3.6 | 1,138 | 2.052 | 397 |
| CC9 | S230 | 2,408 | 12.25 | 1.8 | 1,309 | 2.212 | 217 |
| CC10 | S240 | 2,964 | 12.33 | 2.6 | 1,127 | 2.001 | 281 |
| WSW1 | S250 | 5,379 | 12.50 | 5.9 | 913 | 2.063 | 648 |
| UNT2 | S260L | 3,232 | 12.50 | 3.8 | 855 | 2.052 | 414 |
| CC11 | S260R | 2,410 | 12.17 | 1.7 | 1,461 | 2.305 | 203 |
| GVW1 | S270 | 3,471 | 12.75 | 4.9 | 714 | 2.126 | 551 |
| GVW2 | S280 | 4,340 | 12.58 | 5.9 | 732 | 1.758 | 556 |
| GWW1 | S290 | 6,269 | 12.67 | 7.6 | 821 | 1.927 | 785 |
| GVW3 | S310 | 2,747 | 12.33 | 2.4 | 1,149 | 1.785 | 228 |
| AHW1 | S320 | 945 | 12.00 | 0.5 | 2,100 | 2.526 | 61 |
| AHW4 | S330 | 284 | 12.08 | 0.2 | 1,775 | 3.395 | 29 |
| AHW3 | S340L | 418 | 12.08 | 0.2 | 1,742 | 2.283 | 29 |
| AHW2 | S340R | 125 | 12.00 | 0.1 | 2,083 | 3.342 | 11 |
| AHW5 | S350 | 315 | 12.08 | 0.2 | 1,969 | 2.579 | 22 |
| AHW6 | S360 | 791 | 12.25 | 0.6 | 1,364 | 2.327 | 72 |
| AHW7 | S370 | 634 | 12.08 | 0.3 | 1,865 | 3.565 | 65 |
| AHW8 | S380 | 933 | 12.00 | 0.4 | 2,276 | 2.575 | 56 |
| AHW9 | S390 | 607 | 12.08 | 0.4 | 1,734 | 2.405 | 45 |
| CC12 | S400 | 3,541 | 12.33 | 3.1 | 1,157 | 2.178 | 355 |
| UNT3 | S400L | 3,461 | 13.00 | 5.0 | 688 | 2.099 | 563 |

TABLE 3-11 (continued)

**Summary of 100-year, 24-hour HEC-1 model results for Cave Creek watershed**

| Subbasin ID (1) | HEC-1 ID (2) | Peak Discharge cfs (3) | Time to Peak hrs (4) | Basin Area sm (5) | Unit Peak Discharge cfs/sm (6) | Excess Rainfall Depth in (7) | Excess Rainfall Volume ac-ft (8) |
|---|---|---|---|---|---|---|---|
| CC13 | S410 | 2,169 | 12.17 | 1.3 | 1,656 | 2.241 | 157 |
| — | C110 | 15,136 | 12.83 | 28.5 | 531 | 1.545 | 2,351 |
| — | C120 | 17,293 | 12.83 | 33.3 | 519 | 1.512 | 2,686 |
| — | C130 | 17,526 | 12.92 | 36.2 | 484 | 1.501 | 2,896 |
| — | C140 | 17,929 | 12.92 | 38.0 | 472 | 1.489 | 3,019 |
| — | C150 | 17,932 | 13.08 | 41.1 | 437 | 1.480 | 3,243 |
| — | C160 | 18,188 | 13.08 | 42.4 | 429 | 1.475 | 3,334 |
| — | C170 | 19,152 | 13.08 | 46.7 | 410 | 1.471 | 3,665 |
| — | C180 | 20,249 | 13.17 | 50.5 | 401 | 1.467 | 3,952 |
| — | C190 | 20,761 | 13.33 | 57.7 | 360 | 1.458 | 4,486 |
| — | C200 | 20,679 | 13.50 | 61.6 | 335 | 1.453 | 4,777 |
| — | C210 | 23,119 | 13.58 | 72.0 | 321 | 1.459 | 5,602 |
| — | C220 | 23,260 | 13.58 | 75.6 | 308 | 1.463 | 5,900 |
| — | C230 | 23,235 | 13.67 | 77.5 | 300 | 1.465 | 6,052 |
| — | C240 | 23,394 | 13.75 | 80.1 | 292 | 1.467 | 6,266 |
| — | C250 | 24,045 | 13.75 | 86.0 | 280 | 1.476 | 6,768 |
| — | C260 | 24,661 | 13.75 | 91.4 | 270 | 1.487 | 7,249 |
| — | C295 | 9,547 | 12.75 | 13.6 | 704 | 1.708 | 1,236 |
| — | C300 | 11,828 | 12.83 | 18.4 | 641 | 1.729 | 1,700 |
| — | C310 | 30,867 | 13.33 | 112.2 | 275 | 1.475 | 8,829 |
| — | C310L | 12,838 | 12.83 | 20.8 | 617 | 1.693 | 1,880 |
| — | C340 | 1,747 | 12.08 | 0.9 | 1,899 | 2.670 | 131 |
| — | C350 | 1,987 | 12.08 | 1.1 | 1,840 | 2.645 | 152 |
| — | C360 | 2,620 | 12.25 | 1.7 | 1,578 | 2.491 | 221 |
| — | C370 | 3,011 | 12.25 | 2.0 | 1,506 | 2.644 | 282 |
| — | C385 | 3,416 | 12.25 | 2.4 | 1,412 | 2.601 | 336 |
| — | C390 | 31,176 | 13.33 | 115.0 | 271 | 1.486 | 9,113 |
| — | C390L | 3,798 | 12.25 | 2.8 | 1,376 | 2.555 | 376 |
| — | C400 | 33,856 | 13.17 | 123.1 | 275 | 1.484 | 9,741 |
| — | C400R | 31,437 | 13.42 | 118.1 | 266 | 1.477 | 9,299 |
| — | C410 | 33,771 | 13.33 | 124.4 | 272 | 1.481 | 9,824 |
| — | 110120 | 14,944 | 12.92 | 28.5 | 524 | 1.544 | 2,349 |
| — | 120130 | 16,828 | 12.92 | 33.3 | 505 | 1.509 | 2,681 |
| — | 130140 | 17,396 | 12.92 | 36.2 | 481 | 1.500 | 2,894 |
| — | 140150 | 17,572 | 13.08 | 38.0 | 462 | 1.485 | 3,011 |
| — | 150160 | 17,925 | 13.08 | 41.1 | 436 | 1.480 | 3,243 |

TABLE 3-11(continued)

