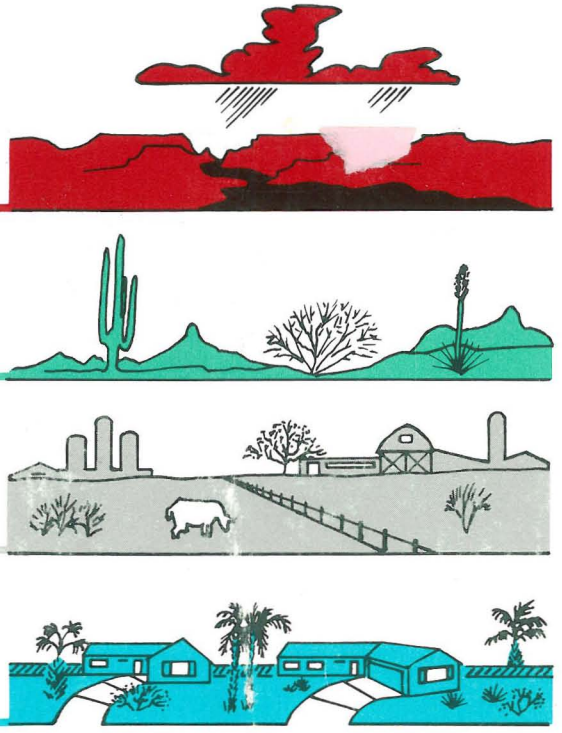

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

TIGER WASH

APPROXIMATE FLOODPLAIN STUDY

PART 1 - HYDROLOGY

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TIGER WASH

APPROXIMATE FLOODPLAIN STUDY

PART 1 - HYDROLOGY

TIGER WASH APPROXIMATE FLOODPLAIN STUDY

PART 1 - HYDROLOGY

Prepared for:

Flood Control District of Maricopa County

3335 W. Durango

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July, 1991

TIGER WASH APPROXIMATE FLOODPLAIN STUDY

PART 1 - HYDROLOGY

TABLE OF CONTENTS

	Page
Abbreviations	
Introduction	1
Previous Studies	2
Watershed Descriptions	
Watershed Areas	2
Topography	3
Structures	3
Soils	4
Vegetation	4
Land Use	4
Watershed Modeling	
Computer Model	5
Field Verification	5
Physical Parameters	5
Rainfall	6
Losses	7
Runoff Conversion	7
Routing	8
Comparisons	
Log-Pearson III Analysis	8
Frequency Plot	9
Summary	9
References	11

TABLE OF CONTENTS (continued)

LIST OF FIGURES, TABLES, AND APPENDICES

List of Figures

Figure 1: Watershed Location Map
Figure 2: Watershed Map
Figure 3: Soils Map
Figure 4: Rainfall Map
Figure 5: Watershed Schematic
Figure 6: Split Flow Analysis

List of Tables

Table 1: Subbasin Parameters
Table 2: HEC-1 Discharge Summary
Table 3: Recommended Flood Study Discharges

Appendices

Appendix A: Rainfall Calculations
Appendix B: Soil Descriptions and Subbasin Losses
Appendix C: Channel Routing Calculations
Appendix D: Reservoir Outflow and Storage Calculations
Appendix E: Log-Pearson III Analysis
Appendix F: HEC-1 Output File TW24.OUT
Appendix G: HEC-1 Output File APEX6.OUT
Appendix H: Portion of USBR Hydrolgic Design Report for TWDB

ABBREVIATIONS

Abbreviation	Definition
ADWR	Arizona Department of Water Resources
ARF	Areal Reduction Factor
CAP	Central Arizona Project
cfs	Cubic Feet per Second
COE	US Army Corps of Engineers
csm	Cubic Feet per Second per Square Mile
DA	Drainage Area
FCDMC	Flood Control District of Maricopa County
FEMA	Federal Emergency Management Agency
FRS	Flood Retarding Structure
HDM	Hydrologic Design Manual for Maricopa County
HEC	Hydrologic Engineering Center, COE
HQFRS	Harquahala Flood Retarding Structure
NOAA	National Oceanic and Atmospheric Administration
RCP	Reinforced Concrete Pipe
SCS	Soil Conservation Service
sq.mi.	Square Mile
SUB	Subbasin
TWAF	Tiger Wash Alluvial Fan
TWDB	Tiger Wash Detention Basin
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WSEL	Water Surface Elevation

INTRODUCTION

The Tiger Wash watershed is located along the Maricopa/La Paz County border in northwestern Maricopa County (see Figure 1), and covers approximately 162 square miles. The watershed is bounded to the northwest by the rugged Harquahala Mountains, to the east by the hills of the Bighorn Mountains, to the northeast by the Aguila Plain, and to the south by the Harquahala Plain. The Tiger Wash Detention Basin, built by the USBR, serves as the primary storage/outlet structure for the watershed, protecting both the CAP canal and the Interstate 10 freeway to the south.

