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FINAL REPORT

FLOODPLAIN DELINEATION FOR A 30 MILE REACH OF GILA RIVER, ARIZONA FOR THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD CONTROL DISTRICT
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REMARKS

Dames & Moore
Pointe Corporate Centre
7500 North Dreamy Draw Drive, Suite 145
Phoenix, Arizona 85020

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October 7, 1988

D&M Job. No. 15448-001-022

Flood Control District of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

Attention: Mr. Pedro Calza

Final Report
Floodplain Delineation for a
30 Mile Reach of Gila River,
Arizona for the Flood Control
District of Maricopa County

Gentlemen:

The enclosed report is our Final Report for the above referenced project. We have addressed all of your previous review comments in this final submission which includes:

- Four copies of the Final Report.
- Two full size bound sets of the HEC-2 printouts for the 100-year (unencroached and encroached), 10-year, 50-year and 100-year flows.
- One floppy disc of the HEC-2 input files.
- Two full size bound sets of the blueline contour maps with cover and index sheets.
- One full size set of the mylar originals.

Should you have any questions regarding this final submission, please call us.

Very truly yours,

DAMES & MOORE
Design Services Group

George J. Geiser P.E.
Project Manager

W. Gary Rogers
Manager

GJG/baw
Enclosures

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ENCLOSURES

1. HEC-2 Computer Runs

2. Floodplain Delineation Maps
(Cover sheet, index sheet and 34 contour map sheets)

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1.0 INTRODUCTION

This report presents the results of Dames & Moore's floodplain redelineation study for a reach of the Gila River extending from just downstream of the Bullard Avenue bridge to Gillespie Dam (see Figure 1). The flooding redelineation study was completed for the Flood Control District of Maricopa County (FCDMC). The reach of the Gila River upstream of this study reach (including the Bullard Avenue bridge) was redelineated by the U.S. Army Corps of Engineers during 1984. The floodplain redelineations were necessary because of changed hydrologic and topographic data. Each of these factors is discussed in more detail below.

