FLOOD INSURANCE STUDY

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AGUA FRIA RIVER
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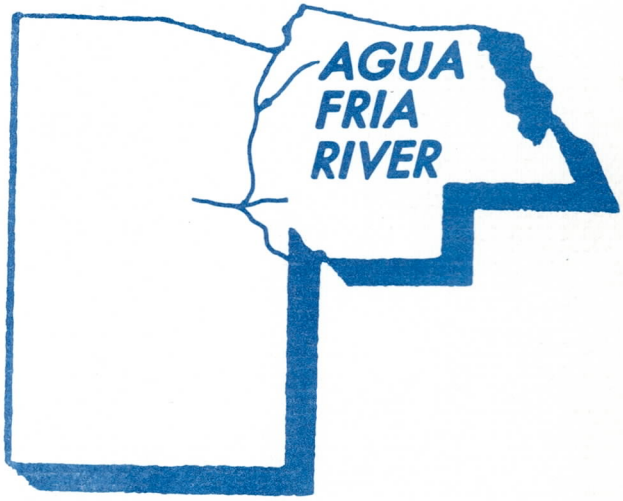

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 87-2

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REMARKS

AGUA FRIA RIVER
FLOOD INSURANCE STUDY

PREPARED FOR
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
CONTRACT FCD 87-2
JJA JOB NO. 286-080.01

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JANUARY, 1989

(REP-6)

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HEC-2
HEC-1

*Under Separate Cover

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15677
ROGER E.
BAELE
Date Signed 2-6-89
ARIZONA, U.S.A.

CERTIFICATION

This is to certify that all work accomplished in the conduct of this study was done in accordance with the Statement of Work and General Provisions of Contract FCD 87-2, and all amendments thereto, together with all such modifications, either written or oral, as the Project Officer and/or the Contracting Officer or their representatives have directed, as such modifications affect this contract, and that all such work has been accomplished in accordance with sound and accepted engineering practice within the contract provisions for respective phases of the work.

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Manager, Phoenix Office

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1.0 INTRODUCTION

1.1 Purpose of Study

This study investigates the existence and severity of flood hazards along the Agua Fria River in Maricopa County, Arizona. It aids in the administration of the Floodplain Ordinance of Maricopa County, in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data along the Agua Fria River that will be used in floodplain management and to establish actuarial flood insurance rates. Minimum floodplain management requirements for participation on the National Flood Insurance Program (NFIP) are set forth on the Code of Federal Regulations at 44 cfr, 60.3.

1.2 Authority and Acknowledgements

The hydraulic analyses for the riverine portions of this study and the hydrologic and hydraulic analyses for the ponding adjacent to levees were performed by Jerry R. Jones & Associates for the Flood Control District of Maricopa County (FCDMC) under Contract No. FCD 87-2. This work was completed in January, 1989. Discharges for the river were provided by FCDMC.

1.3 Coordination

On March 3, 1987, representatives of Jerry R. Jones & Associates and the FCDMC held an initial meeting to discuss possible sources of information helpful to the completion of the study and the completion of the channelization construction in progress on the river. The FCDMC, Arizona Department of Transportation, Southern Pacific Transportation Company, and the Atchison, Topeka and Santa Fe Railway Company provided bridge plans used in the hydraulic modeling of the bridges within the study limits. The Maricopa Water District provided plans for the elevated Beardsley Canal flume crossing of the river. The Cities of Phoenix, Glendale, Avondale, Peoria and the Towns of Goodyear and Youngtown supplied maps used to delineate jurisdictional limits on the base of maps. The FCDMC supplied channelization plans and hydrologic/hydraulic design reports for the ponding outlet structures through the levees. The FCDMC and Jerry R. Jones & Associates' staff met throughout the study to discuss results of the study and hydrologic/hydraulic modeling guidelines. The starting water surface elevations at the confluence with the Gila River were based upon a study by the Corps of Engineers in 1984. It was approved by the Federal Emerengcy Management Agency (FEMA) and is depicted in the current Flood Insurance Study (FIS, Reference 11).

2.0 AREA STUDIED

2.1 Scope of Study

This F.I.S. covers the reach of the Agua Fria River between the outlet of the diversion dam south of Waddell Dam (Lake Pleasant) and the Gila River. This is essentially the entire Agua Fria River within Maricopa County. The study area is shown on the Vicinity Map (Figure 1). In addition to the study of riverine flooding, ponding caused by the blockage of overland tributary inflows to the river was studied.

This restudy of the river was precipitated due to modifications to the floodplain, and construction of new structures affecting the floodplain. The detailed analysis within the current FIS (Reference 11) stopped at Jomax Road. Continuous topographic mapping of the river will allow for consistent analysis along the entire river. This study considers pre-New Waddell Dam hydrology. It incorporates new bridges constructed along the river and soil cement levees constructed between Indian School Road and Broadway Road.

The Agua Fria River, which flows intermittently, begins in the Prescott National Forest within Yavapai County and flows southward to its confluence with the Gila River. The total drainage area is 2,340 square miles (Reference 1). Waddell Dam, a water-supply dam constructed in 1927, backs up the water of the Agua Fria to form Lake Pleasant. The river flows downstream of the outlet of the diversion dam located south of Waddell Dam (River Mile 33.3). The 100-year floodplain in this area is about 400 feet wide and the area is largely undeveloped. Significant development, mostly residential, along the river does not begin until near Rose Garden Lane (River Mile 22). At this point the 100-year floodplain is about 3,000 feet wide.

Near Grand Avenue (River Mile 17), the land uses are a mix of residential, commercial and industrial. The 100-year floodplain is about 4,000 feet wide. Near Glendale Avenue (River Mile 11) the 100-year floodplain width has increased to about 8,000 feet. Beginning at a point just upstream of Indian School Road (River Mile 8) the river is confined between two soil-cement levees, rangeing between 1,100 and 1,300 feet wide. Along the east side of the river and south of Interstate 10 (River Mile 5.3) the use is currently agricultural. However, due to the protection provided by the levees, it is expected that this area will be developed into a mixture of residential, commercial, and industrial uses. This levee system was constructed by FCDMC and ends at Buckeye Road (approximately mile 3.7). There is a levee constructed by the COE along the west side of the channel from Buckeye Road to a point downstream of Lower Buckeye Road (approximately River Mile 1.9). They also constructed a horseshoe levee which protects the existing Rio Vista subdivision along the east bank just upstream of Lower Buckeye Road. These levees will be maintained by the FCDMC. Most of the land between Buckeye Road and the confluence with the Gila River is agricultural. The 100-year floodplain is about 9,000 feet wide at the Gila River.

2.2 Community Description

The Agua Fria River generally flows from a northerly to a southerly direction. It is approximately 14 miles west of Central Avenue in Phoenix. Central Avenue is a main north-south street that divides the central business district of downtown Phoenix. Due to the shallow sloping nature of terrain, the area has historically seen rural, agricultural land uses. Demand for accessible land to accommodate a growing population in the Phoenix metropolitan area, as well as plans for major transportation improvements have caused growing pressure for development in recent years near and within floodplains. Along the study reach the river affects land within Maricopa County, as well as the following municipalities: Avondale, El Mirage, Glendale, Goodyear, Peoria, Phoenix, Surprise, and Youngtown. Most of these communities cooperate with the FCDMC on questions of floodplain management.

2.3 Principal Flood Problems

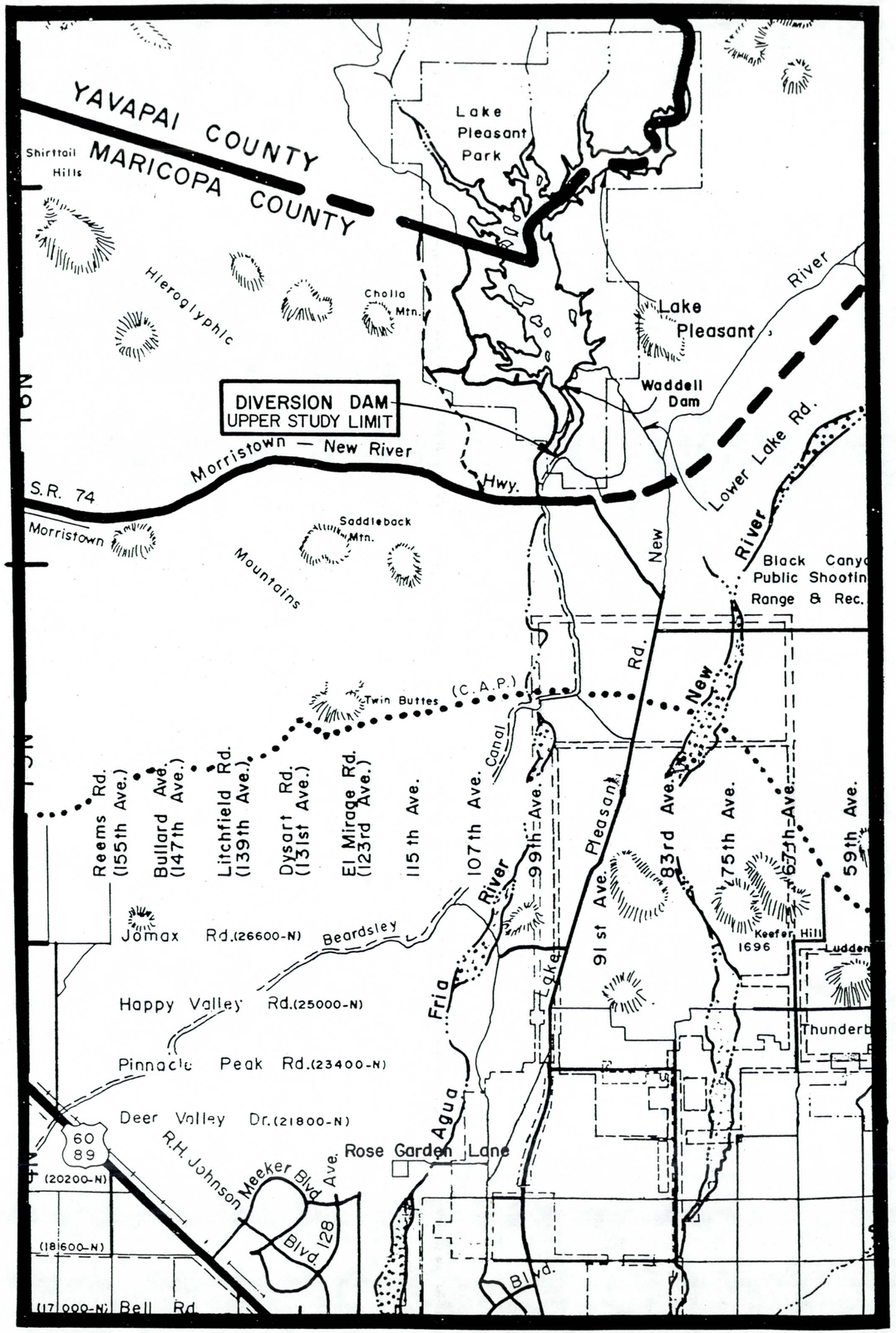
The principal flood hazard results from the inundation of the wide, flat floodplain adjacent to the river channel. The flood of February 1980 inundated an area averaging between three thousand and four thousand feet wide from Jomax Road (approximately River Mile 25.3) to the confluence with the Gila River. This is depicted on Figure 2 below. Extensive erosional patterns can be observed on the aerial photos taken soon after the peak flow.

The peak release from the dam was about 66,600 cubic feet per second (Reference 2) and has a recurrence interval of about 13 years. Other major floods occurred on the river in January 1916, November 1919, and September 1922 (Reference 1).

2.4 Flood Protection Measures

Waddell Dam, a water-supply dam constructed in 1927, is capable of providing some degree of flood protection even though it is not designed for that purpose. During the flood of December 1978, the maximum inflow to Lake Pleasant was 79,500 cfs and the maximum discharge was 59,900 cfs. During the flood of January 1980, the maximum inflow was 73,300 cfs and the maximum outflow was 66,600 cfs (Reference 2). The Bureau of Reclamation is constructing a new dam, (i.e. New Waddell Dam) downstream of the existing dam. The final height of the dam will be significantly higher than the existing dam. The principal reason for the modifications is to provide storage for Central Arizona Project (CAP) flows. Those modifications will afford some degree of additional flood protection. The COE is currently investigating the revised hydrology. The dam is schedule to be complete in 1992 with reservoir filling to be complete by 1995.