Tiger Wash, an ephemeral desert watercourse, serves as the main drainage channel in the watershed. It is a broad, sometimes deep, and well defined sandy and gravelly channel in most areas along it's northern length, however, when no longer confined by the Harquahala and Big Horn mountains, flows split into two main branches. The west branch eventually becomes the Tiger Wash Alluvial Fan and flows over Buckeye-Salome Road via numerous dip crossings to the TWDB. The east branch continues southward from the split as a relatively small, low flow channel, with larger flows breaking out of the banks and travelling as sheet flow. The east branch also flows over Buckeye-Salome Road and into the TWDB.

This analysis will attempt to achieve two primary goals:

1. To develop a hydrologic model for the area upstream of the Tiger Wash Alluvial Fan apex, as required by Contract # FCD 90-22, Alluvial Fan Data Collection and Monitoring Project, and
2. To develop peak 100-year discharge values at several points along Tiger Wash for use in an Approximate Floodplain Delineation Study, as requested by the Floodplain Management Branch, Hydrology Division, FCDMC.

PREVIOUS STUDIES

Previous hydrologic studies for the Tiger Wash watershed are limited because of it's remote and undeveloped condition. "Hydrologic Design Data for Tiger Detention Basin, Reach 5, Granite Reef Aqueduct" was completed by the USBR in 1974, and was used to design the Tiger Wash Detention Basin. This study was reviewed and pertinent information was incorporated into this report. Other studies, reports, plans, and construction drawings used in this analysis are listed in the References section at the end of this report.

WATERSHED DESCRIPTION

Watershed Areas

The Tiger Wash watershed was divided into 9 subbasins on USGS 15-minute topogaphic maps, except for the east and west boundaries between the TWDB and the Harquahala and Big Horn Mountains, which were delineated on 7.5-minute USGS maps, then transferred to the 15-minute maps. Subbasin areas were calculated from the 15-minute base map (Figure 2) using an electronic planimeter (see Table 1), and ranged from 9.78 to 34.61 square miles. The area upstream of USGS Gage No. 09517280 was calculated to be 85.3 square miles. The published value is 85.2 or 85.5 square miles depending on the source (Ref. No. 3, p.221 and Ref. No. 2, p.580 respectively). The calculated area upstream of the TWAF is 96.41 sq.mi., and the entire watershed area above the TWDB is 161.52 square miles.

Topography

Topography in the watershed can be catagorized into three main types. Steep, rugged mountains in Subbasins 3, 5, 6, and 7 have slopes generally greater than 200 feet/mile. The hillslope areas of eastern Subbasin 3, Subbasins 2 and 4, and the northern portions of Subbasins 7 and 8 have slopes from 100 to 200 feet/mile. Subbasins 1, 9, and the southern portions of 7 and 8 are primarily alluvial slopes and valley plains with slopes less than 100 feet per mile. It should be noted that below the upper portions of subbasins 7 and 8, the drainage patterns are no longer dendritic, but become parallel. This means that combined peak discharge values reported by the model at the TWDB never physically combine and hence are rather meaningless, but volume estimates should remain accurate.

Structures

Except for a few small stock watering ponds, the only major drainage structure in the watershed is the Tiger Wash Detention Basin. This earthen dam averages 18 feet in height, is approximately 6.5 miles long, and has a storage capacity of approximately 24,350 acre-feet of water below the top of dam, of which 1150 ac-ft are allocated for sediment strorage. To estimate the storage capacity, a table of surface area vs. elevation was developed from the 7.5 minute USGS maps and from the USBR plan and profile drawings (Ref. 1), and input into the HEC-1 model. The principal outlet is a pair of ungated 72 inch diameter RCP's which discharge water directly to Centennial Wash on the southwest corner of the structure. The emergency spillway consists of an 800 foot diameter semi-circular dike at the northwest corner of the structure. The dike guides the overflow around the western end of the structure and southward to a tributary wash which conveys the flow to Centennial Wash.