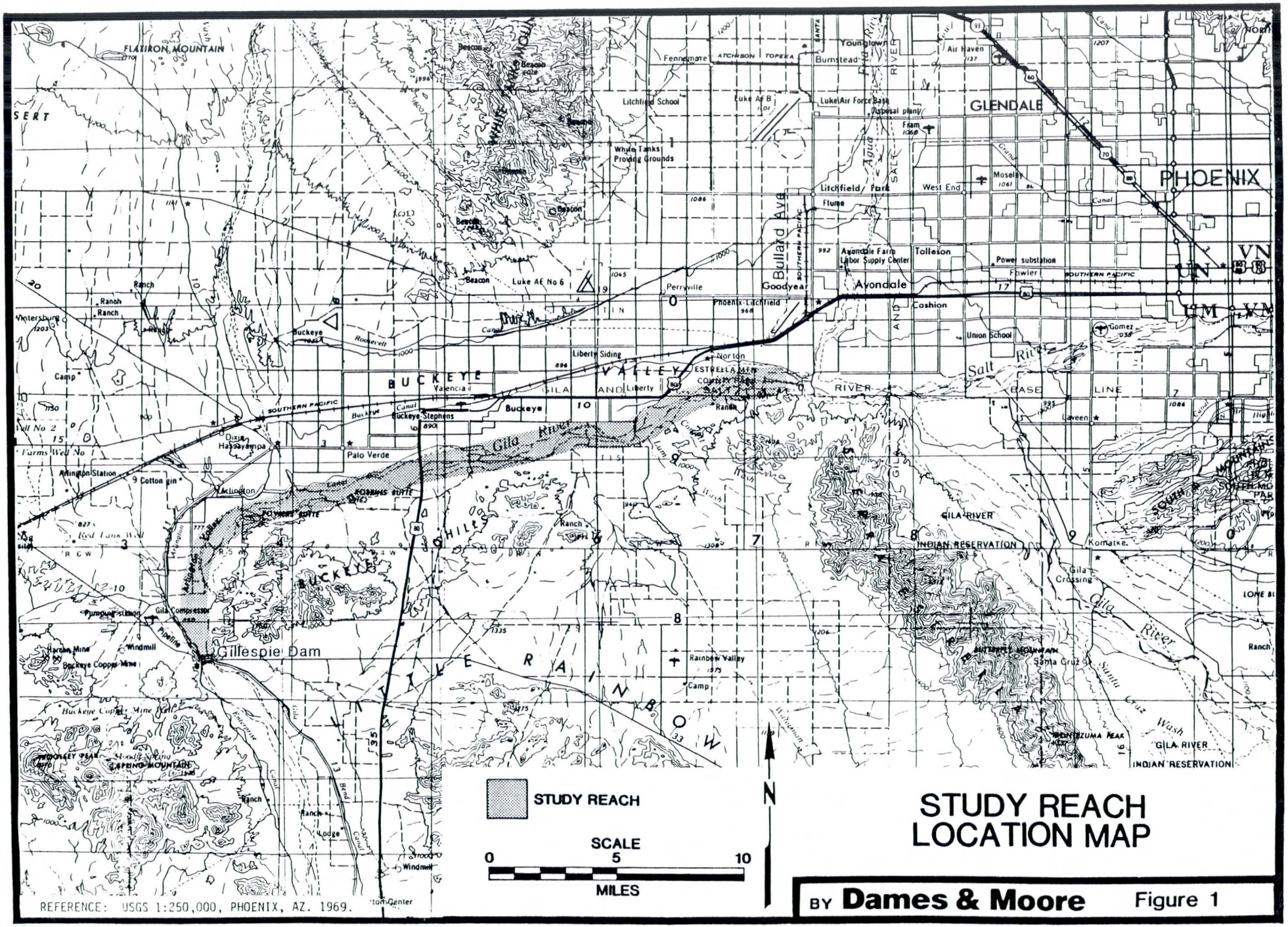
1.1 PURPOSES OF THE STUDY

1.1.1 New Hydrologic Data

The U.S. Army Corps of Engineers (COE) developed new hydrologic data for this study reach during 1982 subsequent to the numerous high flowrates experienced during 1978, 1979, and 1980 (USACOE, 1982). This analysis showed larger flowrates for the study reach for each of the 10- 50- 100- and 500-year events. The COE flowrates were used for this study and no new hydrologic analysis was completed specifically for this study. The results of the COE analysis are presented in Section 3.2.7 of this report.

1.1.2 New Topographic Mapping of Alluvial River

The Gila River along the study reach is an alluvial river. Although small flows occur in some reaches of the Gila River nearly year round, the study reach is best defined as an ephemeral river in which larger flows are infrequent but significant. These larger flows may be the result of releases from upstream dams on the Gila, Salt, or Agua Fria River systems, or intense storm events below the dams, or a combination of both. During these larger flows, the Gila River is subject to significant sediment transport. Thus, the most recent topographic information for the area is desirable when redelineating the floodplain.


STUDY REACH
SCALE
0
5
10
MILES
N
BY Dames & Moore
Figure 1
REFERENCE: USGS 1:250,000, PHOENIX, AZ. 1969.
PHOENIX
GLENDALE
Avondale
Tolleson
Buckeye
Gillespie Dam
Palo Verde
Arlington
Gila River
Salt River
Agua Fria River
Bullard Ave
Litchfield Park
Goodyear
Perryville
Youngtown
Sun City
Gila Crossing
Komatke
GILA RIVER INDIAN RESERVATION
Santa Cruz Wash
Santa Cruz River
Rainbow Valley
Luke AFB
Luke Air Force Base
Litchfield School
Whyle Tanks Proving Grounds
Luke AF No 6
Phoenix-Litchfield
Liberty Siding
Norton
Estrella
Cashion
Union School
Power substation
Fowler
Avondale Farm Labor Supply Center
Air Haven
Burnstead
Fennemore
Moselle
West End
Flume
Gomez
Laveen
Valencia
Buckeye Stephens
Dixie
Hassayampa
Arlington Station
Cotton gin
Pumping station
Gila Compressor
Windmill
Buckeye Copper Mine
Harden Mine
Buckeye Copper Mine Well
Red Tank Well
Farms Well No 1
Well No 2
Ranch
Camp
Lodge
Whitesburg
Roosevelt
Canal
Southern Pacific
Atchison Topeka
Santa Fe
Buckeye Hills
Tiley Rainbow Valley
Butterfly Mountain
Montezuma Peak
Hoodoo Peak
Sierra Vista
Capitol Mountain
Flatiron Mountain
Sierra
Tom Center