As previously stated, several flood control levees have been constructed since 1985 along the lower reaches of the Agua Fria River by FCDMC. The area between the levees was excavated to provide more channel area and a more hydraulically-efficient cross-section.



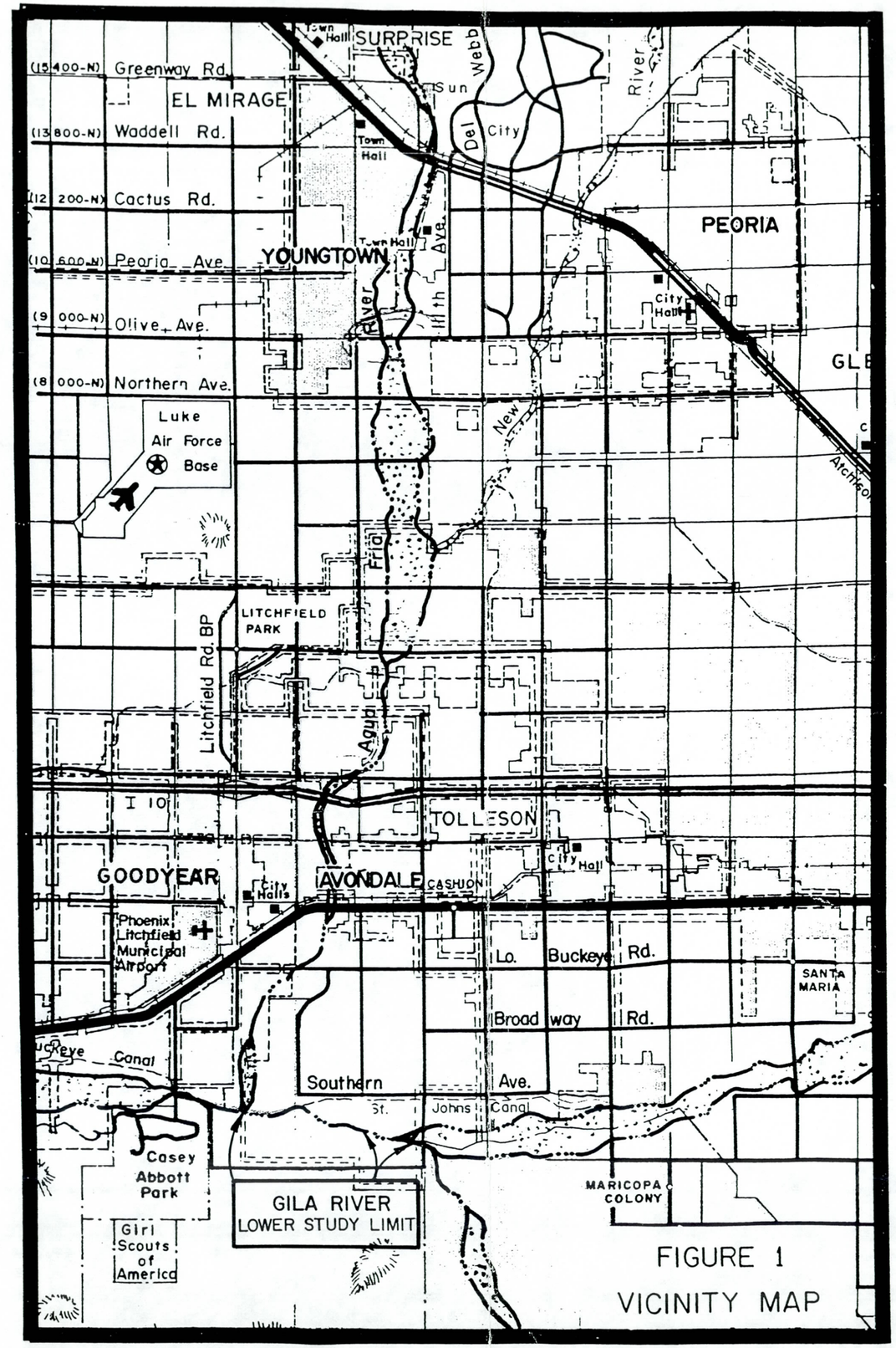


FIGURE 1
VICINITY MAP

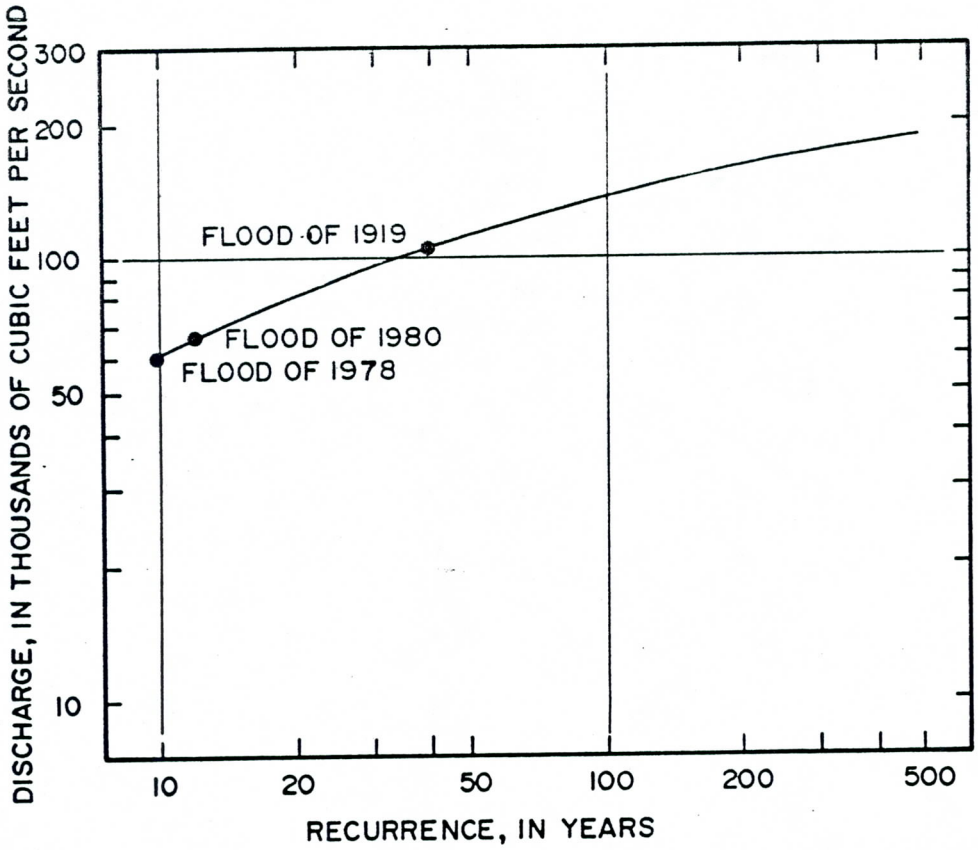


FIGURE 2. FLOOD-FREQUENCY CURVE, AGUA FRIA RIVER DOWNSTREAM OF WADDELL DAM.

The regulatory flood is contained within the levees. However, there exist areas of ponding on the landward side of the levees due to the blockage of overland flows into the channel by the levees. The ponding is discussed in greater detail within Section 3.1. A detailed discussion is included on the Technical Addendum to this report. The main channel adjacent to the COE levee below Buckeye Road has been excavated to provide more cross-sectional area. A channel has been constructed on the landward side of the levee and is capable of conveying the 100-year runoff from behind the levee into the river. A horeshoe levee has also been constructed along the east side of the river just upstream of lower Buckeye Road.

3.0 ENGINEERING METHODS

3.1 Hydrologic Analyses

3.1.1 Agua Fria River

Peak discharge - flood frequency relationships were provided by the Flood Control District of Maricopa County based on data used by the U.S. Army Corps of Engineers (COE) in the 1984 study of the Agua Fria River from the confluence with the Gila River to north of Jomax Road. The COE data was modified to account for the loss of channel storage resulting from channelization, and to provide more gradual attenuation of flow from one reach to the next. Discharge values for several locations within the study reach are given in Table A. This modification in the hyrology was previously approved by FEMA in a December 28, 1987 letter to FCDMC. There are no major tributaries other than the New River which flows into the Agua Fria near River Mile 9.7. The discharges used in this study do not account for future flood attenuations due to New Waddell Dam.

TABLE A - SUMMARY OF DISCHARGES
AGUA FRIA RIVER

Channel Station (River Mile)	10-Year Discharge (cfs)	50-Year Discharge (cfs)	100-Year Discharge (cfs)	500-Year Discharge (cfs)
0.00 Gila Confluence with Gila River	22,000	68,000	94,000	183,000
1.87 Above Downstream End COE Levee (0.7 miles below Lower Buckeye Road)	22,000	69,000	95,000	184,000
8.34 Above MCFCD Levees at Indian School Road	23,000	69,000	95,000	184,000
9.90 Above New River Confluence	18,005	66,010	90,015	177,000
13.32 Above Olive Avenue	19,970	69,970	98,780	179,900
18.91 Above Bell Road	23,000	87,000	115,000	182,000
25.05 Above Jomax Road	51,360	101,220	127,440	182,000
32.99 - 33.25 Below New Waddell Dam	60,000	110,000	135,000	182,000

For the analysis of the split flow west of the El Mirage Landfill located south of Grand Avenue, the discharge used in this study was based on a hydraulic analysis of the flow conditions at Grand Avenue (see Addendum). Because the landfill creates a split flow situation where the water in the main channel east of the landfill cannot flow into the overbank west of the landfill, each floodplain had to be modeled separately. The results of the analysis are shown in Table B.

The split flow discharge west of the El Mirage Landfill modeled by this study was 22,334 cfs during the 100-year event. This differs from the discharge of 30,000 cfs provided by the District.

TABLE B. SPLIT FLOW AT GRAND AVENUE WEST OF LANDFILL

Recurrence Interval (Years)	Total of Split Flow (CFS)	Flow Through Bridges (CFS)	Flow Over Railroad And Roadway (CFS)	Comments
10	0	0	0	Flow stays in primary floodplain east of landfill
50	9,985	9,985	0	
100	22,334*	20,983	1,351	Some water flows over roadway and railway
500	81,822	48,908	32,914	

*Note: The Corps of Engineers assumed that 30,000 cfs flows west of the landfill during a 100-year flood. No figure was given for floods of other frequencies.

3.1.2 Levee Ponding Areas

The discharges used for the analysis of ponding areas were determined using the COE computer program HEC-1 (Reference 3). Watershed boundaries were based on a report prepared by Simons, Li & Associates (SLA) for the determination of the size and number of the levee outlet structures at each ponding location (References 4 and 5). The watershed boundaries were field checked and modified where necessary to conform to present conditions. Soil Conservation Service methods (curve numbers, lag, unit hydrographs) were used to calculate the hydrograph at each ponding location. In some cases, all or a portion of the hydrograph at an upstream ponding location was added to a downstream ponding location because no ponding physically could occur at the upstream location. The upstream and downstream hydrographs were combined when one of the two scenarios below applied:

1. There is no physical barrier to prevent the water ponding at one location from flowing along the landside of the levee toward the next downstream ponding location;

OR,

2. The water is unable to discharge through the levee outlet due to the high water level in the river and flows along the landward side of the levee toward the next downstream ponding location.

Level-pool routing was used to route the flow through the outlet and into the main channel of the river. The 100-year, 24-hour precipitation as determined from the Region VIII NOAA Atlas (Reference 6) was used as the design storm. Table C below lists the ponding elevations investigated.

TABLE C. SUMMARY OF PONDING AT LEVEES

Location	Water Surface Elevation (Ft. NGVD)
East levee, north of Buckeye Road	964.31
West levee, north of Buckeye Road	962.72
East levee, north of Van Buren	971.76
West levee, north of Van Buren	974.18
West levee, north of I-10	*980.00
East levee, north of McDowell Road	983.95
West levee, north of McDowell Road	983.34
West levee, north of R.I.D. Canal	1000.19
West levee, north of Indian School Road	1007.88

* Does not appear on maps due to scale.