Soils

The typical hyperthermic and thermic arid soils found within the Tiger Wash watershed can be categorized into two topographic regions: (1) mountains, buttes, and hillslopes; and (2) valley plains and alluvial slopes (Ref 11). The mountains, buttes, and hillslopes consist mainly of rock outcrops, gravelly loams, gravelly clay loams, loams, and sandy loams. The Maricopa County soil surveys catagorize the alluvial slopes and valley plains into two associations: (1) soils formed in recent alluvium, and (2) soils formed in old alluvium. The recent alluvium consists mainly of loamy sand and sandy loam, while the older fan terraces and valley plains consist of sandy loams, loams, gravelly loams, and clay loams.

Vegetation

The variety of vegetation throughout the subbasins within the Tiger Wash watershed remains relatively constant. Typical vegetation in the mountain and hillslope areas are creosote bush, bursage, cactus, mesquite trees, and paloverde trees. On the lower alluvial slopes and valley plain areas, the vegetation consists of mesquite, ironwood, and paloverde trees, cactus, bursage, creosote, and annual weeds and grasses. Total canopy cover was estimated to be 25% in the mountain and hillslope areas and 15% on the alluvial slopes and valley plains.

Land Use

Land use in the watershed has changed very little in the last 30 years since the USGS 15-minute series was published for the Tiger Wash area. Range land is the dominant land use on the valley plains and alluvial slopes. The

hillslope and mountain areas are also used as range land on a limited basis, and these areas are also used as mining claims.

WATERSHED MODELING

Computer Models

The Corps of Engineers' HEC-1 computer program, Version 4.0, September, 1990, was used to develop peak discharges, times to peak, and runoff volumes. FORTRAN program MCUHP2 (from the HDM) was used to develop the subbasin unit hydrographs. Public domain programs written in BASIC were used for caluculations involving Manning's equation and the Corps of Engineers' lag time equation. Several watershed models were developed, including different rainfall scenarios using 6 and 24-hour storms over the areas above the USGS gaging site, the TWAF apex, and the TWDB, for 2, 10, and 100-year frequencies.

Field Verification

Field reconnaissance was conducted in order to verify estimates of Manning's "n" values, channel geometries and bed materials, split-flow boundaries, watershed boundaries, basin roughness, vegetation cover, and connected imperviousness of rock outcrop areas. Outlet works and the emergency spillway area of the TWDB were also verified.

Physical Parameters

The following section describes how the physical subbasin parameters were measured, calculated, or selected.

Lengths (L): Flow path lengths were measured along the longest major watercourse in each subbasin using a 1/8"=1 ft. map wheel on the 1:62500 scale

topographic maps. The upstream limit of each watercourse was considered the point at which channel flow begins, since the basin roughness coefficient used in the COE lag equation is the average "n" value for all the channels. The lengths to centroid (Lca) were measured as the point along L opposite (at 90 degrees to) the subbasin centroid.

Slopes (S): Slopes were calculated along L using the Pima County adjustment method. The equation is:

$$I = \left[\frac{\Delta L_1^3}{\Delta H_1}\right]^{1/2} + \left[\frac{\Delta L_2^3}{\Delta H_2}\right]^{1/2} + \left[\frac{\Delta L_3^3}{\Delta H_3}\right]^{1/2} \ldots, \qquad S_c = \left[L/I\right]^2$$

where $L = \sum_{i=1}^{n} \Delta L_i$ and ΔH is the incremental elevation difference in feet.

Basin Factor (Kn): Basin factors used in the Lag equation were estimated based on guidance from Figure 5.11 in the HDM. Weighted Kn's were calculated for each subbasin based on values of .070 for rangeland (primarily overland flow during large runoff events), .060 for mountains (flow in very rough channels), and .040 for hillslopes (flow in moderately rough channels).

Lag Time (Tl): Lag times were calculated using a BASIC program written by the author of this report. The program uses the equation described in Section 5.6.4 of the HDM, with the following error correction: C = 24Kn instead of C = 20Kn. Lag times were calculated using adjusted slopes as referrenced above.