**Summary of 100-year, 24-hour HEC-1 model results for Cave Creek watershed**

| Subbasin ID (1) | HEC-1 ID (2) | Peak Discharge cfs (3) | Time to Peak hrs (4) | Basin Area sm (5) | Unit Peak Discharge cfs/sm (6) | Excess Rainfall Depth in (7) | Excess Rainfall Volume ac-ft (8) |
|---|---|---|---|---|---|---|---|
| --- | 160170 | 18,051 | 13.17 | 42.4 | 426 | 1.473 | 3,329 |
| --- | 170180 | 19,074 | 13.17 | 46.7 | 408 | 1.470 | 3,662 |
| --- | 180190 | 19,633 | 13.42 | 50.5 | 389 | 1.462 | 3,938 |
| --- | 190200 | 20,566 | 13.50 | 57.7 | 356 | 1.455 | 4,477 |
| --- | 200210 | 20,482 | 13.58 | 61.6 | 332 | 1.447 | 4,757 |
| --- | 210220 | 22,987 | 13.67 | 72.0 | 319 | 1.454 | 5,583 |
| --- | 220230 | 23,134 | 13.67 | 75.6 | 306 | 1.458 | 5,880 |
| --- | 230240 | 23,199 | 13.75 | 77.5 | 299 | 1.463 | 6,044 |
| --- | 240250 | 23,213 | 13.83 | 80.1 | 290 | 1.461 | 6,241 |
| --- | 250260 | 24,030 | 13.83 | 86.0 | 280 | 1.475 | 6,763 |
| --- | 270300 | 3,213 | 13.17 | 4.9 | 661 | 2.049 | 531 |
| --- | 280295 | 3,983 | 12.83 | 5.9 | 672 | 1.566 | 495 |
| --- | 295300 | 9,465 | 12.83 | 13.6 | 697 | 1.697 | 1,228 |
| --- | 300310 | 11,751 | 12.83 | 18.4 | 637 | 1.718 | 1,690 |
| --- | 310390 | 30,821 | 13.33 | 112.2 | 275 | 1.473 | 8,817 |
| --- | 320340 | 933 | 12.08 | 0.5 | 2,073 | 2.521 | 61 |
| --- | 330340 | 277 | 12.17 | 0.2 | 1,731 | 3.390 | 29 |
| --- | 340350 | 1,690 | 12.17 | 0.9 | 1,837 | 2.665 | 131 |
| --- | 350360 | 1,868 | 12.25 | 1.1 | 1,730 | 2.636 | 152 |
| --- | 360370 | 2,564 | 12.33 | 1.7 | 1,545 | 2.485 | 220 |
| --- | 370385 | 2,979 | 12.33 | 2.0 | 1,490 | 2.640 | 282 |
| --- | 380385 | 886 | 12.00 | 0.4 | 2,161 | 2.568 | 56 |
| --- | 385390 | 3,370 | 12.33 | 2.4 | 1,393 | 2.601 | 336 |
| --- | 390400 | 30,982 | 13.50 | 115.0 | 269 | 1.471 | 9,021 |
| --- | 400410 | 33,698 | 13.33 | 123.1 | 274 | 1.479 | 9,709 |

---- Note: HEC-1 operation accounts for more than one subbasin

## TABLE 3-12

### Summary of 100-year, 6-hour HEC-1 model results for Andora Hills Wash

| Subbasin ID | HEC-1 ID | Peak Discharge cfs | Time to Peak hrs | Tributary Drainage Area sm | Unit Peak Discharge cfs/sm | Excess Rainfall Depth in | Excess Rainfall Volume ac-ft |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| AHW1 | S320 | 1,385 | 4.07 | 0.5 | 3,078 | 2.242 | 54 |
| AHW4 | S330 | 388 | 4.10 | 0.2 | 2,425 | 2.701 | 23 |
| AHW3 | S340L | 568 | 4.13 | 0.2 | 2,367 | 2.097 | 27 |
| AHW2 | S340R | 181 | 4.07 | 0.1 | 3,017 | 2.677 | 9 |
| AHW5 | S350 | 447 | 4.07 | 0.2 | 2,794 | 2.269 | 19 |
| AHW6 | S360 | 895 | 4.33 | 0.6 | 1,543 | 2.112 | 65 |
| AHW7 | S370 | 862 | 4.10 | 0.3 | 2,535 | 2.769 | 50 |
| AHW8 | S380 | 1,419 | 4.03 | 0.4 | 3,461 | 2.320 | 51 |
| AHW9 | S390 | 829 | 4.10 | 0.4 | 2,369 | 2.201 | 41 |
| ---- | C340 | 2,070 | 4.10 | 0.9 | 2,250 | 2.244 | 110 |
| ---- | C350 | 2,260 | 4.13 | 1.1 | 2,093 | 2.216 | 128 |
| ---- | C360 | 2,615 | 4.30 | 1.7 | 1,575 | 2.100 | 186 |
| ---- | C370 | 2,902 | 4.33 | 2.0 | 1,451 | 2.176 | 232 |
| ---- | C385 | 3,192 | 4.33 | 2.4 | 1,319 | 2.155 | 278 |
| ---- | C390L | 3,456 | 4.33 | 2.8 | 1,252 | 2.123 | 313 |
| ---- | 320340 | 1,325 | 4.10 | 0.5 | 2,944 | 2.240 | 54 |
| ---- | 330340 | 376 | 4.13 | 0.2 | 2,350 | 2.699 | 23 |
| ---- | 340350 | 2,025 | 4.17 | 0.9 | 2,201 | 2.242 | 110 |
| ---- | 350360 | 2,146 | 4.27 | 1.1 | 1,987 | 2.213 | 127 |
| ---- | 360370 | 2,572 | 4.33 | 1.7 | 1,549 | 2.097 | 186 |
| ---- | 370385 | 2,870 | 4.37 | 2.0 | 1,435 | 2.174 | 232 |
| ---- | 380385 | 1,273 | 4.07 | 0.4 | 3,105 | 2.317 | 51 |
| ---- | 385390 | 3,166 | 4.37 | 2.4 | 1,308 | 2.155 | 278 |