3.2 Hydraulic Analyses

3.2.1 Agua Fria River

Cross-section data for the backwater analyses and ponding storage calculations were derived from topographic maps obtained from aerial photographs taken in 1987 and 1988 (Reference 7). Bridge, culvert, and flume data were obtained from structural plans and field checked to verify information. Additional elevations were obtained by field survey where necessary.

Water surface elevations were computed using the U.S. Army Corps of Engineers program HEC-2 (Reference 8). Starting water surface elevations at the Gila River confluence were provided by the FCDMC. They are based upon the previously approved F.I.S.

Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgement and were based on field observations of the river channel and overbank areas.

The channel "n" values ranged from 0.022 to 0.059, and the overbank "n" values ranged from 0.032 to 0.070. The dominant factor governing the choice of roughness factor was the degree of vegetation present in the channel or overbank. Areas with more vegetation had correspondingly higher "n" values than relatively barren areas. A clogging factor of fifty percent of the pier width was added to all pier widths to estimate the effects of debris accumulation on the piers.

Maps of the study area, at a scale of 1:4800 (1"=400') with a contour interval of 4 feet, were used for the topographic data. The land use and land cover data were obtained by field survey and aerial photographs (Reference 7).

Information about the flood of February 1980 (Reference 2) was utilized to verify the reasonableness of the modeled floodprone areas in unchannelized reaches of the river. The inundated areas for the flood area near the 107th Avenue Sewer Treatment Plant - Rose Garden Lane area and at Grand Avenue were compared with the computed 10-year flood-prone areas to check cross-section alignment and roughness values. There were no apparent major discrepancies. The observed flow pattern for the area south of Broadway Road was used to set the limits of the effective flow zone in that area.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

3.2.2 Levee Ponding Areas

Ponding elevations for the 100-year storms were calculated using the level-pool routing method within HEC-1. The water surface within the river was assumed to be the 100-year elevation and was assumed constant for the entire duration of the ponding. Elevation-discharge relationships were calculated for each outlet using Hydraulic Engineering Circular No. 5 (Reference 8). All outlets have one-way flapgates and no water was assumed to discharge from the river into the ponding area.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

4.1 Floodplain Boundaries

Floodplain boundaries were delineated using topographic maps at a scale of 1:4800 (1"=400') with a contour interval of four feet (Reference 7). The boundaries of the 100-year flood were delineated using the elevations determined at each cross-section and interpolated elevations between cross-sections. The 500-year flood boundaries were determined using the results of the 1979 F.I.S. for Maricopa County (Reference 10). In cases where the 100-year and 500-year flood boundaries are close together, only the 100-year boundary has been shown. Small islands, both natural and manmade, are not shown.

4.2 Floodways

The floodway presented in this study was computed by using both Method 4 and Method 1 in the HEC-2 model with a maximum allowable rise in water surface not exceeding 1.0 feet at any location. The principal of equal overbank conveyance reduction (i.e. Method 4) was utilized with a target of 1.0 foot of rise allowed. After initial runs, Method 1 was used to "smooth out" the floodway and assure that the 1.0 foot allowable rise criteria was adhered to.

Several places along the study are shown to have the floodway coincident with the 100-year floodplain limit. Where the river has been channelized by levees, the floodway is shown at the landward toe of the levee. By definition, the floodway cannot encroach into the main channel which in this case is the area between the levees. Also, the upper reaches of the river are steeper with a narrower overbank. In these reaches generally above Jomax Road (River Mile 25.3) the floodway is shown to be coincident with the 100-year floodplain. In general, overbank flows are relatively deep and fast moving with a high potential for erosion and shifting of the main channel.

Because a floodway applies to flowing water, none is depicted within the ponding areas included on the base maps.

Where the floodway and floodplain boundaries are close together or coincident, only the floodway line is shown.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A
Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE
Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH
Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
A	0.160	3170.[2]	22101.	4.3	922.4	919.0	920.0	1.0
B	0.250	3185.[2]	19033.	4.9	922.4	919.5	920.5	1.0
C	0.350	3275.[2]	18353.	5.1	922.5	920.3	921.3	1.0
D	0.440	3375.[2]	17467.	5.4	922.8	921.4	922.3	0.9
E	0.540	3315.[2]	17014.	5.5	923.2	922.6	923.4	0.8
F	0.630	3255.[2]	15361.	6.1	923.8	923.8	924.6	0.8
G	0.730	3160.[2]	16985.	5.6	925.2	925.2	926.1	0.9
H	0.830	3080.[2]	16218.	5.8	926.5	926.5	927.2	0.7
I	0.920	3010.[2]	14998.	6.3	927.4	927.4	928.3	0.9
J	1.010	3000.[2]	14252.	6.6	928.5	928.5	929.5	1.0
K	1.100	2930.[2]	17192.	5.5	929.9	929.9	930.8	0.9
L	1.170	2880.[2]	15717.	6.0	931.0	931.0	931.9	0.9
M	1.250	2830.[2]	13381.	7.0	932.0	932.0	932.9	0.9
N	1.330	2760.[2]	15184.	6.2	934.3	934.3	934.9	0.6
O	1.400	2670.[2]	12711.	7.4	935.5	935.5	936.2	0.7
P	1.480	2530.[2]	15150.	6.2	937.4	937.4	938.0	0.6
Q	1.560	2422.[2]	18884.	5.0	938.1	938.1	938.9	0.8
R	1.640	2633.[2]	19610.	4.8	938.5	938.5	939.4	0.9
S	1.710	2650.[2]	17841.	5.3	939.0	939.0	939.8	0.8
T	1.790	2703.[2]	17206.	5.5	939.4	939.4	940.3	0.9
U	1.870	2708.[2]	17174.	5.5	940.0	940.0	940.9	0.9
V	1.940	2466.[2]	14675.	6.5	940.7	940.7	941.5	0.8
W	2.020	2324.[2]	14011.	6.8	941.6	941.6	942.4	0.8
X	2.100	2056.[2]	13167.	7.2	942.4	942.4	943.3	0.9
Y	2.180	1989.[2]	13570.	7.0	943.4	943.4	944.3	0.9
Z	2.250	1818.[2]	12081.	7.9	944.3	944.3	945.2	0.9
AA	2.330	1683.[2]	12200.	7.8	945.7	945.7	946.5	0.8
AB	2.410	1810.[2]	12952.	7.3	946.8	946.8	947.8	1.0
AC	2.510	1835.[2]	13727.	6.9	947.8	947.2	948.8	1.0
AD	2.600	2050.[2]	14269.	6.7	949.1	949.1	949.1	0.7
AE	2.700	1964.[2]	14707.	6.5	950.1	950.1	950.7	0.6
AF	2.800	2013.[2]	15569.	6.1	950.7	950.7	951.3	0.6
AG	2.890	2200.[2]	16523.	5.7	951.3	951.3	951.9	0.6
AH	2.990	1926.[2]	14973.	6.3	951.9	951.9	952.3	0.4
AI	3.080	1872.[2]	15620.	6.1	952.4	952.4	952.8	0.4
AJ	3.180	1622.[2]	12771.	7.4	952.9	952.9	953.2	0.3