Rainfall

Rainfall depths and distributions were estimated from Chapter 2 of the HDM, and from NOAA Atlas II (Ref. 9). Six and 24-hour duration rainfall depths were consistant across the entire watershed except over the Harquahala Mountains, so a slightly higher depth was applied in the model for Subbasins 3, 5, and 6 (see Fig.5). The SCS Type II distribution was selected to be used with the 24-hour depths, and applied to the entire watershed. Aerial

reduction for the 24-hour duration storm was selected from Figure 15 in NWS HYDRO-40 (Ref. 4). The 6-hour storm was applied to areas upstream of the USGS gaging site and above the TWAF apex. The distribution and areal reduction used are from Tables 2.3 and 2.1 respectively in the HDM. See Appendix 1 for depth values and areal reduction ratios.

Losses

The Green and Ampt loss rate method was used for this analysis. Soil texture data was compiled from the "Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona" (Ref 11). The soil map (Fig. 3) shows the approximate map unit boundaries transposed from the Soil Survey maps. Appendix B contains the soil descriptions for each subbasin, as well as the Green & Ampt parameter calculations. Soil percentages were normalized to account for the imperviousness of rock outcrop areas when the map unit's average rock outcrop percentage was greater than 10%. Since the percentage of rock outcrop areas is less than 30% for any map unit in this study, these areas were not adjusted to reflect connected imperviousness. Due to the approximates nature of this Floodplain Analysis and insufficient time to collect samples or accurately characterize the Tiger Wash streambed, channel transmission losses were not estimated.

Runoff Conversion

The S-graph method of unit hydrograph synthesis was used for all subbasins per recommendations in Chapter 4 of the HDM. The "Phoenix Valley" S-graph was used for Subbasins 1, 8, and 9, and the "Phoenix Mountain" S-graph was used for the remaining subbasins.

Routing

Channels: Since the watershed consists exclusively of natural channels, the Muskingum routing method was used as recommended by the HDM. Typical sections between concentration points were estimated from field photos, measurements, and surveys. Floodwave velocities for Muskingum "K" were estimated using Manning's equation and a floodwave velocity factor provided in the HDM. A value of 0.25 for Muskingum "X" was assigned to all channel reaches. Flow across the Salome Highway travels over wide dip sections rather than culverts, so routing along the Highway was ignored. Special consideration in routing flows through the alluvial fan area were not given because of the lack of sufficient applicable data.

Reservoir Routing: Storage routing through the TWDB was accomplished using the Modified Puls method in HEC-1. Principal outlet, emergency spillway, overtoping, and storage calculations are contained in Appendix D.

COMPARISONS

A Log-Pearson III flood flow frequency analysis was performed on the 17 years of annual peak discharge data at USGS Gage No. 09512780. The analysis generates a 100-year peak discharge at the gage of 11,400 cfs, with a 5% confidence limit of 41,700 cfs and a 95% confidence limit of 5,200 cfs (see Appendix E). The modeling effort produced 100-year peak discharges of 19,269 cfs for the 6-hour design storm and 22,120 cfs for the 24-hour design storm. Although greater than 11,400 cfs, both design discharges are well within the the 90% confidence interval calculated for the 17 years of record. Also, the

effects of transmission losses were not taken into account, which would reduce the design discharges.

A frequency plot of the data was constructed using the Cunnane plotting position and USGS extreme log data paper, in order to examine the results of the LP III analysis. A straight line through the data points, ending at a Q100 of 11,400 cfs, appears reasonable (see Appendix E, page 6).

The original design report for the TWDB by the USBR lists a maximum 100-year water surface elevation of 1404.9 feet from a 100-year, 6-hour storm, including 1150 acre-feet of sediment storage for a 100-year period. The 24-hour, 100-year strorm used in this analysis generated a peak water surface elevation of 1406.08 feet, also accounting for sediment storage.

The orignal design report used the following hydrologic methods:

1. Rainfall: 6-hour storm, distribution unknown, depths from 1967 NOAA Atlas.
2. Runoff: Paradise Valley Dimensionless Graph, Lag time from same COE equation used in this study (entire 166 sq.mi. drainage area treated as one basin).
3. Losses: Curve numbers based on geologic surface data.
4. Routing: Puls method for the reservoir, no channel routing.

A portion of the Tiger Detention Basin design report is included as Appendix H of this report.

SUMMARY

The primary goals of this analysis were to develop multi-frequency discharge values at the TWAF apex, and to develop 100-year discharge values for an approximate floodplain analysis of the Tiger Wash channel. Table 2 summarizes 2, 10, and 100-year discharges for various points in the watershed for both 6

and 24-hour design storm durations. Table 3 lists the recommended 100-year discharges along Tiger Wash based on the highest discharge produced by the design models at each concentration point. The discharge and volume estimates generated by this study appear reasonable when compared to an analysis of measured flow data from a gauge within the watershed, and to the original hydrologic analysis used to design the TWDB.