The topographic mapping used for this study was derived from aerial photography. The western (downstream) reach of the study reach (cross section numbers 45 to 198) was mapped by Kenney Aerial Mapping, Inc. based on aerial photography dated May 1984 (KAMI, 1984). The eastern reach (cross section numbers 200 to 386) was mapped by Aerial Mapping Company, Inc. based on aerial photography dated March 1984 (AMCI, 1984). Photogramatic control and elevation reference marks were documented for the study by AMCI (AMCI, 1984a, 1987 and Dames & Moore 1988). Cross sections at selected locations, and approximately 3 miles apart, were verified by AMCI during a ground-based field survey in April and May of 1987.

1.1.3 New Bridges at Tuthill and Reems Roads

A new Tuthill Road bridge over the Gila River was constructed under the direction of the Maricopa County Highway Department (MCHD) in 1981 (MCHD, 1981). A new Reems Road bridge over the Gila River is presently in the final phases of construction by private developers (FCDMC, 1988). These new bridges were included in the analysis of the floodplain.

1.1.4 Expanded Bridge at AZ-85

The bridge over the Gila River at AZ-85 (U.S. 80) was approximately doubled in length in 1982. Construction of both the older section and the newer (southern) section of the bridge was under the direction of the Arizona Department of Transportation (ADOT, 1969, 1982). The lengthened bridge was included in the analysis of the floodplain.

1.1.5 Establishment of Riparian Vegetation

Thick stands of trees and heavy brush have become established in many areas of the study reach where ground water is at shallow depth. The trees are mostly salt cedar with occasional cottonwood trees. The trees range in height from 6 feet to 20 feet with trunks ranging from 3 inches to 12 inches in diameter. Since the last major flow during 1980, this vegetation has increased significantly in both density and areal extent. The establishment of this riparian vegetation represents the most significant

impact to the flows in the study reach and was included in the analysis of the floodplain.

1.1.6 Flood Control District Policy for Vegetation Maintenance

Subsequent to the large flood events of 1978-80, the FCDMC established a new policy for vegetation maintenance along the study reach. This policy includes the legal right and funds necessary to clear, on a recurring basis, the thick riparian vegetation from a 1000-foot-wide swath through the entire study reach. The 1000-foot-wide swath policy is consistent with the historic channel braiding and lateral migration, and attempts to control where the new channel may be formed.

1.2 AUTHORITY FOR STUDY

This investigation was authorized by a contract (FCD 86-28) with the FCDMC, dated November 10, 1986.

1.3 COORDINATION OF STUDY

1.3.1 Agency Contacts

The FCDMC has provided written notice of the redelineation study to the following agencies and organizations in January 1987.

- U.S. Army Corps of Engineers
- U.S. Geology Survey, Water Resources Division
- U.S. Fish and Wildlife Services
- U.S. Soil Conservation Service
- U.S. Bureau of Land Management
- U.S. Bureau of Reclamation
- Arizona Game and Fish Department
- Maricopa County, General Services
- Roosevelt Irrigation District
- Town of Buckeye
- Town of Goodyear

1.3.2 Review Process

Each of the agencies and organizations notified of the study was also solicited for comments and any relevant technical information. As of the date of this report, no response has been received by the FCDMC.

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2.0 SCOPE OF WORK

The scope of work for this investigation includes computer modeling of the 10-, 50-, 100- and 500-year flows to determine water surface profiles and delineation of the 100-year floodplain and the 100-year floodway for the study reach of the Gila River. The scope of work is discussed in greater detail below. The work was performed according to guidelines established by the Federal Emergency Management Agency (FEMA, 1985, 1985a).