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
AK	3.270	1430.[2]	11163.	8.5	953.6	953.6	953.9	0.3
AL	3.370	1326.[2]	10780.	8.8	954.6	954.6	954.8	0.2
AM	3.400	1317.[2]	7189.	13.2	954.9	954.9	955.0	0.0
AN	3.430	1300.[2]	9084.	10.5	956.4	956.4	956.7	0.3
AO	3.470	1300.[2]	8659.	9.8	957.5	957.5	957.5	0.0
AP	3.550	1276.[2]	9147.	10.4	958.3	958.3	958.3	0.0
AQ	3.640	1246.[2]	7083.	13.4	959.4	959.4	959.7	0.3
	3.690	1056.[2]	7963.	11.9	961.6	961.6	961.6	0.0
	3.729	1178.[2]	13133.	7.2	963.4	963.4	963.4	0.0
	3.734	1190.[2]	11918.	8.0	963.3	963.3	963.3	0.0
	3.747	1191.[2]	12058.	7.9	963.4	963.4	963.4	0.0
AR	3.757	1120.[2]	12557.	7.6	963.6	963.6	963.6	0.0
	3.767	1128.[2]	9694.	9.8	963.2	963.2	963.2	0.0
	3.770	1129.[2]	9773.	9.7	963.3	963.3	963.3	0.0
AS	3.780	1117.[2]	12017.	7.9	963.9	963.9	963.9	0.0
	3.800	1135.[2]	11988.	7.9	964.0	964.0	964.0	0.0
	3.810	1133.[2]	10839.	8.8	963.9	963.9	963.9	0.0
AT	3.830	1141.[2]	12333.	7.7	964.3	964.3	964.3	0.0
AU	3.930	1119.[2]	11643.	8.2	964.6	964.6	964.6	0.0
	4.020	1120.[2]	12026.	7.9	965.1	965.1	965.1	0.0
	4.040	1117.[2]	9837.	9.7	964.9	964.9	964.9	0.0
AV	4.060	1120.[2]	11584.	8.2	965.4	965.4	965.4	0.0
AW	4.094	1112.[2]	6782.	14.0	964.7	964.7	964.7	0.0
AX	4.160	1128.[2]	10181.	9.3	967.3	967.3	967.3	0.0
	4.260	1121.[2]	9932.	9.6	967.9	967.9	967.9	0.0
	4.270	1120.[2]	9433.	10.1	967.9	967.9	967.9	0.0
AY	4.300	1119.[2]	10680.	8.9	968.5	968.5	968.5	0.0
AZ	4.390	1127.[2]	10951.	8.7	969.1	969.1	969.1	0.0
	4.480	1126.[2]	11485.	8.3	969.6	969.6	969.6	0.0
	4.500	1117.[2]	10655.	8.9	969.6	969.6	969.6	0.0
BA	4.520	1112.[2]	11502.	8.3	969.9	969.9	969.9	0.0
BB	4.600	1117.[2]	11648.	8.2	970.3	970.3	970.3	0.0
BC	4.700	1112.[2]	11172.	8.5	970.7	970.7	970.7	0.0
	4.754.	1117.[2]	6552.	14.5	699.7	969.7	969.7	0.0
BD	4.759	1119.[2]	9058.	10.5	972.2	972.2	972.2	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
BE	4.790	1128.[2]	11625.	8.2	973.1	973.1	973.1	0.0
BF	4.890	1178.[2]	11590.	8.2	973.6	973.6	973.6	0.0
	4.980	1258.[2]	12289.	7.7	974.1	974.1	974.1	0.0
	5.000	1271.[2]	11793.	8.1	974.1	974.1	974.1	0.0
BG	5.020	1290.[2]	11962.	7.9	974.3	974.3	974.3	0.0
BH	5.100	1352.[2]	10650.	8.9	974.6	974.6	974.6	0.0
BI	5.150	1394.[2]	8815.	10.8	974.7	974.7	974.7	0.0
	5.201	1396.[2]	8853.	10.7	975.5	975.5	975.5	0.0
BJ	5.203	1394.[2]	7283.	13.0	975.2	975.2	975.2	0.0
	5.250	1383.[2]	7644.	12.4	976.7	976.7	976.7	0.0
BK	5.270	1332.[2]	7078.	13.4	977.1	977.1	977.1	0.0
	5.290	1392.[2]	9460.	10.0	978.8	978.8	978.8	0.0
BL	5.305	1393.[2]	9748.	9.7	979.0	979.0	979.0	0.0
	5.317	1393.[2]	9622.	9.9	979.1	979.1	979.1	0.0
BM	5.328	1393.[2]	9866.	9.6	979.3	979.3	979.3	0.0
BN	5.380	1296.[2]	8900.	10.7	979.7	979.7	979.7	0.0
BO	5.480	1188.[2]	8863.	10.7	981.0	981.0	981.0	0.0
BP	5.510	1156.[2]	6907.	13.8	980.6	980.6	980.6	0.0
	5.540	1142.[2]	8535.	11.1	982.2	982.2	982.2	0.0
BQ	5.650	1137.[2]	10475.	9.1	983.9	983.9	983.9	0.0
	5.689	1160.[2]	11311.	8.4	984.4	984.4	984.4	0.0
BR	5.700	1160.[2]	11385.	8.3	984.4	984.4	984.4	0.0
BS	5.750	1129.[2]	10607.	9.0	984.6	984.6	984.6	0.0
	5.770	1132.[2]	10552.	9.0	984.8	984.8	984.4	0.0
	5.790	1121.[2]	8831.	10.8	984.8	984.8	984.4	0.0
BT	5.810	1116.[2]	10837.	8.8	985.8	985.8	985.8	0.0
BU	5.900	1118.[2]	10303.	9.2	986.3	986.3	986.3	0.0
BV	5.990	1116.	10127.	9.4	986.9	986.9	986.9	0.0
BW	6.070	1117.	10196.	9.3	987.5	987.5	987.5	0.0
BX	6.160	1120.	9858.	9.6	988.1	988.1	988.1	0.0
BY	6.260	1121.	8917.	10.7	988.8	988.8	988.8	0.0
BZ	6.350	1099.	8940.	10.6	989.8	989.8	989.8	0.0
CA	6.430	1071.	7928.	12.0	990.6	990.6	990.6	0.0
	6.520	1101.	10682.	8.9	992.7	992.7	992.7	0.0
	6.540	1106.	9007.	10.5	992.5	992.5	992.5	0.0
CB	6.560	1115.	10743.	8.8	993.3	993.3	993.3	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
	6.590	1119.	11611.	8.2	993.7	993.7	993.7	0.0
	6.610	1120.	9947.	9.6	993.6	993.6	993.6	0.0
	6.640	1119.	11178.	8.5	994.2	994.2	994.2	0.0
CC	6.660	1119.	10381.	9.2	994.2	994.2	994.2	0.0
	6.690	1120.	11443.	8.3	994.7	994.7	994.7	0.0
	6.710	1119.	11247.	8.4	994.8	994.8	994.8	0.0
CD	6.730	1119.	11948.	8.0	995.0	995.0	995.0	0.0
	6.770	1111.	8218.	11.6	994.8	994.8	994.8	0.0
	6.790	1110.	7984.	11.9	995.0	995.0	995.0	0.0
CE	6.820	1113.	10224.	9.3	996.3	996.3	996.3	0.0
	6.890	1117.	7678.	12.4	996.5	996.5	996.5	0.0
	6.910	1130.	6916.	13.7	996.7	996.7	996.7	0.0
CF	6.930	1140.[2]	10080.	9.4	998.9	998.9	998.9	0.0
	6.970	1150.[2]	9871.	9.6	999.2	999.2	999.2	0.0
	6.990	1145.[2]	8298.	11.4	999.1	999.1	999.1	0.0
CG	7.020	1124.[2]	10522.	9.0	1000.3	1000.3	1000.3	0.0
	7.060	1101.	9906.	9.6	1000.5	1000.5	1000.5	0.0
	7.080	1094.	9009.	10.5	1000.6	1000.6	1000.6	0.0
CH	7.100	1089.[2]	8876.	10.7	1000.8	1000.8	1000.8	0.0
CI	7.200	1070.[2]	10240.	9.3	1002.1	1002.1	1002.1	0.0
CJ	7.290	1031.[2]	8698.	10.9	1002.6	1002.6	1002.6	0.0
CK	7.390	1011.[2]	9176.	10.4	1003.7	1003.7	1003.7	0.0
CL	7.490	989.[2]	8769.	10.8	1004.5	1004.5	1004.5	0.0
CM	7.580	982.[2]	9507.	10.0	1005.7	1005.7	1005.7	0.0
CN	7.670	1021.[2]	12016.	7.9	1006.8	1006.8	1006.8	0.0
CO	7.770	1045.[2]	10591.	9.0	1007.0	1007.0	1007.0	0.0
CP	7.870	1122.[2]	10802.	8.8	1007.6	1007.6	1007.6	0.0
CQ	7.960	1321.[2]	12425.	7.6	1008.3	1008.3	1008.3	0.0
	7.990	1402.[2]	13260.	7.2	1008.8	1008.8	1008.8	0.0
	8.000	1472.[2]	11879.	8.0	1008.8	1008.8	1008.8	0.0
	8.010	1472.[2]	11998.	7.9	1008.9	1008.9	1008.9	0.0
CR	8.030	1467.[2]	13158.	7.2	1009.1	1009.1	1009.1	0.0
CS	8.100	1523.	13679.	6.9	1009.5	1009.5	1009.5	0.0
CT	8.210	1512.	11469.	8.3	1009.8	1009.8	1009.8	0.0
CU	8.340	1492.	7954.	11.9	1010.5	1010.5	1010.5	0.0
CV	8.440	1978.	11199.	8.5	1013.5	1013.5	1013.5	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
CW	8.540	2410.	11109.	8.6	1015.0	1015.0	1015.0	0.0
CX	8.640	2360.	9239.	10.3	1016.9	1016.9	1016.9	0.0
CY	8.730	2348.	11759.	8.1	1019.5	1019.5	1019.5	0.0
CZ	8.830	2203.	10705.	8.9	1020.8	1020.8	1020.9	0.1
DA	8.930	2060.	12179.	7.8	1022.2	1022.2	1022.5	0.3
DB	9.020	1837.	11783.	8.1	1023.3	1023.3	1023.5	0.2
	9.120	1711.	11519.	8.2	1024.2	1024.2	1024.4	0.2
	9.130	1700.	10311.	9.2	1024.2	1024.2	1024.4	0.2
	9.135	1702.	10655.	8.9	1024.5	1024.5	1024.6	0.1
DC	9.150	1630.	11078.	8.6	1024.8	1024.8	1024.8	0.0
DD	9.250	1900.	11088.	8.6	1026.0	1026.0	1026.0	0.0
DE	9.340	2190.	12884.	7.4	1027.0	1027.0	1027.2	0.2
DF	9.440	2490.	12536.	7.6	1027.9	1027.9	1028.1	0.2
DG	9.530	2820.	14817.	6.4	1028.9	1028.9	1029.3	0.4
DH	9.620	3090.	16073.	5.9	1029.2	1029.2	1030.2	1.0
DI	9.710	3700.[2]	11980.	7.9	1030.3	1030.3	1030.9	0.6
DJ	9.810	4070.[2]	17039.	5.6	1032.0	1032.0	1033.0	1.0
DK	9.900	4205.[2]	12002.	7.5	1033.3	1033.3	1034.0	0.7
DL	10.000	4290.[2]	16796.	5.4	1035.3	1035.3	1036.1	0.8
DM	10.080	4410.[2]	15689.	5.7	1036.0	1036.0	1036.8	0.8
DN	10.160	4520.[2]	15488.	5.8	1036.8	1036.8	1037.6	0.8
DO	10.250	4505.[2]	15546.	5.8	1037.8	1037.8	1038.7	0.9
DP	10.340	3549.[2]	13473.	6.7	1038.8	1038.8	1039.6	0.8
DQ	10.460	4014.[2]	14836.	6.1	1040.4	1040.4	1041.0	0.6
DR	10.530	4115.[2]	13137.	6.9	1041.6	1041.6	1042.1	0.5
DS	10.620	4710.[2]	15498.	5.9	1043.3	1043.3	1044.3	1.0
DT	10.720	4660.[2]	15372.	5.9	1045.4	1045.4	1045.8	0.4
DU	10.830	4610.[2]	19115.	4.7	1047.5	1047.5	1047.6	0.1
DV	10.910	4750.[2]	22746.	4.0	1048.5	1048.5	1048.7	0.2
DW	11.010	4430.	23521.	3.9	1049.2	1049.2	1049.4	0.2
DX	11.110	4230.	17670.	5.1	1049.7	1049.7	1049.8	0.1
DY	11.200	4095.	16670.	5.4	1051.1	1051.1	1051.2	0.1
DZ	11.300	3938.	13481.	6.7	1052.5	1052.5	1052.5	0.0
EA	11.340	3958.	39796.	2.3	1058.9	1058.9	1058.9	0.0
EB	11.430	3933.	40510.	2.2	1059.0	1059.0	1059.0	0.0
EC	11.520	3867.	33499.	2.7	1059.1	1059.1	1059.1	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
ED	11.620	3827.	24259.	3.7	1059.2	1059.2	1059.2	0.0
EE	11.710	3901.	22352.	4.1	1059.7	1059.7	1059.8	0.1
EF	11.800	3880.	16746.	5.4	1060.1	1060.1	1060.2	0.1
EG	11.890	3829.	29487.	3.1	1060.8	1060.8	1061.0	0.2
EH	11.990	3721.	35136.	2.6	1061.0	1061.0	1061.2	0.2
EI	12.080	3490.	21333.	4.3	1061.1	1061.1	1061.3	0.2
EJ	12.180	3394.	35096.	2.6	1061.5	1061.5	1061.7	0.2
EK	12.270	3000.	14070.	6.8	1061.3	1061.3	1061.5	0.2
EL	12.380	2769.	8250.	11.6	1062.9	1062.9	1062.9	0.0
EM	12.460	2646.	9519.	10.0	1066.1	1066.1	1066.1	0.0
EN	12.560	2440.	11330.	8.4	1068.8	1068.8	1068.8	0.0
EO	12.650	2240.	9682.	10.0	1069.4	1069.4	1069.7	0.3
EP	12.750	1975.	8891.	10.9	1071.7	1071.7	1071.7	0.0
EQ	12.840	1809.	10370.	9.3	1073.9	1073.9	1074.3	0.4
ER	12.940	1699.	12898.	7.5	1076.0	1076.0	1076.4	0.4
ES	13.030	1600.	11445.	8.5	1077.0	1077.0	1077.2	0.2
ET	13.130	1500.	9616.	10.1	1078.0	1078.0	1078.1	0.1
EU	13.220	1430.	11719.	8.3	1080.1	1080.1	1080.1	0.0
	13.310	1340.	11158.	8.7	1081.0	1081.0	1081.0	0.0
	13.320	1381.	12681.	7.8	1081.3	1081.3	1081.5	0.2
	13.330	1273.	11712.	8.4	1081.6	1081.6	1081.6	0.0
	13.335	1274.	13078.	7.6	1081.8	1081.8	1081.8	0.0
EV	13.340	1340.[2]	8101.	12.2	1081.2	1081.2	1081.2	0.0
EW	13.430	1650.[2]	14582.	6.8	1083.6	1083.6	1083.9	0.3
EX	13.530	2080.[2]	14174.	7.0	1084.1	1084.1	1084.4	0.3
EY	13.620	2370.[2]	12726.	7.8	1084.8	1084.8	1085.2	0.4
EZ	13.720	2550.[2]	13178.	7.5	1085.9	1085.9	1086.2	0.3
FA	13.810	2660.[2]	12510.	7.9	1086.8	1086.8	1087.3	0.5
FB	13.900	2790.[2]	11425.	8.6	1088.3	1088.3	1088.7	0.4
FC	14.000	2840.[2]	15911.	6.2	1089.9	1089.9	1090.6	0.7
FD	14.100	2775.[2]	15246.	6.5	1090.5	1090.5	1091.3	0.8
FE	14.190	2750.[2]	15059.	6.6	1091.6	1091.6	1092.2	0.6
FF	14.280	2680.[2]	13885.	7.1	1092.5	1092.5	1093.0	0.5
FG	14.380	2600.[2]	11830.	8.4	1093.9	1093.9	1094.1	0.2
FH	14.470	2390.[2]	13119.	7.5	1095.6	1095.6	1095.9	0.3
FI	14.560	2250.[2]	12130.	8.5	1097.0	1097.0	1097.0	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
FJ	14.660	2100.[2]	12009.	8.5	1098.3	1098.3	1098.6	0.3
FK	14.750	1970.[2]	12176.	8.4	1099.0	1099.0	1099.7	0.7
FL	14.850	1282.[2]	7744.	13.3	1100.4	1100.4	1100.5	0.1
FM	14.940	1894.[2]	13743.	7.5	1103.2	1103.2	1103.8	0.6
FN	15.040	1840.[2]	11528.	8.9	1103.9	1103.9	1104.5	0.6
FO	15.130	1723.[2]	11570.	8.9	1105.3	1105.3	1105.8	0.5
FP	15.230	1500.[2]	9667.	10.6	1106.6	1106.6	1107.0	0.4
FQ	15.320	1500.[2]	11636.	8.8	1108.3	1108.3	1109.1	0.8
FR	15.420	1783.[2]	12375.	8.3	1109.4	1109.4	1110.3	0.9
FS	15.510	1959.[2]	10483.	10.1	1110.6	1110.6	1110.9	0.3
FT	15.610	687.[2]	6153.	13.5	1111.9	1111.9	1112.6	0.7
FU	15.700	749.[2]	7471.	11.1	1115.2	1115.2	1115.2	0.0
FV	15.790	784.[2]	8448.	9.8	1116.6	1116.6	1116.6	0.0
FW	15.890	816.[2]	10144.	8.2	1117.7	1117.7	1117.7	0.0
FX	15.980	857.[2]	9687.	8.6	1118.1	1118.1	1118.1	0.0
FY	16.080	836.[2]	9494.	8.8	1118.6	1118.6	1118.6	0.0
FZ	16.170	801.[2]	6108.	13.6	1118.5	1118.5	1118.5	0.0
GA	16.270	636.[2]	6698.	12.4	1120.8	1120.8	1120.8	0.0
GB	16.370	428.[2]	5101.	16.3	1121.5	1121.5	1121.6	0.1
GC	16.410	488.[2]	6837.	12.5	1124.6	1124.6	1124.6	0.0
	16.412	442.[2]	6642.	12.9	1124.5	1124.5	1124.5	0.0
	16.420	445.[2]	7758.	11.0	1126.1	1126.1	1126.8	0.0
	16.446	466.[2]	6590.	13.0	1125.8	1125.8	1126.7	0.0
	16.450	469.[2]	7809.	11.0	1128.3	1128.3	1129.3	1.0
GD	16.460	533.[2]	9489.	9.0	1129.3	1129.3	1130.1	0.8
GE	16.530	750.[2]	10607.	8.1	1130.0	1130.0	1130.4	0.4
GF	16.630	1493.[2]	17681.	4.8	1130.9	1130.9	1131.5	0.6
GG	16.720	2521.[2]	25541.	4.2	1131.0	1131.0	1131.8	0.8
GH	16.820	2787.[2]	23192.	4.6	1131.4	1131.4	1132.0	0.6
GI	16.910	3081.[2]	20794.	5.2	1131.6	1131.6	1132.2	0.6
GJ	17.000	3273.[2]	21528.	5.0	1132.0	1132.0	1132.7	0.7
GK	17.090	3485.[2]	14101.	7.7	1132.6	1132.6	1133.2	0.6
GL	17.190	3706.[2]	21637.	5.0	1134.4	1134.4	1135.1	0.7
GM	17.280	3680.[2]	25251.	4.3	1134.9	1134.9	1135.7	0.8
GN	17.380	3431.[2]	19509.	5.5	1135.0	1135.0	1135.8	0.8
GO	17.470	3000.[2]	14665.	7.4	1135.4	1135.4	1136.1	0.7