---- Note: HEC-1 operation accounts for more than one subbasin

## TABLE 3-13

### Summary of 100-year, 24-hour HEC-1 model results for Andora Hills Wash

| Subbasin ID | HEC-1 ID | Peak Discharge cfs | Time to Peak hrs | Basin Area sm | Unit Peak Discharge cfs/sm | Excess Rainfall Depth in | Excess Rainfall Volume ac-ft |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| AHW1 | S320 | 866 | 12.03 | 0.5 | 1,924 | 2.283 | 55 |
| AHW4 | S330 | 262 | 12.10 | 0.2 | 1,638 | 3.063 | 26 |
| AHW3 | S340L | 381 | 12.10 | 0.2 | 1,588 | 2.056 | 26 |
| AHW2 | S340R | 117 | 12.07 | 0.1 | 1,950 | 3.040 | 10 |
| AHW5 | S350 | 289 | 12.07 | 0.2 | 1,806 | 2.325 | 20 |
| AHW6 | S360 | 716 | 12.23 | 0.6 | 1,234 | 2.085 | 64 |
| AHW7 | S370 | 584 | 12.10 | 0.3 | 1,718 | 3.239 | 59 |
| AHW8 | S380 | 849 | 12.00 | 0.4 | 2,071 | 2.305 | 50 |
| AHW9 | S390 | 554 | 12.10 | 0.4 | 1,583 | 2.142 | 40 |
| ---- | C340 | 1,591 | 12.10 | 0.9 | 1,729 | 2.407 | 118 |
| ---- | C350 | 1,827 | 12.13 | 1.1 | 1,692 | 2.386 | 137 |
| ---- | C360 | 2,450 | 12.27 | 1.7 | 1,476 | 2.256 | 200 |
| ---- | C370 | 2,814 | 12.27 | 2.0 | 1,407 | 2.404 | 256 |
| ---- | C385 | 3,204 | 12.23 | 2.4 | 1,324 | 2.368 | 306 |
| ---- | C390L | 3,568 | 12.27 | 2.8 | 1,293 | 2.328 | 343 |
| ---- | 320340 | 852 | 12.07 | 0.5 | 1,893 | 2.278 | 55 |
| ---- | 330340 | 257 | 12.13 | 0.2 | 1,606 | 3.058 | 26 |
| ---- | 340350 | 1,558 | 12.13 | 0.9 | 1,693 | 2.403 | 118 |
| ---- | 350360 | 1,754 | 12.27 | 1.1 | 1,624 | 2.378 | 137 |
| ---- | 360370 | 2,414 | 12.30 | 1.7 | 1,454 | 2.250 | 199 |
| ---- | 370385 | 2,794 | 12.33 | 2.0 | 1,397 | 2.400 | 256 |
| ---- | 380385 | 834 | 12.07 | 0.4 | 2,034 | 2.299 | 50 |
| ---- | 385390 | 3,194 | 12.30 | 2.4 | 1,320 | 2.368 | 306 |

---- Note: HEC-1 operation accounts for more than one subbasin

## TABLE 3-14

**Summary of controlling 100-year storm duration for Andora Hills Wash peak discharges**

| Subbasin ID | HEC-1 ID | 100-Year Peak Discharge 6-Hour cfs | 100-Year Peak Discharge 24-Hour cfs | Controlling Storm Duration |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| AHW1 | S320 | 1,385 | 866 | 6-Hour |
| AHW4 | S330 | 388 | 262 | 6-Hour |
| AHW3 | S340L | 568 | 381 | 6-Hour |
| AHW2 | S340R | 181 | 117 | 6-Hour |
| AHW5 | S350 | 447 | 289 | 6-Hour |
| AHW6 | S360 | 895 | 716 | 6-Hour |
| AHW7 | S370 | 862 | 584 | 6-Hour |
| AHW8 | S380 | 1,419 | 849 | 6-Hour |
| AHW9 | S390 | 829 | 554 | 6-Hour |
| ---- | C340 | 2,070 | 1,591 | 6-Hour |
| ---- | C350 | 2,260 | 1,827 | 6-Hour |
| ---- | C360 | 2,615 | 2,450 | 6-Hour |
| ---- | C370 | 2,902 | 2,814 | 6-Hour |
| ---- | C385 | 3,192 | 3,204 | 24-Hour |
| ---- | C390L | 3,456 | 3,568 | 24-Hour |
| ---- | 320340 | 1,325 | 852 | 6-Hour |
| ---- | 330340 | 376 | 257 | 6-Hour |
| ---- | 340350 | 2,025 | 1,558 | 6-Hour |
| ---- | 350360 | 2,146 | 1,754 | 6-Hour |
| ---- | 360370 | 2,572 | 2,414 | 6-Hour |
| ---- | 370385 | 2,870 | 2,794 | 6-Hour |
| ---- | 380385 | 1,273 | 834 | 6-Hour |
| ---- | 385390 | 3,166 | 3,194 | 24-Hour |

---- Note: HEC-1 operation accounts for more than one subbasin

approximately concentration point C370. Below that point, the 100-year, 24-hour storm dictates the peak discharges. Only the 100-year, 24-hour storm is modeled for the Cave Creek watershed.

### 3.5.2 Summary of HEC-1 Modeling Nomenclature, Schematic Diagram and Output

The following is a summary of the nomenclature used in the HEC-1 models' identification records:

| HEC-1 ID | DESCRIPTION |
|---|---|
| S190L<br>S190R | Hydrograph identifier for the subbasin operation at concentration point 190. The "S" qualifier denotes a subbasin operation. The "L" or "R" qualifiers indicate that the hydrograph enters concentration point 190 as a left or right branch, respectively. The directional basis for those qualifiers assumes an orientation looking downstream. |
| C310<br>C310L | Hydrograph identifier for a combine operation at concentration point 190. The "C" qualifier denotes a combination of multiple hydrographs. The use of "L" or "R" indicates that the operation is an interim combination of hydrographs for a branch point just upstream and left or right of the main concentration point, respectively. The directional basis for those qualifiers assumes an orientation looking downstream. |
| 190200 | Hydrograph identifier for a Modified Puls channel storage route operation. The first and last three numbers indicate the upstream and downstream concentration points for the reach, respectively. |

A schematic of the Cave Creek and Andora Hills Wash HEC-1 models is shown on Figure 3-5. The HEC-1 output file for the Cave Creek watershed 100-year, 24-hour model is provided in Appendix G. The 100-year, 6- and 24-hour HEC-1 model output files for the Andora Hills Wash sub-watershed are provided in Appendices H and I, respectively.

### 3.5.3 Comparison with Previous Cave Creek Watershed Studies

The two studies establishing the current FIS peak discharges along the study reach of Cave Creek and all of Andora Hills Wash, are briefly summarized as follows:

1. Harris-Toups Associates, September 1978 (HTA,1978). A study of Cave Creek and 6 tributaries. The Cave Creek study limits are 0.7 miles downstream of Carefree Highway to 0.14 miles upstream of Morning Star Road. The 6 tributaries that were studied are Andora Hills Wash, Galloway