2.1 STUDY REACH

The study reach is bounded on the upstream end by Bullard Avenue, and on the downstream end by Gillespie Dam. The limits of the study reach are shown in Figure 1.

2.2 FACILITIES INCLUDED/EXCLUDED

Facilities included in this investigation which were also included in the previous delineation of the floodplain include Gillespie Dam and the older part of the AZ-85 (U.S. 80) bridge. New facilities which have also been included in this investigation include the in-place Tuthill Avenue bridge, the Reems Road bridge (under construction) and the in-place new section of the AZ-85 bridge. The 1000-foot-wide swath through the thick vegetation was included. The Bullard Avenue bridge was not included in this investigation because it had been included in the recently completed redelineation study by the COE for the reach just upstream of this study reach. Other structures which might encroach into the floodplain, but are still in the planning stages, were not included in this investigation.

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3.0 ENGINEERING METHODOLOGY

3.1 HYDROLOGIC DATA

Due to the unusually high occurrence of large flows in the late 1970s and 1980, much of the hydrology for large portions of the Gila River watershed has been reevaluated. Dames & Moore was instructed by FCDMC (FCDMC, 1987) to utilize the 1984 hydrologic data developed by the U.S. Army Corps of Engineers (USACOE, 1982) for this floodplain delineation. This new analysis has resulted in increased flowrate estimates for recurrence interval flows along most of the Gila River below its confluence with the Salt River. These flowrates are summarized in Table 1. The flowrates decrease in the downstream direction due to channel and overbank storage and high infiltration losses to the river alluvium. Each flowrate was assumed constant from its upstream location to the next downstream location identified in Table 1.

Table 1

DESIGN FLOWRATE VERSUS
RECURRENCE INTERVAL FOR
GILA RIVER STUDY REACH
(cfs)

Location	Return Interval			
	10-year	50-year	100-year	500-year
Below confluence with Salt River	95,000	200,000	250,000	360,000
Below confluence with Waterman Wash	88,000	195,000	245,000	350,000
Below confluence with Hassayampa River	82,000	190,000	240,000	340,000
At Gillespie Dam	78,000	186,000	235,000	335,000

(USACOE, 1982)

3.2 HYDRAULIC ANALYSIS

3.2.1 HEC-2 Applications

The water surface elevations for the various flood profiles were estimated using the COE HEC-2 Water Surface Profiles computer model (USACOE, 1982a). The HEC-2 program was also used in developing the 100-year floodway. A step backwater analysis was used in the program to model the subcritical flow in the river. The downstream control section used in the analysis was the crest of Gillespie Dam. At this control section, critical depth was used to begin the analysis.

A HEC-2 model output was compared to 1980 pictures of flows over the top of Gillespie Dam (USACOE, 1980). These pictures were taken at an unknown time but within 24 hours of the peak flow of 180,000 cfs on February 16, 1980. The comparison was used to establish the reasonableness of the starting water surface elevation at the crest of the dam. The normal bridge routine was used at each bridge modeled in the study reach according to COE guidelines (USACOE, 1974, 1982a). To model the wide variety of vegetation which exists in both the channel and the floodplain, NH cards were used at each cross section. This allowed the maximum flexibility in locating the areas of different roughness coefficients.

3.2.2 Contour Mapping

The cross-sections used in the analysis were derived from 1 inch = 400 feet, 4 foot contour interval topographic maps (KAMI, 1984 and AMCI, 1984). The digitized cross-sections were provided to Dames & Moore by the FCDMC (FCDMC, 1987). To comply with Federal Emergency Management Agency guidelines (FEMA, 1985), some of the photogremetrically derived cross sections were verified by a field survey in 1987. The cross sections verified, along with a brief description of their location is presented in Table 2.