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    - Gladden, 1961
    - Aguila, 1962
    - Big Horn Mountains, 1961
    - Lone Mountain, 1961

    7.5 Minute Series (provisional)
    - Soccoro Mine
    - Weldon Hill
    - Lone Mountain
    - Courthouse Well

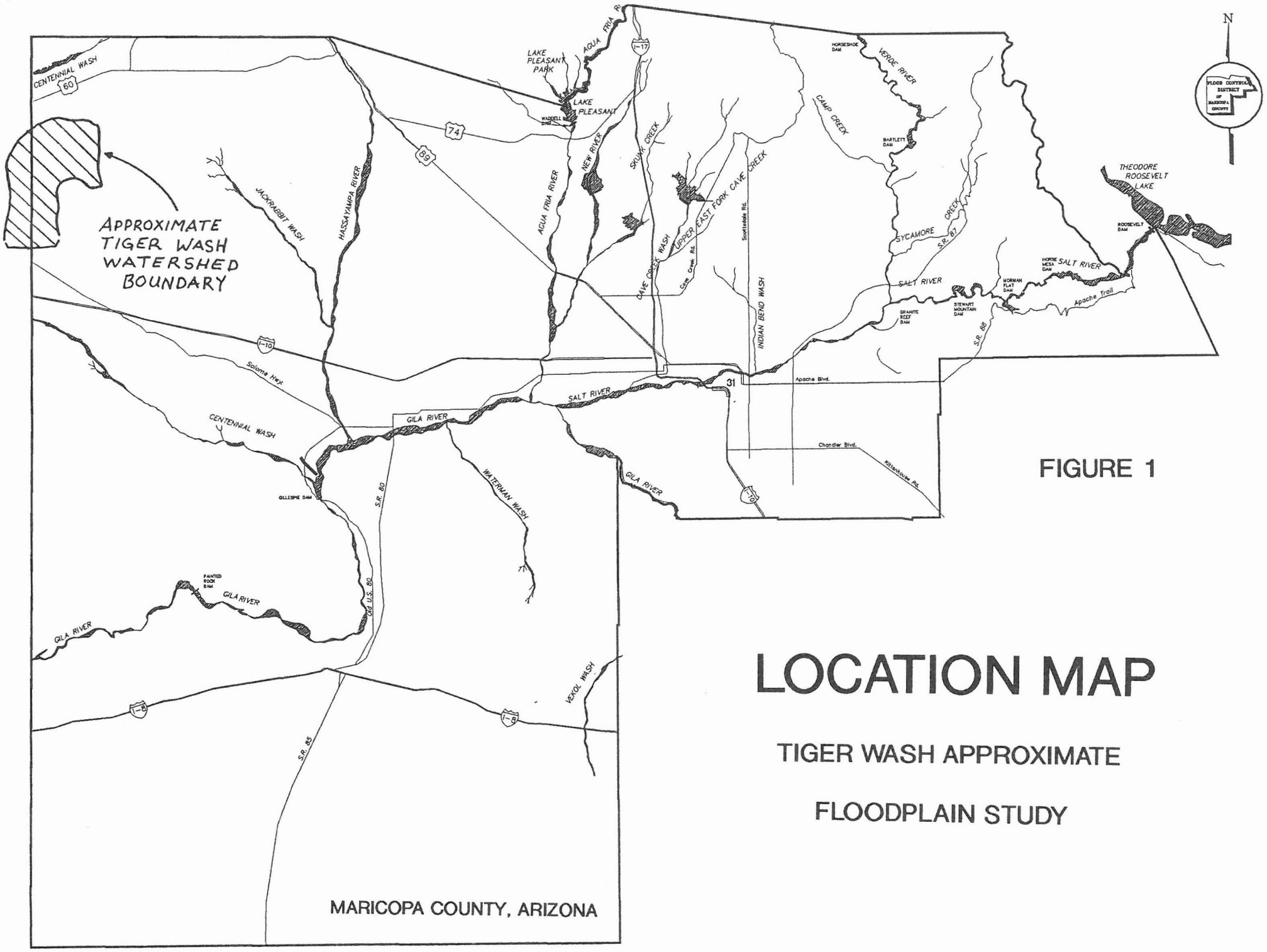
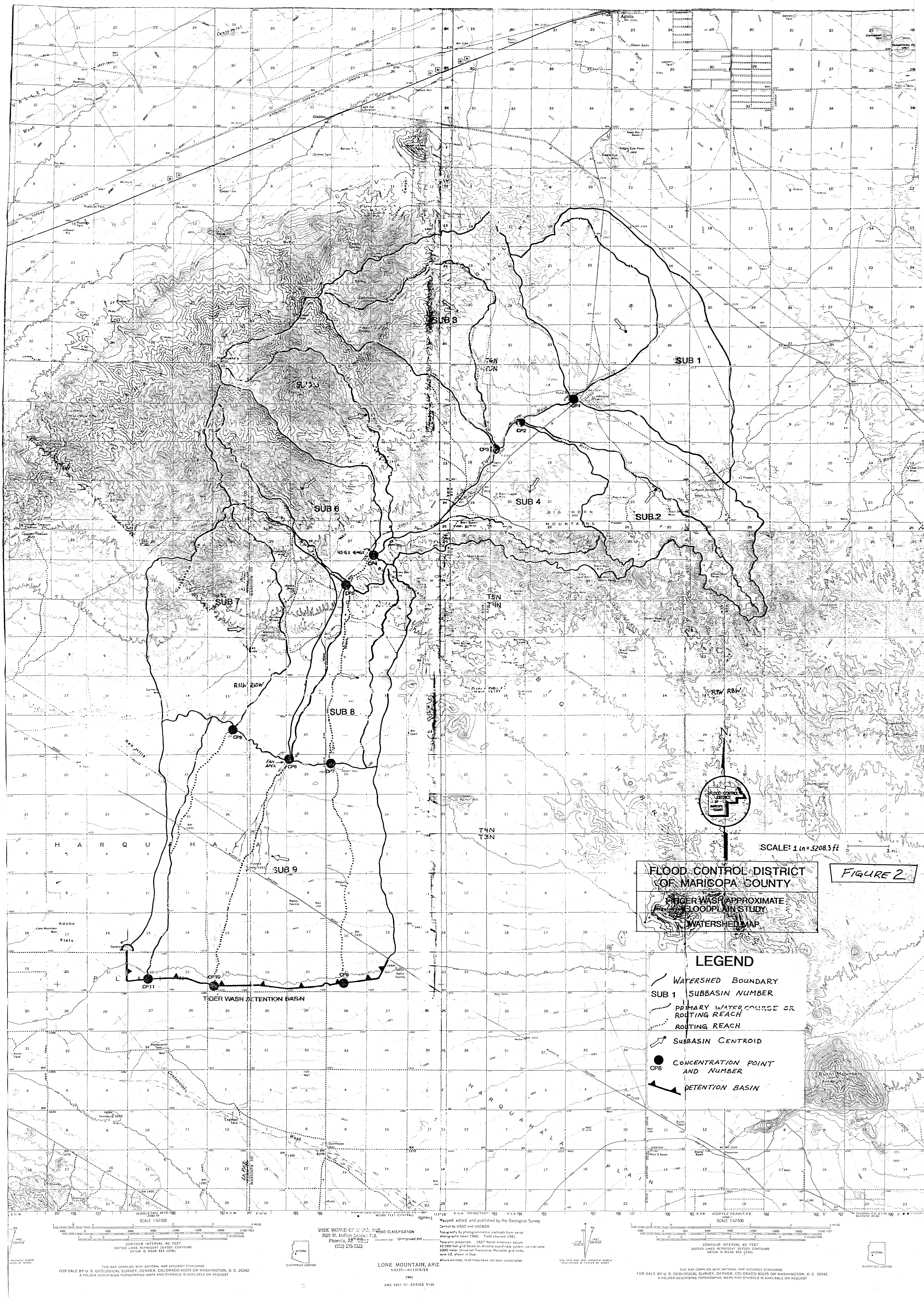