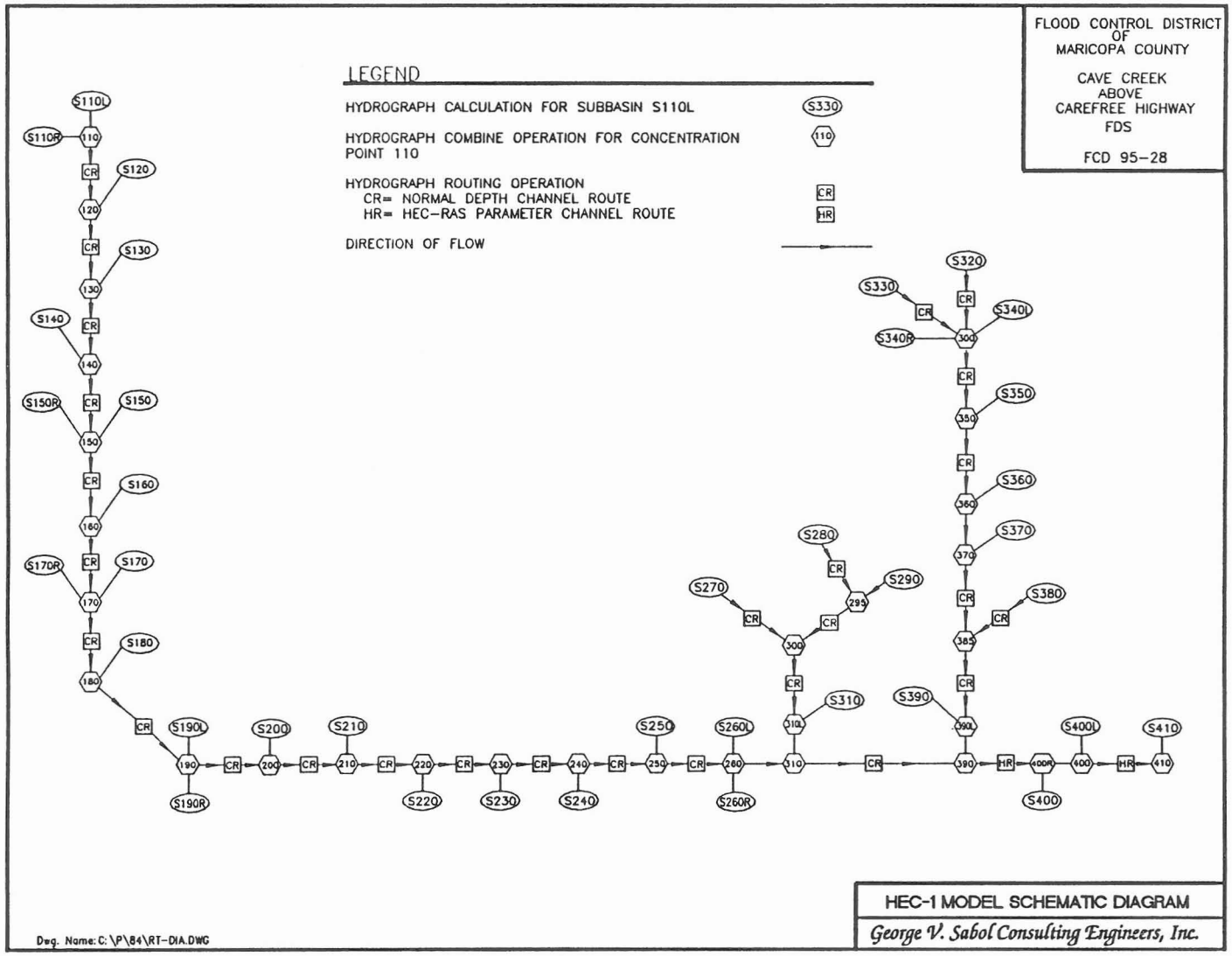



**FIGURE 3-5**

**Schematic diagram for HEC-1 models of Cave Creek and Andora Hills Wash**

Wash, Grapevine Wash, Ocotillo Wash, Rowe Wash and Willow Springs Wash. Hydrology was performed using the SCS TR-20 computer program. Water surface profiles were computed using HEC-2 for the 10-, 50-, 100-, and 500-year floods.

2. CH2M Hill, March 1990, Final Hydrologic and Hydraulic Report for Cave Creek/Carefree Flood Delineation Study, (CH2MHILL,1990). A flood delineation study of Cave Creek and 5 tributaries prepared under contract with the FCDMC (FCD 88-53). The Cave Creek study limits are river mile 35.49 to the Tonto National Forest boundary (3.3 miles). The 5 tributaries that were studied are Cottonwood Creek, Willow Springs Wash, Ocotillo Wash, Grapevine-Rowe Washes and the North Tributary of Galloway Wash. Hydrology was performed using a modified version of the Cave Creek/Bloody Basin HEC-1 model developed by the FCDMC. Water surface profiles were computed using HEC-2 for the 10-, 50-, 100-, and 500-year floods.

Table 3-15 summarizes and compares the 100-year peak discharges estimated in the two previous reports and this study's HEC-1 models. For Cave Creek, the peak discharges estimated by this study are consistently less than those presented in the previous reports. Conversely, the Andora Hills Wash peak discharges estimated by this study are consistently greater than the previous report estimates. The following discussion summarizes reasons for those differences.

The reductions in Cave Creek peak discharges estimated by this study, as compared to those estimated by previous studies, are mostly due to improved modeling techniques and better estimation of rainfall losses for the 62 square mile portion of watershed situated within the Tonto National Forest (TNF). According to the CH2M Hill study, no soils data were obtained for the TNF. A hydrologic soil group "D" classification was assumed, resulting in the use of a 0.05 inch per hour bare ground uniform loss rate (ULR in ULR+IL method of HEC-1) for the entire TNF portion of the watershed. The TNF bare ground XKSAT values estimated in this study, which are technically equivalent to the ULR parameter, range from 0.13 to 0.34 inches per hour with an approximate average of 0.25 inches per hour (see Section 3.2.2.3 and Appendix A). This is an appreciable difference when applied to a 62 square mile area. Detailed modeling information for the HTA report is

## TABLE 3-15

**Summary and comparison of the HEC-1 model results with previous Cave Creek watershed FIS study results at selected locations**

| Comparison Point Location Description | GVSCE 100-year Estimates | | | Previous Report 100-year Estimates: Harris-Toups | | Previous Report 100-year Estimates: CH2M Hill | |
|---|---|---|---|---|---|---|---|
| | HEC-1 ID | Drainage Area sm | Peak Discharge cfs | Drainage Area sm | Peak Discharge cfs | Drainage Area sm | Peak Discharge cfs |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Cave Creek** | | | | | | | |
| Below Carefree Highway Bridge | C410 | 124.38 | 33,771 | 126.92 | 36,860 | ---- | ---- |
| Just below Andora Hills Wash Confluence | C390 | 114.99 | 31,176 | 115.14 | 35,000 | ---- | ---- |
| GVSCE upstream FPD limit (RM35.49) | C230 | 77.46 | 23,235 | ---- | ---- | 75.86 | 28,338 |
| Just below Cottonwood Creek Confl. (RM36.40) | C220 | 75.62 | 23,260 | ---- | ---- | 73.94 | 28,271 |
| At Tonto National Forest Boundary | C200 | 61.64 | 20,679 | ---- | ---- | 60.21 | 27,603 |
| **Andora Hills Wash** | | | | | | | |
| Just above Confl. with Cave Creek | C390L | 2.76 | 3,568 | 2.75 | 2,585 | ---- | ---- |
| At School House Road | C360 | 1.66 | 2,615 | 1.60 | 1,820 | ---- | ---- |
| Below Scottsdale Road | S320 | 0.45 | 1,385 | 0.56 | 715 | ---- | ---- |

unavailable, but it is likely that the same kind of generalized assumptions concerning hydrologic soil group classification of the TNF soils were made, since the hydrology was estimated using the TR20 program and SCS curve numbers. Other factors contributing to the differences in values include using the JD option to better model the areal reduction factors of the watershed, and unit hydrograph techniques.