Table 2

CROSS SECTIONS VERIFIED
BY FIELD SURVEY

Cross Section Number	Description of Cross Section Location
45	Crest of Gillespie Dam
82	Near Buckeye Hills
120	Near Powers Butte
170	Near Robins Butte
206	Near AZ-85
254	Near Watson Road Alignment
316	Near Lums Wash
360	Near Cotton Lane Alignment
380	Downstream of Bullard Avenue

3.2.3 Survey Control and Elevation Reference Marks

The survey control for the entire study reach was performed by Aerial Mapping Company, Inc. Two reports identifying the elevation reference marks and containing the horizontal and vertical control tabulation for the eastern and western sections of the study reach were prepared for this study (AMCI, 1984a, 1987). Beloat Road has been paved and the ERMs replaced since the control surveys were originally completed for this study. Dames & Moore prepared a short survey report which ties in the elevation reference marks along Beloat Road (Dames & Moore, 1988).

3.2.4 As-Built Drawings for Bridges

The as-built plans for the Tuthill Bridge and the Tuthill Bridge approaches were provided to Dames & Moore by the FCDMC (MCHD, 1981). The as-built plans for the original bridge at AZ-85 and the as-built plans for the lengthening of the AZ-85 bridge were obtained by Dames & Moore from the Arizona Department of Transportation (ADOT, 1969, 1982).

3.2.5 Reems Road Bridge

Construction plans for the proposed new Reems Road bridge were provided by the FCDMC. These plans were prepared by the bridge and roadway design consultants (AN West, Inc., 1987 and Coe & Van Loo, 1987).

3.2.6 Roughness Coefficients

Dames & Moore and the FCDMC conducted a field visit to the study reach. In some areas of the study reach the dense vegetation prevented direct access to the river channel. Several rolls of film were used in photographing the channel and overbanks and detailed notes were taken to identify the type and the extent of vegetation along the study reach. These photographs and notes were then used with stereoscopic aerial photographs to estimate Manning's roughness coefficients for use in the HEC-2 analysis.

The FCDMC reviewed and accepted the selected roughness coefficients which are presented in Table 3.

A single roughness coefficient was assigned to the 1000-foot-wide swath that the FCDMC will clear on a recurring basis. Because some areas have just been cleared and some areas are nearly grown back and ready for clearing again, a roughness coefficient of 0.045 was selected to represent the average conditions for the entire length of the 1000-foot-wide swath.

3.2.7 Base Flood Elevations

The water surface elevations and a plot of the water surface profiles along the study reach for the 10-, 50-, 100- and 500-year floods are shown on the HEC-2 computer printouts included with this report as Enclosure 1.

Table 3

SUMMARY OF ROUGHNESS COEFFICIENTS

Description	Range of Values[a]	Selected Value
CHANNEL AREAS		
Sandy ground, no vegetation	0.025-0.035	0.030
Sparce brush, Very Short	0.030-0.040	0.035
Scattered brush, Heavy Weeds	0.035-0.070	0.045
1000 Foot Wide Swath		0.045
Light brush and trees	0.040-0.080	0.060
Medium brush and trees	0.070-0.160	0.070
Heavy stand of trees, some undergrowth	0.080-0.160	0.090
Dense trees, heavy undergrowth	0.110-0.200	0.120
OVERBANK AREAS		
Rocky desert slopes	0.030-0.050	0.035
Creosotebush association	0.030-0.050	0.035
Agricultural lands	0.020-0.050	0.035
LIMITED DEVELOPED AREAS		
Farm-related development	0.020-0.050	0.035
Golf course and park areas	0.025-0.050	0.035

a Chow, 1959.

3.2.8 Floodway Identification

The 100-year floodway was initially estimated using HEC-2 encroachment method 4. Encroachment method 1 was then used in the HEC-2 model to provide a smooth and continuous floodway. Once the floodway was established to be continuous, it was plotted on 1 inch = 400 feet topographic mapping. The plots of the floodway are presented on the set of 1 inch = 400 feet contour maps which accompany this report as Enclosure 2.