FIGURE 1

LOCATION MAP

TIGER WASH APPROXIMATE FLOODPLAIN STUDY


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
TIGER WASH APPROXIMATE FLOODPLAIN STUDY
WATERSHED MAP
FIGURE 2
SCALE: 1 in = 5208.3 ft
0
1 mi.
LEGEND
WATERSHED BOUNDARY
SUB 1 SUBBASIN NUMBER
PRIMARY WATERCOURSE OR ROUTING REACH
ROUTING REACH
SUBBASIN CENTROID
CP8 CONCENTRATION POINT AND NUMBER
DETENTION BASIN
SUB 1
SUB 2
SUB 3
SUB 4
SUB 6
SUB 7
SUB 8
SUB 9
CP1
CP2
CP3
CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
USGS GAGE
FAN APEX
TIGER WASH DETENTION BASIN
BIG HORN MOUNTAINS
HARQUAHALA PLAIN
Aguila
LONE MOUNTAIN, ARIZ.
N3330—W11315/15
1961
AMS 3351 III—SERIES V798
SCALE 1:62500
CONTOUR INTERVAL 40 FEET
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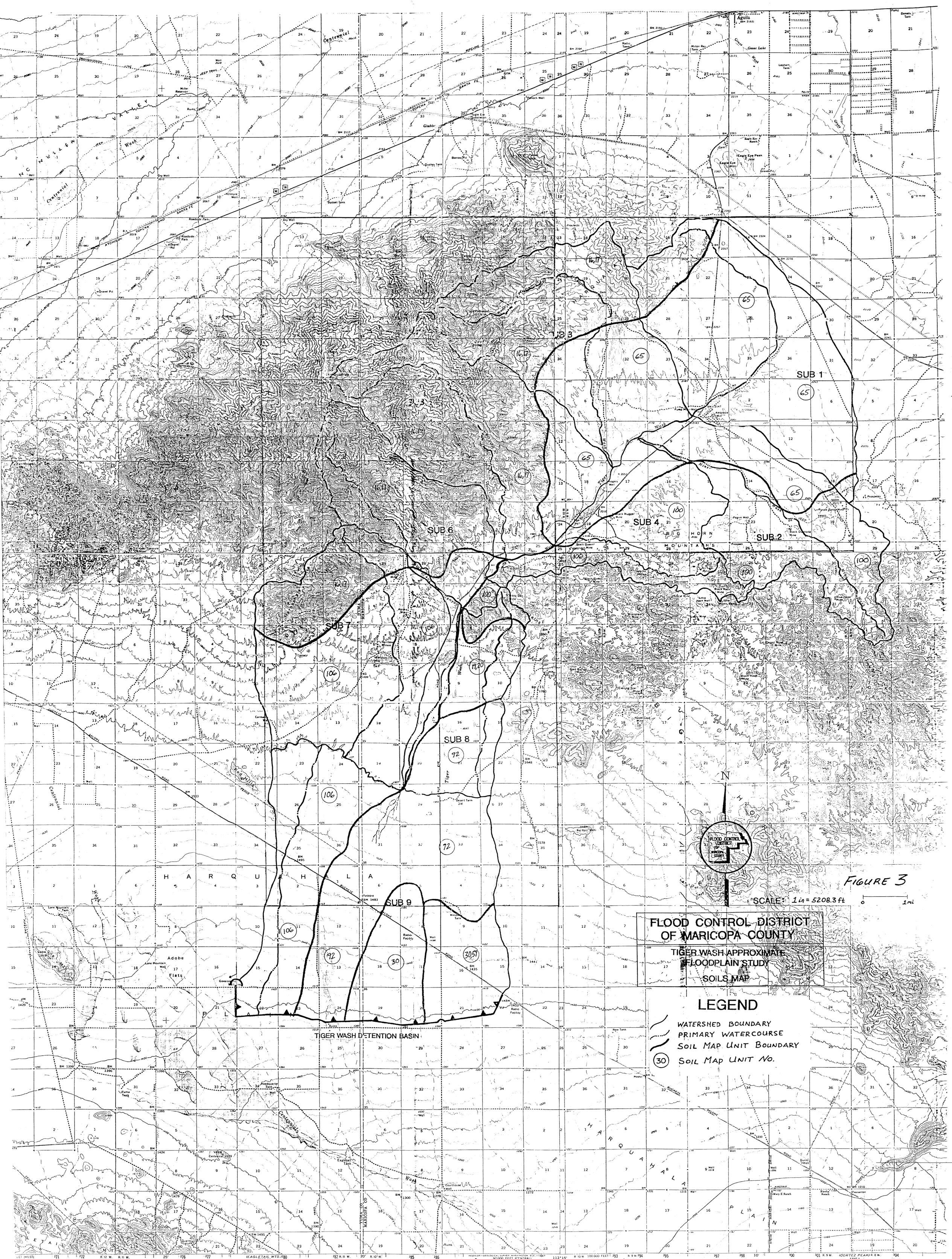