The increase in peak discharge estimates for Andora Hills Wash are mostly due to increased imperviousness on the watershed due to development and the use of 6-hour storms and distributions with higher intensities than the SCS 24-hour methods. As can be noted by comparing the 6-hour results to the 24-hour results in Table 3-14, the 6-hour storm produces significantly higher peak discharges for relatively small (less than 0.5 square mile) subbasins. This, in combination with the increased imperviousness due to development of the area, readily justifies the increase in peak discharges. Another factor contributing to the difference in peaks is the use of the Green and Ampt method to estimate rainfall losses as opposed to the SCS curve number method. With regard to temporal rainfall characteristics, the Green and Ampt infiltration equation provides a more realistic, physically based estimation of rainfall losses than the curve number method. The Green and Ampt methodology is therefore a superior modeling tool for estimation of rainfall losses in rainfall-runoff modeling.

In conclusion, there is no reason to doubt the results of this study based on a comparison with the previous studies. The modeling techniques and tools executed in this study are demonstrated to be preferred over the previous study methodologies and they satisfy the Design Manual criteria.

### 3.5.4 Applicability of Hydrologic Models for Other Uses

The HEC-1 models developed by this study are for a 100-year storm considering existing condition urban development and basin characteristics. The modeling effort is executed at a level of detail that is specifically appropriate for the provision of 100-year peak discharges for use in floodplain delineation and flood insurance evaluations. Secondary uses of the hydrology results for development projects and drainage improvements designs, should be tempered by the following considerations:

1. The basin lag and time of concentration parameters may not be appropriate for storm frequencies other than the 100-year event.

2. Several of the concentration points defined in this study are considered as "intermediate" modeling points and are solely established to provide appropriate hydrograph discharges and volumes for use in reach routes, without the creation of numerous, small modeling subbasins that are hydrologically insignificant for the 100-year event. For example; concentration point (CP) 210 on Cave Creek (see Hydrology Exhibit A) is considered to be an intermediate point. The hydrograph being routed from CP 200 to CP 210 is significantly increased after being combined with the subbasin hydrograph from Cottonwood Creek (HEC-1 operation S210). Delineation of the intermediate tributary area to CP 210 from the west side of Cave Creek, would result in a subbasin that is less than 0.5 square miles in size. The 100-year hydrologic contribution of this subbasin to the combined flood hydrograph at CP 210 is negligible and that area is accounted for in the next downstream subbasin operation (S220). Based on this definition, the concentration points that are considered "intermediate" are: C120, C160, C180, C210, C250, C295, C300, C310, C385 and C390. It should be noted that the 100-year discharges estimated at these points are more than adequate for floodplain delineation purposes. It is recommended, however, that inclusion of the "intermediate" areas as separate subbasins be analyzed, if greater frequency storm peak discharges are desired at those concentration points.

3. The modeling results of this study reflect the existing development condition of the watershed. Future use of the HEC-1 models should include an assessment of the amount of development that has occurred on the watershed since the time of this study.

### 3.6 Final Modeling Results on Diskette

The diskette containing the HEC-1 files for this project is provided in a folder behind Section 7 of this report. An ASCII text file named README.DOC is included on the diskette and summarizes the files and filenames provided.

# SECTION 4: HYDRAULICS ANALYSIS

The entire contents of Study Documentation Section 4 are found in "Cave Creek Above Carefree Highway Floodplain Delineation Study, Technical Data Notebook, Hydraulics."

# SECTION 5: EROSION/SEDIMENT TRANSPORT ANALYSIS

Not part of this report.

# SECTION 6: REFERENCE MATERIALS

## 6.1 Other Published Flood Studies

See discussion in Section 3.5.3 pertaining to previous studies.

## 6.2 Previous FEMA Studies

Same as Section 6.1

## 6.3 Other Applicable Studies

No other studies are referenced in this report.

## 6.4 Published and Unpublished Historical Flood Information

See discussion in Section 3.2.5.1 and Section 3.3.2 of this report.

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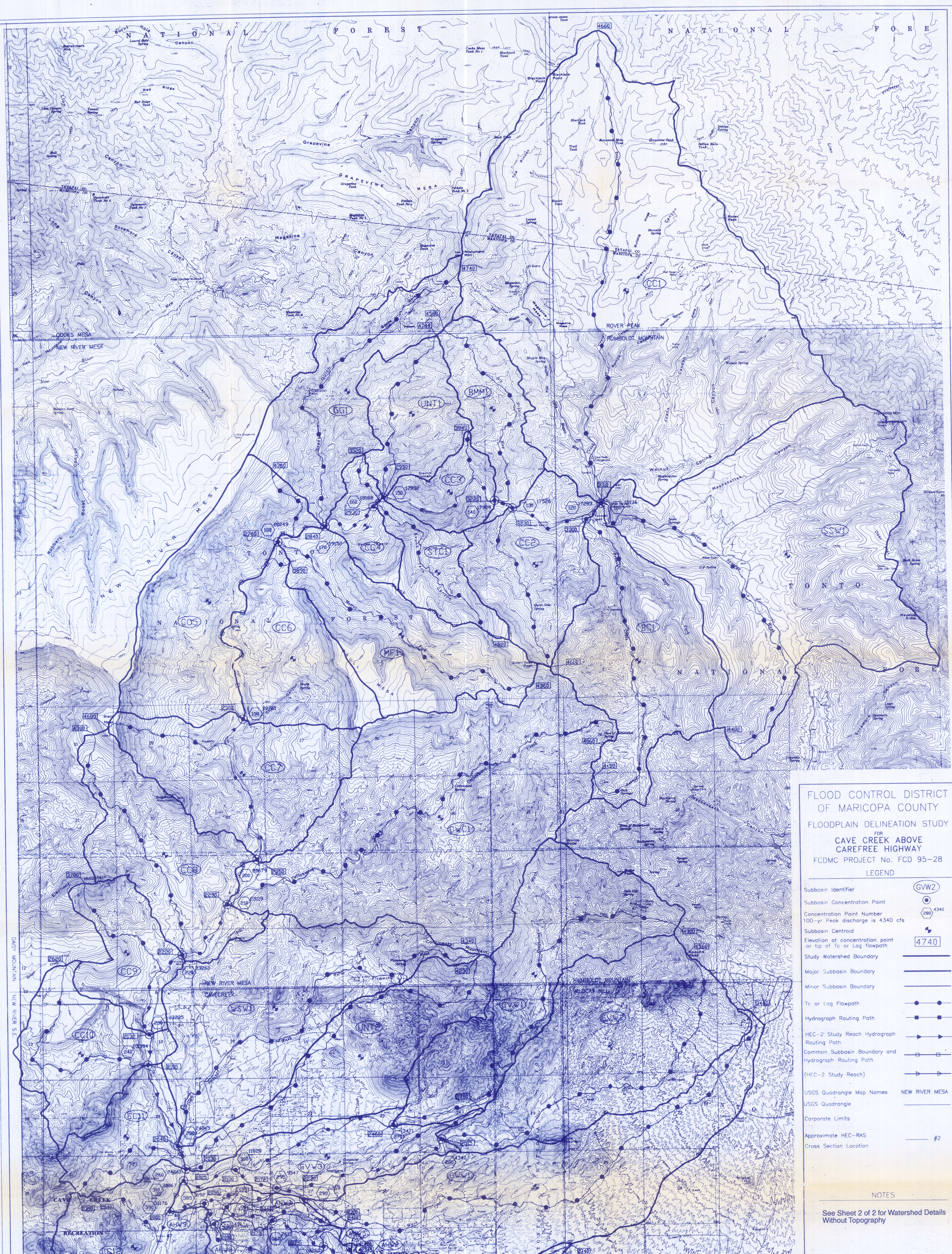
## SECTION 7: CROSS-REFERENCE AND LABELING INFORMATION