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
GP	17.550	2775.[2]	11941.	9.1	1136.2	1136.2	1136.6	0.4
GQ	17.650	2450.[2]	11138.	10.0	1137.8	1137.8	1137.9	0.1
GR	17.760	2197.[2]	17747.	6.3	1139.8	1139.8	1139.9	0.1
GS	17.860	1701.[2]	14573.	7.7	1140.5	1140.5	1140.5	0.0
GT	17.950	2020.[2]	16014.	7.0	1141.1	1141.1	1141.7	0.6
GU	18.050	1929.[2]	11745.	9.5	1141.8	1141.8	1142.6	0.8
GV	18.140	1907.[2]	14297.	7.8	1143.6	1143.6	1144.5	0.9
GW	18.240	1880.[2]	8854.	12.6	1145.5	1145.5	1145.5	0.0
GX	18.330	1709.[2]	12421.	9.0	1148.6	1148.6	1148.7	0.1
GY	18.420	1514.[2]	10842.	10.3	1149.6	1149.6	1149.8	0.2
GZ	18.520	1324.[2]	8969.	12.4	1151.0	1151.0	1151.2	0.2
HA	18.610	1282.[2]	9611.	11.6	1152.9	1152.9	1153.5	0.6
HB	18.710	1132.[2]	8771.	12.7	1155.2	1155.2	1155.4	0.2
HC	18.800	1065.[2]	9689.	11.5	1157.6	1157.6	1157.6	0.0
HD	18.900	1044.[2]	12204.	9.1	1159.3	1159.3	1159.3	0.0
	18.910	1084.[2]	11207.	10.3	1159.2	1159.2	1159.3	0.1
	18.920	1124.[2]	10536.	10.9	1159.1	1159.1	1159.2	0.1
	18.925	1125.[2]	11735.	9.8	1159.7	1159.7	1159.8	0.1
HE	18.940	1089.[2]	10340.	11.1	1159.4	1159.4	1159.5	0.1
HF	18.980	1207.[2]	12294.	9.4	1160.6	1160.6	1160.6	0.0
HG	19.080	1753.[2]	12874.	8.9	1161.7	1161.7	1161.7	0.0
HH	19.170	2158.[2]	12996.	8.8	1162.9	1162.9	1162.9	0.0
HI	19.270	2574.	14393.	8.0	1164.6	1164.6	1164.6	0.0
HJ	19.360	2576.	14349.	8.0	1165.9	1165.9	1165.9	0.0
HK	19.450	2648.	14718.	7.8	1167.2	1167.2	1167.2	0.0
HL	19.540	2737.	13497.	8.5	1168.5	1168.5	1168.5	0.0
HM	19.640	2795.	14752.	7.8	1170.2	1170.2	1170.2	0.0
HN	19.740	2797.	15740.	7.4	1171.5	1171.5	1171.5	0.0
HO	19.830	2807.	13882.	8.4	1172.6	1172.6	1172.6	0.0
HP	19.920	2665.	14428.	8.0	1174.1	1174.1	1174.1	0.0
HQ	20.020	2458.	13585.	8.5	1175.4	1175.4	1175.4	0.0
HR	20.110	2292.	11421.	10.3	1176.9	1176.9	1176.9	0.0
HS	20.210	2218.	13881.	8.4	1179.1	1179.1	1179.2	0.1
HT	20.300	2252.	13060.	9.0	1180.5	1180.5	1180.5	0.0
HU	20.400	2275.	13296.	8.8	1181.9	1181.9	1182.1	0.2
HV	20.490	2058.	9967.	11.7	1183.4	1183.4	1183.6	0.2

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
HW	20.590	2085.	13773.	8.5	1185.9	1185.9	1186.7	0.8
HX	20.680	2153.[2]	14675.	8.1	1187.6	1187.6	1187.8	0.2
HY	20.780	2240.[2]	16548.	7.2	1188.8	1188.8	1188.9	0.1
HZ	20.870	2412.[2]	16271.	7.3	1189.7	1189.7	1189.7	0.0
IA	20.960	2463.[2]	14679.	8.1	1190.5	1190.5	1190.6	0.1
IB	21.050	2313.[2]	16455.	7.2	1191.6	1191.6	1191.7	0.1
IC	21.140	2153.[2]	17980.	6.6	1192.2	1192.2	1192.4	0.2
ID	21.220	2087.	12016.	9.9	1192.3	1192.3	1192.4	0.1
IE	21.310	1849.	11551.	10.3	1193.7	1193.7	1194.0	0.3
IF	21.390	1680.	11300.	10.5	1195.1	1195.1	1195.5	0.4
IG	21.470	1678.	10389.	11.4	1196.5	1196.5	1196.9	0.4
IH	21.550	1957.	12982.	9.2	1198.2	1198.2	1199.2	1.0
II	21.630	2055.	13203.	9.0	1199.6	1199.6	1200.6	1.0
IJ	21.720	1982.	10709.	11.1	1201.0	1201.0	1201.6	0.6
IK	21.800	2043.	15112.	7.9	1203.0	1203.0	1204.0	1.0
IL	21.890	2168.	16580.	7.2	1204.0	1204.0	1205.0	1.0
IM	21.970	2259.	14699.	8.1	1205.1	1205.1	1205.8	0.7
IN	22.060	2383.	15138.	7.9	1206.6	1206.6	1206.8	0.2
IO	22.140	2380.	14406.	8.3	1207.7	1207.7	1208.0	0.3
IP	22.230	2501.	15295.	7.8	1208.9	1208.9	1209.2	0.3
IQ	22.310	2738.	15446.	7.7	1210.2	1210.2	1210.4	0.2
IR	22.400	2818.	14341.	8.4	1211.5	1211.5	1211.7	0.2
IS	22.480	2995.	13730.	8.8	1213.2	1213.2	1213.4	0.2
IT	22.560	3219.	16114.	7.5	1215.4	1215.4	1215.4	0.0
IU	22.640	3418.	15659.	7.7	1216.8	1216.8	1216.8	0.0
IV	22.730	3394.	15506.	7.8	1218.2	1218.2	1218.2	0.0
IW	22.810	3522.	16684.	7.3	1219.7	1219.7	1219.7	0.0
IX	22.890	3599.	16050.	7.5	1220.8	1220.8	1220.8	0.0
IY	22.980	3858.	15821.	7.6	1222.0	1222.0	1222.0	0.0
IZ	23.060	3918.	16765.	7.2	1223.5	1223.5	1223.5	0.0
JA	23.140	4044.	16424.	7.4	1224.7	1224.7	1224.7	0.0
JB	23.220	3921.	15203.	8.0	1225.9	1225.9	1225.9	0.0
JC	23.310	3663.	15780.	7.7	1227.4	1227.4	1227.4	0.0
JD	23.400	3703.	16692.	7.4	1228.6	1228.6	1228.6	0.0
JE	23.490	3531.	14039.	8.8	1229.9	1229.9	1229.9	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
JF	23.570	3331.	14984.	8.2	1231.8	1231.8	1231.8	0.0
JG	23.660	3351.	13863.	8.9	1233.2	1233.2	1233.3	0.1
JH	23.740	3261.	15233.	8.1	1235.1	1235.1	1235.3	0.2
JI	23.840	3160.	15208.	8.1	1236.3	1236.3	1236.7	0.4
JJ	23.920	3185.	14205.	8.7	1238.0	1238.0	1238.3	0.3
JK	24.010	3402.	16759.	7.3	1240.0	1240.0	1240.2	0.2
JL	24.090	3689.	15538.	7.9	1241.4	1241.4	1241.5	0.1
JM	24.180	3414.	14822.	8.4	1243.2	1243.2	1243.0	0.0
JN	24.270	3643.	16258.	7.7	1245.1	1245.1	1245.1	0.0
JO	24.350	4302.	17122.	7.3	1246.7	1246.7	1246.7	0.0
JP	24.440	4577.	17729.	7.0	1248.3	1248.3	1248.3	0.0
JQ	24.520	4692.	15641.	8.0	1249.7	1249.7	1249.8	0.1
JR	24.620	4466.	16480.	7.6	1251.5	1251.5	1251.6	0.1
JS	24.700	4092.	13944.	9.0	1253.3	1253.3	1253.5	0.2
JT	24.790	3779.	14547.	8.6	1255.9	1255.9	1256.1	0.2
JU	24.870	3219.	12950.	9.7	1257.9	1257.9	1258.2	0.3
JV	24.960	3101.	14416.	8.7	1260.3	1260.3	1260.5	0.2
JW	25.050	2698.	12756.	10.0	1261.8	1261.8	1262.1	0.3
JX	25.140	2213.	11555.	11.0	1264.0	1264.0	1264.2	0.2
JY	25.220	2091.	13051.	9.8	1266.5	1266.5	1266.6	0.1
JZ	25.280	1579.	12025.	10.6	1267.5	1267.5	1267.5	0.0
KA	25.340	1332.	9526.	13.4	1267.9	1267.9	1267.9	0.0
KB	25.400	1645.	13950.	9.1	1270.4	1270.4	1270.4	0.0
KC	25.480	1878.	13608.	9.4	1271.4	1271.4	1271.4	0.0
KD	25.550	2133.	15498.	8.2	1272.6	1272.6	1272.6	0.0
KE	25.620	2151.	13181.	9.7	1273.4	1273.4	1273.4	0.0
KF	25.700	2941.	16032.	7.9	1275.9	1275.9	1275.9	0.0
KG	25.780	3268.	18984.	6.7	1277.5	1277.5	1277.5	0.0
KH	25.870	3334.	19763.	6.4	1278.4	1278.4	1278.5	0.1
KI	25.960	3393.	15650.	8.1	1279.5	1279.5	1279.7	0.2
KJ	26.050	3533.	17162.	7.4	1281.7	1281.7	1281.8	0.1
KK	26.130	3494.	18970.	6.7	1283.4	1283.4	1284.5	0.1
KL	26.220	3367.	13887.	9.2	1284.6	1284.6	1284.7	0.1
KM	26.300	3370.	15997.	8.0	1286.9	1286.9	1287.1	0.2
KN	26.390	3312.	17452.	7.4	1288.5	1288.5	1288.8	0.3