3.2.9 Comparison to 1980 Flow

Aerial photographs of the study reach taken during the 1980 flooding were provided to Dames & Moore by the FCDMC (FCDMC, 1982). Flowrates similar to those recorded along the Gila River in 1980 were used with the HEC-2 model. An attempt was then made to calibrate the HEC-2 model with the water surface elevations and floodplain width shown in the photographs. Water surface elevations predicted by the HEC-2 model were over a foot higher in some areas than those shown on the aerial photographs. The higher water surface elevations predicted by the HEC-2 model were the result of changes in the floodplain including the new Tuthill and Reems Road bridges and lengthening the AZ-85 bridge and the establishment of thick riparian vegetation throughout much of the study reach. These changes made a direct calibration of the 1987 HEC-2 model with the 1980 aerial photographs irrelevant.

3.2.10 Comparison to Previous Flood Insurance Rate Maps

A attempt was made to compare the HEC-2 model output with the current (effective date July 2, 1979) FEMA Flood Rate Insurance Maps (FEMA, 1979).

The 1979 Flood Insurance Rate Maps are based on earlier hydrology, and thus have different flowrates than this study. The newer hydrology, which resulted in higher flowrates, and the significant changes to the floodplain discussed in the previous section made direct comparison of the 1987 HEC-2 model with the 1979 Flood Insurance Rate Maps irrelevant.

3.2.11 Compatibility with Recent Upstream Study

The COE recently completed a redelineation of the Gila River floodplain for a study reach directly upstream of this study reach. The modeling results for several of the most downstream cross sections of the COE study were made available to Dames & Moore by the FCDMC (FCDMC, 1987).

Cross section number 189.07 of the COE study is located about 70 feet downstream from this study's cross section number 386.0. The Dames & Moore estimated 100-year flow (250,000 cfs) water surface elevation at the location of COE cross section number 189.07 is 914.63 feet. The COE study was completed before the Reems Road bridge design was finished and their water surface elevation for the same flow is 914.16. The 100-year water surface elevation has been raised about 0.47 feet because of the addition of the Reems Road bridge but this difference is within the 0.50 foot margin allowed by FEMA.

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4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The results of this study are presented in two formats. Copies of the HEC-2 computer printouts are included with this report. River profiles presented with these printouts include the 10-, 50-, 100- and 500-year flows. The 100-year floodway and 10-, 50-, 100- and 500-year computer printouts are bound separately and included with this report as Enclosure 1. A set of 34 one inch equals 400 feet, 4-foot contour maps (24" x 36") have been prepared to display the aerial extent of the 100-year flow. The 100-year floodway is also presented on this set of maps. These contour maps are bound separately and included with this report as Enclosure 2.

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5.0 OTHER STUDIES

5.1 PREVIOUS MAPS OF THE STUDY REACH

FEMA has published Flood Insurance Rate Maps for the study reach with an effective date of July 2, 1979. The eight community-panel numbers of the previous maps are:

- 040037 1700A
- 040037 1465A
- 040037 1470A
- 040037 1490A
- 040037 1480A
- 040037 1495A
- 040037 1485A
- 040037 1505A

5.2 U.S. ARMY CORPS OF ENGINEERS UPSTREAM STUDY

During 1985, the COE completed a redelineation of a section of the Gila River floodplain directly upstream of Dames & Moore's study reach (FCDMC, 1987). The downstream end of the COE study reach is slightly west (downstream) of the Bullard Avenue bridge. The most downstream cross section of the COE study (cross section 189.07) is approximately 70 feet downstream of the most upstream cross section of the Dames & Moore study (cross section 386.0).

The water surface elevation from the Dames & Moore study agrees with the water surface elevation from the COE study at a location about 70 feet downstream of this study's cross section number 386.0 within 0.47 foot, which is within the 0.50 foot requirement set by FEMA.

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6.0 REFERENCES

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AN West, Inc., 1987, Reems Road Bridge Plans, Job Number 4721-06, 6 sheets.

Arizona Department of Transportation, September 24, 1969, Plan and Profile of Proposed State Highway, Gila Bend - Buckeye, Maricopa County, F-023-1-504. As-built drawings, 23 sheets.

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_____, 1982a. HEC-2 Water Surface Profiles, Users Manual, generalized computer program. The Hydrologic Engineering Center, September, 1982.