The entire contents of Study Documentation Section 7 are found in "Cave Creek Above Carefree Highway Floodplain Delineation Study, Technical Data Notebook, Hydraulics."




# FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOODPLAIN DELINEATION STUDY

FOR

**CAVE CREEK ABOVE CAREFREE HIGHWAY**

FCDMC PROJECT No. FCD 95-28

## LEGEND

| | |
|---|---|
| Subbasin Identifier | GVW2 |
| Subbasin Concentration Point | |
| Concentration Point Number 100-yr Peak discharge is 4340 cfs | 280 4340 |
| Subbasin Centroid | |
| Elevation at concentration point or tip of Tc or Lag flowpath | 4740 |
| Study Watershed Boundary | |
| Major Subbasin Boundary | |
| Minor Subbasin Boundary | |
| Tc or Lag Flowpath | |
| Hydrograph Routing Path | |
| HEC-2 Study Reach Hydrograph Routing Path | |
| Common Subbasin Boundary and Hydrograph Routing Path | |
| (HEC-2 Study Reach) | |
| USGS Quadrangle Map Names | NEW RIVER MESA |
| USGS Quadrangle | |
| Corporate Limits | |
| Approximate HEC-RAS Cross Section Location | #2 |

NOTES

See Sheet 2 of 2 for Watershed Details Without Topography

2000 0 2000 4000

SCALE: 1"= 2000'