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
KO	26.490	3011.	15288.	8.4	1289.6	1289.6	1290.1	0.5
KP	26.590	2580.	14130.	9.1	1291.5	1291.5	1291.8	0.3
KQ	26.690	2275.	15371.	8.4	1293.1	1293.1	1293.9	0.8
KR	26.770	1985.	11813.	10.9	1294.3	1294.3	1294.6	0.3
KS	26.850	2135.	18186.	7.1	1297.0	1297.0	1297.8	0.8
KT	26.920	2550.	19382.	6.6	1297.8	1297.8	1298.7	0.9
KU	27.010	2711.	18823.	6.8	1299.1	1299.1	1299.7	0.6
KV	27.090	2966.[2]	18463.	7.0	1300.5	1300.5	1300.9	0.4
KW	27.170	3157.[2]	17112.	7.5	1302.0	1302.0	1302.2	0.2
KX	27.260	3125.[2]	15669.	8.2	1303.8	1303.8	1303.9	0.1
KY	27.340	2601.[2]	14477.	8.9	1305.7	1305.7	1305.7	0.0
KZ	27.430	2990.[2]	14641.	8.8	1307.9	1307.9	1307.9	0.0
LA	27.510	2497.[2]	16117.	8.0	1309.9	1309.9	1309.9	0.0
LB	27.590	2352.[2]	13794.	9.4	1311.3	1311.3	1311.3	0.0
LC	27.680	2523.[2]	17230.	7.5	1313.7	1313.7	1313.7	0.0
LD	27.760	2506.[2]	14751.	8.8	1314.9	1314.9	1314.9	0.0
LE	27.850	2627.[2]	15192.	8.6	1316.7	1316.7	1316.7	0.0
LF	27.930	2357.	14159.	9.2	1318.2	1318.2	1318.2	0.0
LG	28.010	2322.	15344.	8.5	1320.0	1320.0	1320.1	0.1
LH	28.070	1965.	13789.	9.4	1321.0	1321.0	1321.0	0.0
LI	28.140	2002.	13362.	9.7	1322.3	1322.3	1322.3	0.0
LJ	28.200	2076.	15476.	8.4	1323.8	1323.8	1323.9	0.1
LK	28.280	2164.[2]	14844.	8.8	1325.0	1325.0	1325.1	0.1
LL	28.360	2223.[2]	14215.	9.1	1326.2	1326.2	1326.4	0.2
LM	28.450	2193.[2]	14490.	9.0	1328.2	1328.2	1328.2	0.0
LN	28.540	2148.[2]	13812.	9.4	1329.7	1329.7	1329.7	0.0
LO	28.630	2007.[2]	15423.	8.4	1331.5	1331.5	1331.7	0.2
LP	28.710	2151.[2]	15422.	8.4	1332.8	1332.8	1333.0	0.2
LQ	28.790	1778.[2]	13755.	9.5	1334.0	1334.0	1334.1	0.1
LR	28.860	1472.	10173.	12.8	1335.0	1335.0	1335.0	0.0
LS	28.930	1284.	11014.	11.8	1337.9	1337.9	1337.9	0.0
LT	29.020	1128.	10805.	12.0	1339.6	1339.6	1339.6	0.0
LU	29.080	960.	9238.	14.2	1340.8	1340.8	1340.8	0.0
	29.151	1039.	9947.	13.2	1343.2	1343.2	1343.2	0.0
LV	29.160	1072.	11279.	11.6	1344.2	1344.2	1344.2	0.0
LW	29.250	1313.	14334.	9.2	1346.4	1346.4	1346.4	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
LX	29.340	1246.	13236.	9.9	1347.2	1347.2	1347.2	0.0
LY	29.430	1081.	13029.	10.1	1348.1	1348.1	1348.1	0.0
LZ	29.530	902.	8585.	15.3	1348.4	1348.4	1348.4	0.0
MA	29.610	647.	7140.	18.4	1350.4	1350.4	1350.4	0.0
MB	29.710	610.	9643.	13.6	1355.2	1355.2	1355.2	0.0
MC	29.800	1008.	13955.	9.4	1357.8	1357.8	1357.8	0.0
MD	29.900	1270.	16610.	7.9	1358.8	1358.8	1358.8	0.0
ME	29.980	1137.	13107.	10.0	1359.2	1359.2	1359.2	0.0
MF	30.080	1123.	12139.	10.8	1360.3	1360.3	1360.3	0.0
MG	30.180	1182.	11650.	11.3	1361.9	1361.9	1361.9	0.0
MH	30.260	1206.	13079.	10.0	1364.5	1364.5	1364.5	0.0
MI	30.360	1283.	17064.	7.7	1367.3	1367.3	1367.3	0.0
MJ	30.460	1164.	16172.	8.1	1368.0	1368.0	1368.0	0.0
MK	30.550	1170.	15095.	8.7	1368.5	1368.5	1368.5	0.0
ML	30.640	1100.	13483.	9.7	1369.2	1369.2	1369.2	0.0
MM	30.740	1095.	14129.	9.3	1370.2	1370.2	1370.2	0.0
MN	30.830	1036.	11698.	11.2	1370.7	1370.7	1370.7	0.0
MO	30.920	1035.	11639.	11.3	1372.1	1372.1	1372.1	0.0
MP	31.010	949.	10477.	12.7	1373.5	1373.5	1373.5	0.0
MQ	31.110	755.	9599.	13.9	1375.0	1375.0	1375.0	0.0
MR	31.190	776.	10728.	12.4	1377.1	1377.1	1377.1	0.0
MS	31.290	697.	9416.	14.1	1378.1	1378.1	1378.1	0.0
MT	31.380	733.	10207.	13.0	1380.1	1380.1	1380.1	0.0
MU	31.480	701.	9799.	13.6	1381.5	1381.5	1381.5	0.0
MV	31.570	696.	9876.	13.5	1383.1	1383.1	1383.1	0.0
MW	31.670	793.	11132.	12.0	1385.0	1385.0	1385.0	0.0
MX	31.760	737.	10240.	13.0	1386.0	1386.0	1386.0	0.0
MY	31.850	794.	9866.	13.5	1387.5	1387.5	1387.5	0.0
MZ	31.940	897.	11565.	11.5	1389.6	1389.6	1389.6	0.0
NA	32.040	1057.	13231.	10.1	1391.5	1391.5	1391.5	0.0
NB	32.100	923.	10544.	12.6	1392.2	1392.2	1392.2	0.0
NC	32.150	1013.	9668.	13.8	1393.0	1393.0	1393.0	0.0
ND	32.220	1221.	9027.	14.8	1394.2	1394.2	1394.2	0.0
NE	32.290	817.	8969.	14.8	1396.2	1396.2	1396.2	0.0
NF	32.360	643.	9461.	14.1	1398.4	1398.4	1398.4	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1] (MILES)	WIDTH (FEET)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
NG	32.420	517.	6536.	20.4	1398.3	1398.3	1398.3	0.0
	32.469	307.	5493.	24.2	1406.1	1406.1	1406.1	0.0
	32.474	329.	5390.	24.7	1406.7	1406.7	1406.1	0.0
	32.478	343.	6396.	20.8	1410.1	1410.1	1401.1	0.0
NH	32.488	360.	7903.	16.8	1412.7	1412.7	1412.7	0.0
NI	32.540	480.	12034.	11.1	1416.2	1416.2	1416.2	0.0
NJ	32.600	635.	18528.	7.2	1417.7	1417.7	1417.7	0.0
NK	32.660	786.	20925.	6.4	1418.1	1418.1	1418.1	0.0
NL	32.720	987.	22537.	5.9	1418.4	1418.4	1418.4	0.0
	32.770	1121.	22996.	5.8	1418.6	1418.6	1418.6	0.0
NM	32.780	1043.	18195.	7.3	1418.4	1418.4	1418.4	0.0
NN	32.820	687.	14487.	9.2	1418.5	1418.5	1418.5	0.0
NO	32.860	714.	13511.	9.9	1418.9	1418.9	1418.9	0.0
NP	32.910	918.	17883.	7.4	1420.1	1420.1	1420.1	0.0
NQ	32.990	788.	13614.	9.9	1420.3	1420.3	1420.3	0.0
NR	33.080	596.	10663.	12.7	1421.2	1421.2	1421.2	0.0
NS	33.170	640.	11896.	11.3	1423.4	1423.4	1423.4	0.0
NT	33.250	570.	10884.	12.4	1424.8	1424.8	1424.8	0.0

[1] Miles above confluence with Gila River.

[2] This width extends beyond county boundary.

[3] Elevation computed without consideration of backwater from Gila River.

FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
MARICOPA COUNTY, ARIZONA	AGUA FRIA RIVER

Zone AO
Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheetflow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone A99
Zone A99 is the flood insurance rate zone that corresponds to areas of the 100-year floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone X
Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain areas, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

Zone D
Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information or structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains, the floodways, and the floodway is shown at the landward toe of the levee. Because a floodway is not applicable to the ponding areas, none has been computed or shown on the base maps. Portions of the floodway extend into incorporated areas of Maricopa County. Where the floodway and floodplain boundaries are close together or collinear, only the floodway line is shown.

7.0 OTHER STUDIES

Three prior major studies have been performed on the Agua Fria River within the study area from Lake Pleasant to the confluence with the Gila River. Because there are numerous differences between the physical conditions modeled during the previous studies and this study, no attempt was made to note specific points of agreement or disagreement between the studies. The results of the previous studies were used to check general modeling procedures and results.

A Floodplain Information report published in 1968 (Reference 1) studied the river between Camelback Road and the Beardsley Canal flume crossing of the river. The results of that study differ significantly from the Flood Insurance Study due, in part, to two significant items. First, the flow values used in this study to model the floodplain are higher than used in the 1968 study. For example, the previous study used a 100-year discharge of 59,000 cubic feet per second at the dam outlet increasing to 95,000 cubic feet per second at Camelback Road. The discharges for this 1989 study range from 135,000 cfs at the outlet decreasing to 95,000 cfs at Camelback Road. Second, new bridge structures have been built at some locations since the earlier study was published.

A Flood Insurance Study for the unincorporated areas of Maricopa County published in 1979 (Reference 10) studied a 24-mile reach the Agua Fria River between the confluence with the Gila River and Pinnacle Peak Road. The primary difference between this 1989 study and the 1979 study is the hydrology, and extended limits of the detailed study. In addition, four new bridges were constructed after the previous study was published.

The Corps of Engineers studied the portion of the Agua Fria River between the confluence with the Gila River and Jomax Road in 1984. The flow values used in that study are nearly identical to those used in this 1989 study except for minor modification due to the construction of the levees after the Corps' study. This 1989 study also incorporates additional topographic mapping that extends above Jomax Road.

A 1980 study of the February 1980 flood along the Agua Fria (Reference 2) was used to check modeling parameters, especially those relating to the 10-year flow (the 1980 flood has a recurrence interval of approximately 13 years). The flow patterns observed during the 1980 flood are in general agreement with the results of the 10-year flow modeling of the current study.

Two studies (References 4 and 5) were prepared to evaluate ponding adjacent to the levees and design outlets through the levees to discharge the water ponded by the levees. Both of these previous studies used short duration, high intensity storms for the design rainfall. This study used the 100-year, 24-hour storm as the design rainfall. Neither of the previous studies assumed a 100-year water surface elevation in the river channel as a condition of the ponding analysis. This study assumes a constant 100-year water surface elevation exists in the river channel for the entire duration of the ponding. No joint probability analysis was performed.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Flood Control District of Maricopa County, Hydrology Division, 3335 W. Durango, Phoenix, AZ 85009; phone (602) 262-1501. The study was performed by Jerry R. Jones & Associates, Inc., 2207 E. Camelback Road, Suite 302, Phoenix, AZ 85016.

9.0 BIBLIOGRAPHY AND REFERENCES

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2. U.S. Department of the Interior, Geological Survey, Water-Resources Investigations, Open-File Report 80-767, Flood of February 1980 Along the Agua Fria River, Maricopa County, Arizona, Tucson, Arizona, June 1980.