CONTOUR INTERVAL = VARIES

# HYDROLOGY EXHIBIT A

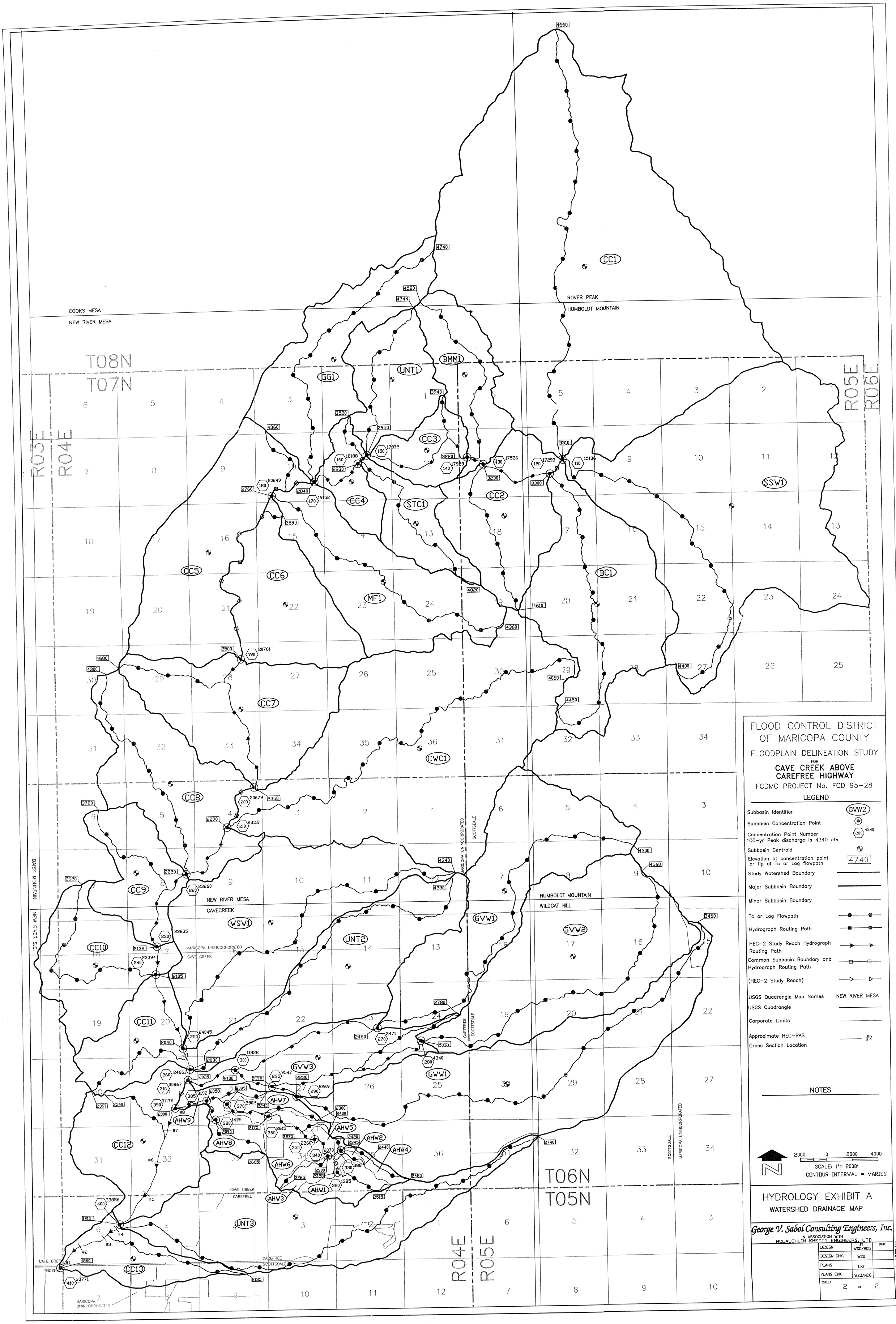
WATERSHED DRAINAGE MAP

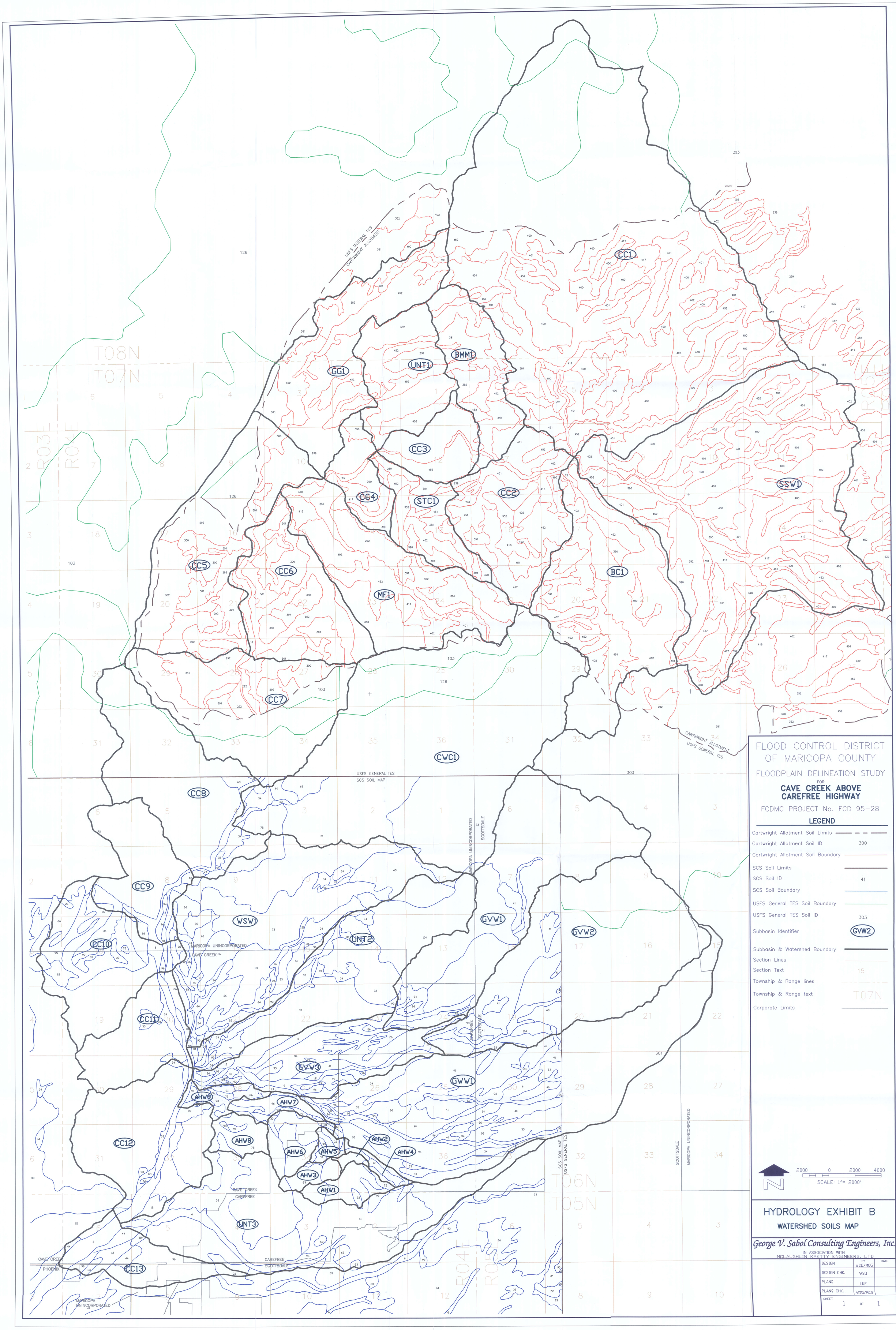
*George V. Sabol Consulting Engineers, Inc.*

IN ASSOCIATION WITH

MCLAUGHLIN KMETTY ENGINEERS, LTD

| | BY | DATE |
|---|---|---|
| DESIGN | WSO/MCG | |
| DESIGN CHK. | WSO | |
| PLANS | LKF | |
| PLANS CHK. | WSO/MCG | |
| SHEET | 1 OF 2 | |


COOKS MESA
NEW RIVER MESA
ROVER PEAK
HUMBOLDT MOUNTAIN
T08N
T07N
R03E
R04E
R05E
R06E
T06N
T05N
DAISY MOUNTAIN
NEW RIVER S.E.
NEW RIVER MESA
CAVECREEK
MARICOPA UNINCORPORATED
CAVE CREEK
HUMBOLDT MOUNTAIN
WILDCAT HILL
SCOTTSDALE
CAREFREE
CC1
CC2
CC3
CC4
CC5
CC6
CC7
CC8
CC9
CC10
CC11
CC12
CC13
CWC1
GG1
UNT1
BMM1
STC1
MF1
BC1
SSW1
WSW1
UNT2
UNT3
GVW1
GVW2
GVW3
GWW1
AHW1
AHW2
AHW3
AHW4
AHW5
AHW6
AHW7
AHW8
AHW9
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
FLOODPLAIN DELINEATION STUDY
FOR
CAVE CREEK ABOVE
CAREFREE HIGHWAY
FCDMC PROJECT No. FCD 95-28
LEGEND
Subbasin Identifier
Subbasin Concentration Point
Concentration Point Number
100-yr Peak discharge is 4340 cfs
Subbasin Centroid
Elevation at concentration point
or tip of Tc or Lag flowpath
Study Watershed Boundary
Major Subbasin Boundary
Minor Subbasin Boundary
Tc or Lag Flowpath
Hydrograph Routing Path
HEC-2 Study Reach Hydrograph
Routing Path
Common Subbasin Boundary and
Hydrograph Routing Path
(HEC-2 Study Reach)
USGS Quadrangle Map Names
NEW RIVER MESA
USGS Quadrangle
Corporate Limits
Approximate HEC-RAS
Cross Section Location
NOTES
SCALE: 1"= 2000'
CONTOUR INTERVAL = VARIES
HYDROLOGY EXHIBIT A
WATERSHED DRAINAGE MAP
George V. Sabol Consulting Engineers, Inc.
IN ASSOCIATION WITH
MCLAUGHLIN KMETTY ENGINEERS, LTD
DESIGN WSO/MCG
DESIGN CHK. WSO
PLANS LKF
PLANS CHK. WSO/MCG
SHEET 2 OF 2




FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOODPLAIN DELINEATION STUDY

FOR

**CAVE CREEK ABOVE CAREFREE HIGHWAY**

FCDMC PROJECT No. FCD 95-28

**LEGEND**

| | |
|---|---|
| Cartwright Allotment Soil Limits | |
| Cartwright Allotment Soil ID | 300 |
| Cartwright Allotment Soil Boundary | |
| SCS Soil Limits | |
| SCS Soil ID | 41 |
| SCS Soil Boundary | |
| USFS General TES Soil Boundary | |
| USFS General TES Soil ID | 303 |
| Subbasin Identifier | GVW2 |
| Subbasin & Watershed Boundary | |
| Section Lines | |
| Section Text | 15 |
| Township & Range lines | |
| Township & Range text | T07N |
| Corporate Limits | |

2000 0 2000 4000

SCALE: 1"= 2000'

# HYDROLOGY EXHIBIT B

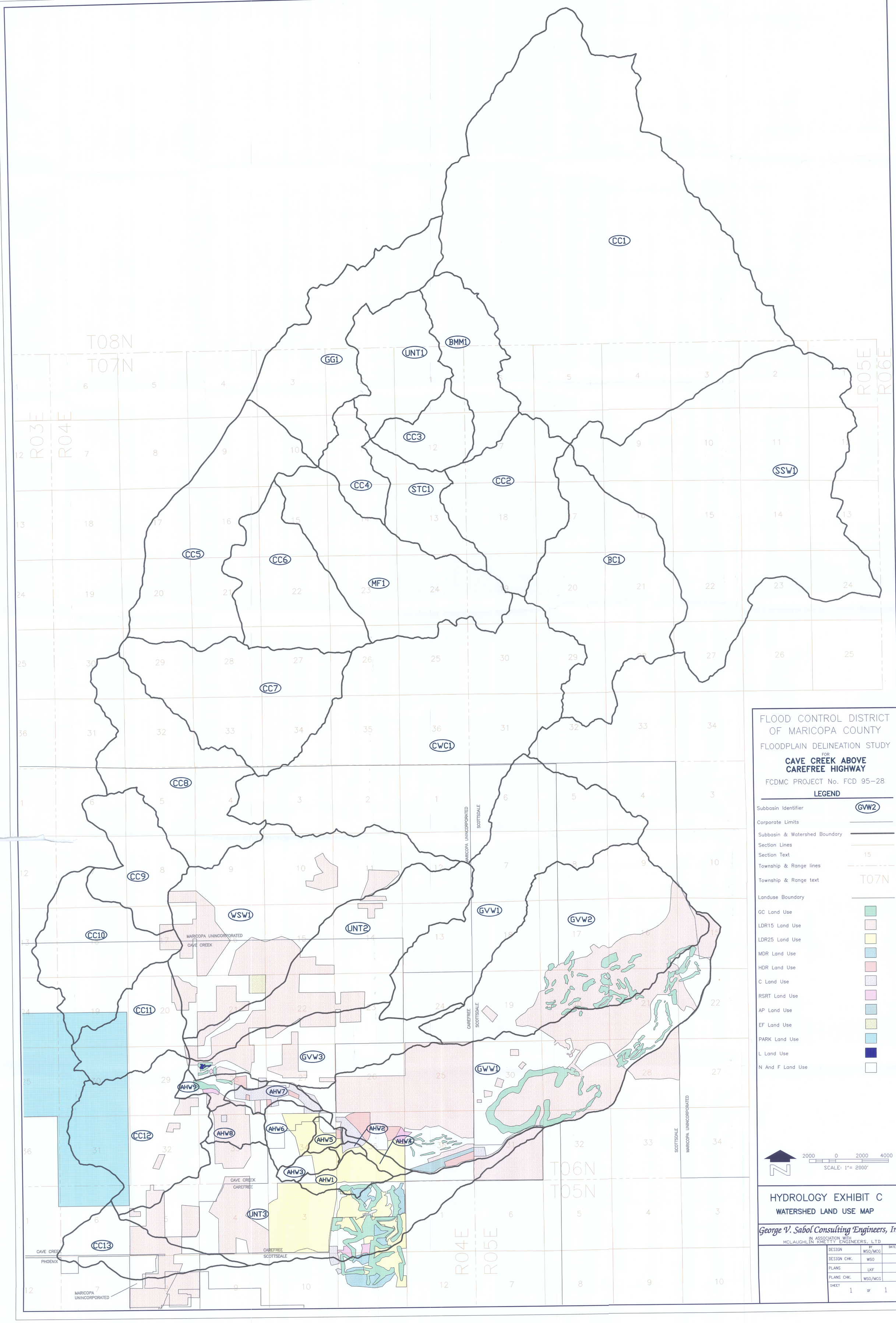
## WATERSHED SOILS MAP

*George V. Sabol Consulting Engineers, Inc.*

IN ASSOCIATION WITH
MCLAUGHLIN KMETTY ENGINEERS, LTD

| | BY | DATE |
|---|---|---|
| DESIGN | WSD/MCG | |
| DESIGN CHK. | WSD | |
| PLANS | LKF | |
| PLANS CHK. | WSD/MCG | |

SHEET 1 OF 1


CC1
BMM1
UNT1
GG1
CC3
CC2
STC1
CC4
SSW1
CC5
CC6
BC1
MF1
CC7
CWC1
CC8
CC9
WSW1
UNT2
GVW1
GVW2
CC10
CC11
GVW3
GWW1
AHW9
AHW7
AHW8
AHW6
AHW5
AHW2
AHW4
AHW3
AHW1
CC12
UNT3
CC13
T08N
T07N
T06N
T05N
R03E
R04E
R05E
R06E
MARICOPA UNINCORPORATED
SCOTTSDALE
CAVE CREEK
CAREFREE
PHOENIX
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FLOODPLAIN DELINEATION STUDY
FOR
CAVE CREEK ABOVE CAREFREE HIGHWAY
FCDMC PROJECT No. FCD 95-28
LEGEND
Subbasin Identifier
Corporate Limits
Subbasin & Watershed Boundary
Section Lines
Section Text
Township & Range lines
Township & Range text
Landuse Boundary
GC Land Use
LDR15 Land Use
LDR25 Land Use
MDR Land Use
HDR Land Use
C Land Use
RSRT Land Use
AP Land Use
EF Land Use
PARK Land Use
L Land Use
N And F Land Use
2000 0 2000 4000
SCALE: 1"= 2000'
HYDROLOGY EXHIBIT C
WATERSHED LAND USE MAP
George V. Sabol Consulting Engineers, Inc.
IN ASSOCIATION WITH
MCLAUGHLIN KMETTY ENGINEERS, LTD
DESIGN WSO/MCG
DESIGN CHK. WSO
PLANS LKF
PLANS CHK. WSO/MCG
SHEET 1 OF 1