3. U.S. Army Corps of Engineer, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Generalized Computer Program, Davis, California, February 1981 (updated October 30, 1981).

4. Simons, Li & Associates, Agua Fria River Channelization Side Drainage Analysis, Tucson, Arizona, November 1984.

5. Simons, Li & Associates, Agua Fria River Control Project, Analysis of Side Drainage Requirements, Buckeye Road to 1,500 Feet South of Interstate 10, Tucson, Arizona, January 30, 1985.

6. U.S. Department of Commerce, National Weather Service, Precipitation - Frequency Atlas of the Western United States, Volume VIII - Arizona, Silver Spring, Maryland, 1973.

7. Cooper Aerial Survey Company, Miscellaneous Photographs and Maps Prepared for Jerry R. Jones & Associates under Contract 870526, 1987-1988.

8. U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Charts for the Selection of Highway Culverts, Hydraulic Engineering Circular No. 5, Washington, D.C., December 1965.

9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, November 1976 (Updated March 1982).

10. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Maricopa County, Arizona, Washington, D.C., May 1979.

11. Federal Emergency Management Agency, Flood Insurance Study Maps, Maricopa County, Arizona, Washington, D.C., April 15, 1988.

REFERENCE MARK	DESCRIPTION OF LOCATION	ELEVATION (feet NGVD)
RM1	U.S. ARMY CORPS OF ENGINEERS -BRASS CAP ON A 2" PIPE AT THE INTERSECTION OF SOUTHERN AVENUE & LITCHFIELD ROAD	916.83
RM2	BRASS CAP IN PARAPET @ N.E. CORNER OF BULLARD RD. BRIDGE OVER THE GILA RIVER	927.45
RM3	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF SOUTHERN AVENUE & DYSART ROAD	929.63
RM4	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF BROADWAY ROAD & DYSART ROAD	933.58
RM5	COTTON SPINDLE FLUSH WITH PAVEMENT AT THE INTERSECTION OF LOWER BUCKEYE & DYSART ROADS	944.24
RM6	BRASS CAP WEST END OF BUCKEYE ROAD BRIDGE OVER THE AGUA FRIA RIVER	973.58
RM7	1/2" REBAR IN HANDHOLE AT THE INTERSECTION OF VAN BUREN STREET & DYSART ROAD	982.19
RM8	A.D.O.T. BRASS CAP @ N.E. CORNER OF INTERSTATE HIGHWAY 10 BRIDGE OVER THE AQUA FRIA RIVER.	994.71
RM9	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF McDOWELL & DYSART ROADS	993.98
RM10	5/8" REBAR FLUSH WITH PAVEMENT AT THE INTERSECTION OF McDOWELL & ELMIRAGE ROADS	979.21
RM11	1 1/2" IRON PIN AT THE INTERSECTION OF THOMAS & EL MIRAGE ROADS	995.24
RM12	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF INDIAN SCHOOL & EL MIRAGE ROADS	1016.03
RM13	A.D.O.T. BRASS CAP @ S.W. CORNER OF INDIAN SCHOOL ROAD BRIDGE OVER THE AQUA FRIA RIVER	1022.43
RM14	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF CAMELBACK & EL MIRAGE ROADS	1026.56
RM15	BRASS CAP FLUSH WITH PAVEMENT AT THE INTERSECTION OF BETHANY HOME & EL MIRAGE ROADS	1036.31

REFERENCE MARK	DESCRIPTION OF LOCATION	ELEVATION (feet NGVD)
RM16	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF GLENDALE AVENUE & EL MIRAGE ROAD	1063.68
RM17	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF NORTHERN AVENUE & EL MIRAGE ROAD	1088.09
RM18	BRASS CAP IN HAND HOLE AT THE INTERSECTION OF NORTHERN & 115th AVENUES	1064.70
RM19	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF GLENDALE & 115th AVENUES	1054.03
RM20	TOP OF STONE AT THE EAST QUARTER CORNER OF SECTION 25, TOWNSHIP 3 NORTH, RANGE 1 WEST	1087.36
RM21	1/2" REBAR AT THE NORTHEAST CORNER OF SECTION 24, TOWNSHIP 3 NORTH, RANGE 1 WEST	1105.61
RM22	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF CACTUS & EL MIRAGE ROADS	1117.52
RM23	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF PEORIA AVENUE & EL MIRAGE ROAD	1106.18
RM24	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF OLIVE AVENUE & EL MIRAGE ROAD	1096.34
RM25	MARKED STONE AT SOUTHEAST CORNER OF SECTION 12, TOWNSHIP 3 NORTH, RANGE 1 WEST	1121.41
RM26	1/2" REBAR AT NORTHEAST CORNER OF SECTION 12, TOWNSHIP 3 NORTH, RANGE 1 WEST	1129.22
RM27	1 1/2" IRON PIN AT EAST QUARTER CORNER OF SECTION 1, TOWNSHIP 3 NORTH, RANGE 1 WEST	1146.04
RM28	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF 115th AVENUE & BELL ROAD	1163.03
RM29	5/8" REBAR AT THE INTERSECTION OF 115th AVENUE & UNION HILLS ROAD	1173.46
RM30	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF 123rd AVENUE & BELL ROAD	1176.64
RM31	BRASS CAP 0.4' ABOVE GROUND AT THE NORTHWEST CORNER OF SECTION 30, TOWNSHIP 4 NORTH, RANGE 1 EAST	1189.78

REFERENCE MARK	DESCRIPTION OF LOCATION	ELEVATION (feet NGVD)
RM32	BRASS CAP (CITY OF PEORIA) FLUSH AT THE NORTH QUARTER CORNER OF SECTION 30, TOWNSHIP 4 NORTH, RANGE 1 EAST	1221.85
RM33	BRASS CAP IN HANDHOLE AT THE INTERSECTION OF 107th AVENUE & BEARDSLEY ROAD	1238.92
RM34	BRASS CAP (CITY OF PEORIA) FLUSH AT THE EAST QUARTER CORNER OF SECTION 19, TOWNSHIP 4 NORTH, RANGE 1 EAST	1238.86
RM35	1" IRON PIN AT THE SOUTHEAST CORNER OF SECTION 13, TOWNSHIP 4 NORTH, RANGE 1 WEST	1206.57
RM36	TOP OF STONE AT THE NORTHWEST CORNER OF SECTION 18, TOWNSHIP 4 NORTH, RANGE 1 EAST	1237.28
RM37	ARIZONA PUBLIC SERVICE BRASS CAP AT THE EAST QUARTER CORNER OF SECTION 12, TOWNSHIP 4 NORTH RANGE 1 WEST	1261.05
RM38	5/8" REBAR AT THE SOUTHEAST CORNER OF SECTION 1, TOWNSHIP 4 NORTH, RANGE 1 WEST	1299.47
RM39	G.L.O. BRASS CAP AT THE NORTHWEST CORNER OF SECTION 6, TOWNSHIP 4 NORTH, RANGE 1 EAST	1328.67
RM40	ARIZONA PUBLIC SERVICE BRASS CAP MARKED SECTION CORNER (SEC 7, T4N, R1E) AT THE INTERSECTION OF 107th AVENUE & HAPPY VALLEY ROAD	1244.21
RM41	BRASS CAP (LS 6177) AT THE NORTH QUARTER CORNER OF SECTION 5, TOWNSHIP 4 NORTH, RANGE 1 EAST	1359.88
RM42	BRASS CAP (U.S.C. & G.S.) L-266 IN CONCRETE 100" ± EAST AND 1900 ± NORTH OF SOUTHWEST CORNER OF SECTION 32, TOWNSHIP 5 NORTH, RANGE 1 EAST	1277.68
RM43	BRASS CAP (U.S.C. & G.S.) R-366 IN CONCRETE LOCATED 300' ± EAST AND 300' ± NORTH OF THE SOUTHWEST CORNER OF SECTION 31, TOWNSHIP 5 NORTH, RANGE 1 EAST, ALSO 45' ± SOUTH CENTERLINE OF THE LOWER BEARDSLEY CANAL ROAD AND ON CREST OF HILL.	1353.38

REFERENCE MARK	DESCRIPTION OF LOCATION	ELEVATION (feet NGVD)
RM44	CROSS ON NORTHEAST CORNER OF CATTLE GUARD AT THE NORTH SIDE OF ORCHARD ON BEARDSLEY CANAL ROAD, LOCATED 1950' ± EAST AND 400' ± NORTH OF SOUTHWEST CORNER SECTION 17, TOWNSHIP 5 NORTH, RANGE 1 EAST.	1355.76
RM45	FD. 1/2" REBAR AT THE SOUTH 1/4 CORNER, SECTION 8, TOWNSHIP 5 NORTH, RANGE 1 EAST, ALSO 500' ± NORTH AND 1900' WEST OF FLUME	1372.18
RM46	FD. 5/8" BAR AT SOUTH 1/4 CORNER, SECTION 4, TOWNSHIP 5 NORTH, RANGE 1 EAST, 400' ± EAST OF ROAD, TOP OF HILL	1454.47
RM47	FD. STONE WITH MARKING AT THE NORTHEAST CORNER, SECTION 5, TOWNSHIP 5 NORTH, RANGE 1 EAST	1412.88
RM48	A.D.O.T. BRASS CAP TOP HEADWALL AT THE NORTHEAST CORNER OF THE EAST BRIDGE ON LAKE PLEASANT	1469.31

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SECTION 10 - ADDENDUM

ADDENDUM TO FLOOD INSURANCE STUDY FOR THE AGUA FRIA RIVER IN MARICOPA COUNTY, ARIZONA

PREPARED BY JERRY R. JONES & ASSOCIATES, INC.
JANUARY, 1989

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EXHIBITS

EXHIBIT 1 - Ponding Analysis Watershed Map — Map Envelope

1.0 PURPOSE OF REPORT

The purpose of this report is to provide an addendum to the primary report that discusses the technical aspects of the Flood Insurance Study in greater detail. Unusual or difficult aspects of the hydrologic and hydraulic modeling techniques or deviations from standard Flood Insurance Study methodologies are provided within this addendum for clarification.

2.0 ASSUMPTIONS

2.1 Backwater Modeling

General:

a) Left and right orientation considerd facing downstream.
b) The thalweg is station 100+00.
c) Expansion downstream of constrictions and fixed points is generally considered to be 4:1 (longitudinal:horizontal).
d) Contractions upstream of constrictions and fixed points is generally considered to be 1:1 (longitudinal:horizontal).
e) Floodways were determined using either Method 1 or Method 4 in the HEC-2 modeling.
f) Areas of deep flow with high velocities were considered to be in the floodway even if there was not one foot rise in the 100 year water surface elevation.
g) Gravel pits were coded to reflect a fully inundated situation. The top elevations at the edge of the pit were coded across the pit to accomplish this.

2.2 Ponding Analysis

General:

a) Curve numbers and watershed areas were obtained from References 4 and 5. Deviations from these watershed areas are discussed below at specific locations where they occur.
b) Reservoir routing for ponding utilized a level-pool algorithm.
c) Kinematic wave routing methodology was utilized to route channelized flows and overflows from other watersheds to ponding locations. Thus, any of these type flows are routed to the ponding locations without attenuation.
d) The SCS unit hydrograph was used to develop the inflow hydrograph at each location. Lag and lag factor were calculated using equations 9 and 11 in Reference 4.
e) Outlet pipes were rated using HEC 5. A surcharge of 0.2 feet was added to all headwater calculations to account for energy losses due to flapgates. For example, if a 20 cfs flow was calculated to have a headwater elevation of 1000.0, the elevation used in the HEC-1 modeling for 20 cfs was 1000.2.

f) The watershed areas from References 4 and 5 were reduced when a gravel pit intercepted flow prior to it reaching the ponding area. However, if the pit was filled and water overflowed and continued onto the ponding area of interest, the watershed area was not altered.

g) Where no physical barrier existed to pond flow and create headwater at pipes through the levee, watersheds were summed proceeding downstream until ponding did occur.

h) Rainfall values are the 100-year, 24-hour rainfall from the NOAA VIII atlas.

i) Rainfall distribution is an SCS Type II distribution.

j) The 100-year water surface elevation was assumed to exist on the river during the entire ponding analysis.

3.0 AREAS OF STUDY

3.1 Gila River Confluence to Broadway Road

The entire floodplain along the westside of the floodplain downstream of the soil cement dike is considered to be an effective flow area. Flow is expanding as it enters the Gila River floodplain. The west overbank flow begins to turn in a westerly direction here. The cross sections here were modeled as curved lines to approximate lines of equipotential. The limit of the effective flow area generally conforms to the flow pattern of the February 1980 flood (see Reference 1).

3.2 Broadway Road to Buckeye Road

A soil-cement dike has been constructed along the west side of the channel and protects the wastewater treatment facility for the City of Avondale. Earthen dikes have also been constructed along the east side of the channel between Section O and Section Y. Unlike the west side soil-cement dike, these dikes do not have sufficient height and are not of substantial construction. Therefore, overtopping or erosion may occur and the dikes were analyzed accordingly. Based upon this analysis, the floodplain extends east of the dikes to the higher ground along Vermesh Road.

3.3 Buckeye Road to Indian School Road

The river is channelized between two soil-cement levees along this entire reach. All bridges are elevated sufficiently and will not be overtopped or will not divert flow over the levees. These bridges were modeled using the normal bridge routine. Spaced throughout this reach are soil-cement "islands" within the channel built to protect electrical transmission towers. All of these "islands" were analyzed using three cross-section (upstream, through obstruction, downstream) in order to model the obstructions. The transmission towers are noted on comment cards within the HEC-2 deck (Reference 2).

Ponding was analyzed using HEC-1 at several locations along the landward side of the levees. The ponding generally occurs where tributary flows are concentrated by a levee and a raised embankment. Drainage outlets (culverts with one-way flapgates) were placed along the levees at all the upstream ponding locations to alleviate the potential depth and extent of ponding at each location. The flapgates will prevent flow in the Agua Fria channel from backing up and flooding adjacent lands.

The expansion of the effective flow area along the west side of the floodplain differs slightly from the normal 4 (parallel to flow) to 1 (perpendicular to flow) ratio used throughout this study.

The ponding analysis for the west levee at the R.I.D. canal considered a reduction on the watershed area. This was due to the gravel pit located along the RID canal at El Mirage Road. Along the east levee no pending is anticipated due to the interception of flows from the east by the low area/gravel pit there.

Along the west levee, upstream of I-10 a very small amount of ponding occurs at the inlet of the culvert. It is not of sufficient nature to warrant depiction on the maps. The analysis along the east levee, upstream of McDowell Road assumes that flapgates have been installed on the culvert outlet across McDowell Road. Water from the river backs up to the culvert outlet.

3.4 Indian School Road to Olive Road

The levees along both sides of the channel end at Indian School Road. Spur dikes have been constructed north (upstream) of Indian School Road to direct the flow into the channel south (downstream) of the road.

The modeling of the Glendale Avenue bridge differed from the modeling of other bridges in this study. The east approach to the bridge is lower than the west approach. Using the normal bridge method showed the bridge to have capacity to pass the 50-, 100-, and 500-year flows with pressure and/or weir flow. However, if there were weir flow over the east approach, the tailwater would be lower because not all of the water was passing under the bridge. Thus, there would not be pressure flow at the bridge. Therefore, the bridge was modeled using the special bridge method. A weir coefficient of 2.5 was used to model the flow over Glendale Avenue and contraction/expansion coefficients of 0.4/0.6 were chosen to model the flow upstream/downstream of the bridge. After many trials, it was found that the calculated flow in the east overbank upstream of the bridge was significantly different than the east overbank flow downstream of the bridge. This did not apply to the modeling of the 10-year flow because the bridge has capacity to pass the 10-year flow without exceeding the elevation of Glendale Avenue. X5 cards were used to set a water surface upstream of the bridge that produced equal flows in the left overbank upstream and downstream of the east approach.

3.5 Olive Road to Bell Road

The modeling of the flows at the Grand Avenue and Atchison, Topeka and Santa Fe Railroad bridges was the most complex modeling performed for this FIS. The bridges over the river channel do not have the capacity to pass large flows. Also, the smaller bridges located west of the main channel in the overbank flow areas do not have the capacity to pass large flows. Thus, during a flood, water will flow under the highway/railroad bridges located at the main channel and in the west overbank, and weir flow over the roadway and railway will occur near the smaller structures located in the west overbank area.

In addition, an elevated landfill has been constructed along the west bank of the main channel downstream of the bridge. This landfill, which is elevated approximately 50 feet, effectively separates the flows in the main channel from the flows passing through and over the bridges located in the west overbank. Several split flow analyses and conventional backwater analyses were performed to develop a split flow rating curve for the final analysis.

Floodways were developed on both sides of the landfill. Because the landfill is in the middle of the combined floodplain, encroachment on the west floodplain was only from the west and encroachment on the east floodplain only from the east. The landfill was given a Zone A designation because it is quite massive, but unprotected from erosion.

The most significant ponding occurs adjacent to the east and west levees north of Buckeye Road. The ponding results, in part, from water flowing past the inlets to culverts located farther upstream along the levee. The flow then concentrates and ponds downstream north of Buckeye Road and the S.P. Railroad as both the roadway and track are elevated. The case of the ponding along the west levee illustrates the uncommon aspects of the ponding analysis; an example of the ponding analysis is described below:

> In the report prepared for the design of the culvert for drainage outlets through the levee (Reference 7), the culvert outlet at Buckeye Road was designed for runoff generated by the 10-year, 2-hour storm. A peak flow of 185 cfs, which was generated from a watershed of 1.98 square miles, produced a ponding elevation of 960.10 based on inlet control. That is, no effect from the Agua Fria tailwater on the culvert through the levee. Storage on the landward side of the levee was not considered.
>
> The analysis for this FIS at this same culvert location at Buckeye Road used the same method (SCS curve numbers) as the original report to determine a rainfall-runoff parameter. The design storm was the 100-year, 24-hour storm rather than the 10-year, 2-hour storm. A peak flow of 324 cfs is generated from a watershed of 2.13 square miles. The watershed area is greater in size than in the original design report because there is additional flow which breaks over from another watershed located further north (upstream) along the levee. The watersheds west of Central Avenue in Avondale were kinematically routed through the channel adjacent to Western Avenue to the ponding location. There they were combined with the flow from the watersheds adjacent to the levee.
>
> The upstream culvert, located through the levee, is about three-fourths of one mile north of the Buckeye Road ponding location. However, at the upstream culvert, the 100-year water surface elevation, in the main Agua Fria channel is sufficiently to prevent the conveyance of local runoff into the channel. As a result, the local runoff continues to flow unobstructed downstream to the Buckeye Road location. The watershed area for this upstream watershed has been added to the watershed area for Buckeye Road.

In addition, there is runoff from north of Van Buren Road that overflows and affects the Buckeye Road location. The ponding area north of Van Buren Road is sufficiently deep to overtop Van Buren Road and to then flow south to the ponding area north of Buckeye Road. This increases the total flow at the Buckeye ponding location to 355 cfs. Of this amount only 17 cfs discharges through the levee via the culvert at an upstream headwater elevation of 964.31 feet. The remainder of the flow is stored on the landward side of the levee and is shown as an Zone AE floodprone area at an elevation of 964.31. Other ponding areas were analyzed using the same methodology. Along the east levee in this reach, the watersheds are combined at the downstream ponding location at the outlet. Also, some flow from areas north of Van Buren ponds and flows across the road. This flow was routed using the kinematic wave methods to the downstream pending location.

3.6 Bell Road to End of Study

North of Bell Road along the east bank, a privately-constructed dike has been built to protect the Brookview Village development. The dike is sufficiently high to meet levee height requirements and a LOMR has been issued.

Because the channel is deep and narrow in the areas north of Jomax Road, the entire floodplain was modeled as the channel for many areas. There is no floodway encroachment in these areas and the entire 100-year floodplain is classified as floodway. The floodplain in this upstream reach is deeper and the velocity is higher than on the lower reaches of the river and any encroachments might create hazardous conditions. As a result, the entire channel is classified as floodway.

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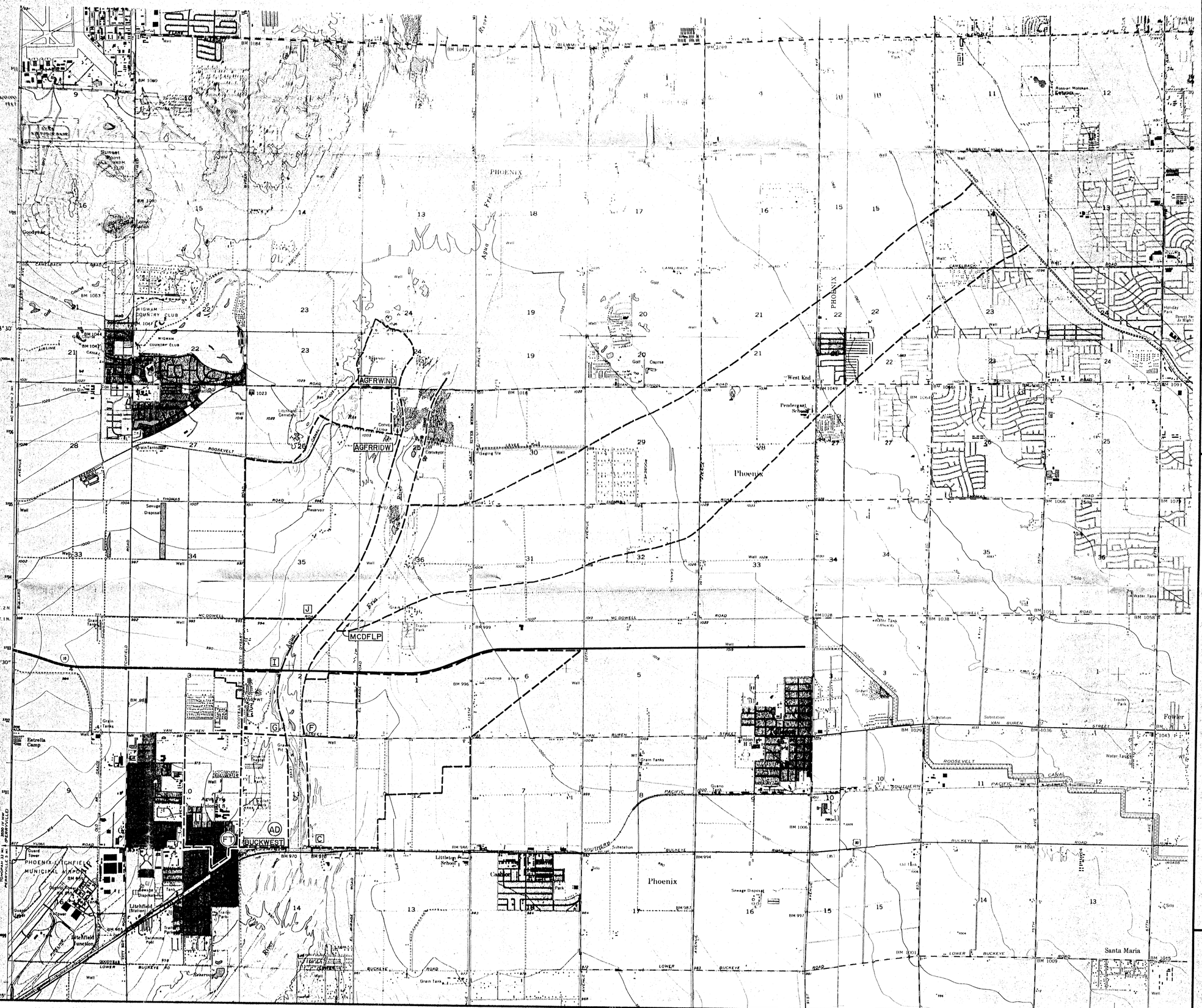

LEGEND

X Y	WATERSHED
⊗	SUBWATERSHED
— — —	WATERSHED BOUNDARY LINE

N

SCALE: 1" = 2000'

FLOOD CONTROL DISTRICT
RECEIVED
OCT 02 1989

CH ENG	P & PM
DEP	HYDRO
ADMIN	CNST
FINANCE	FILE
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ENGR	
REMARKS	

AGUA FRIA F.I.S. PONDING

WATERSHED MAP

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