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GS

tric methods from aerial
d 1960. Field checked 1961

7 North American datum
Arizona coordinate system,

verse Mercator grid ticks,

ve not been established

UTM GRID AND 1961 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:62500

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

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ROAD CLASSIFICATION
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QUADRANGLE LOCATION

LONE MOUNTAIN, ARIZ.
N3330—W11315/15

1961

AMS 3351 III—SERIES V798

LONE MOUNTAIN 1
00000 00814
$ 3.25

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1960. Field checked 1961

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Where omitted, land lines have not been established

UTM GRID AND 1961 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:62500

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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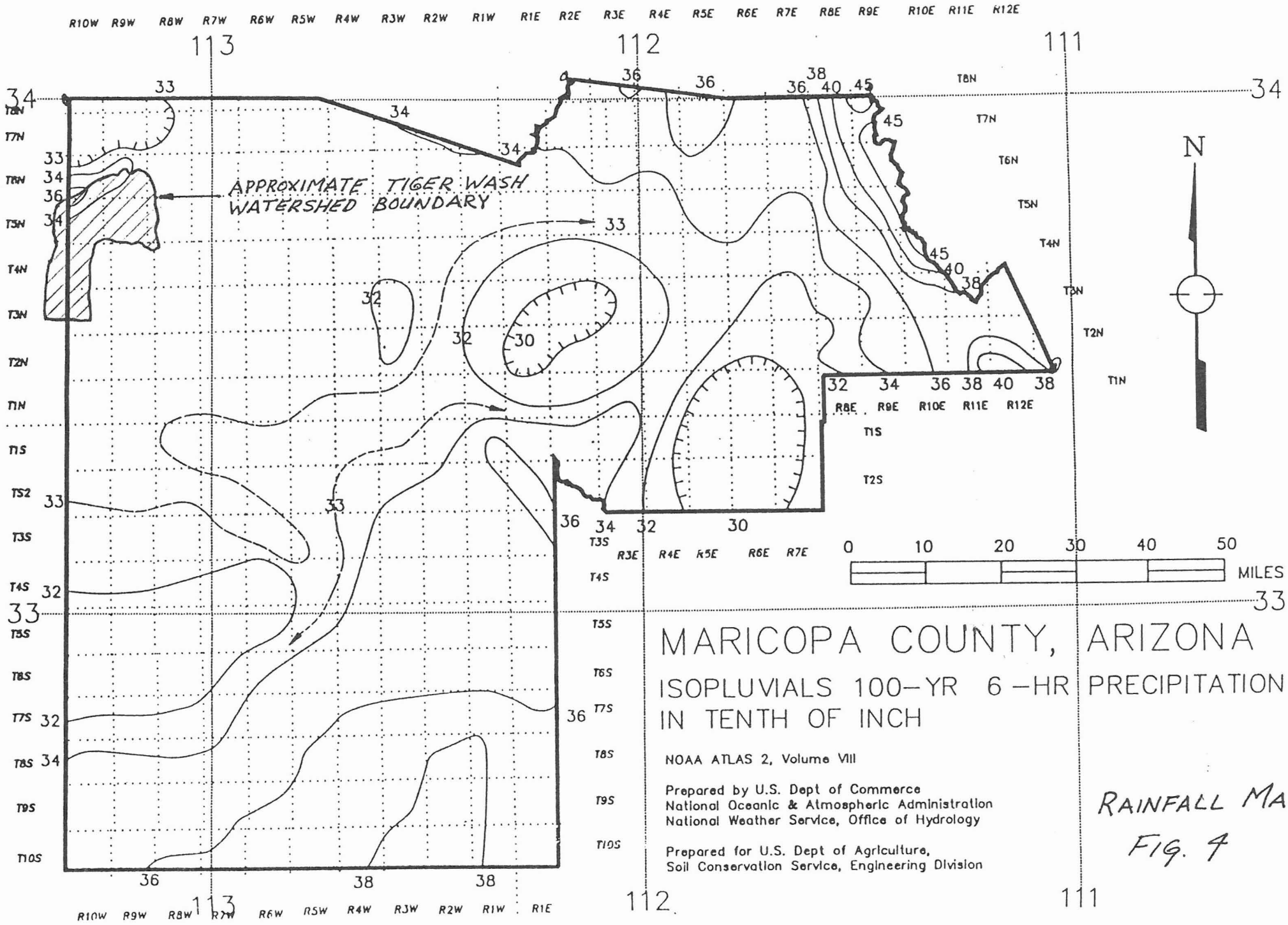


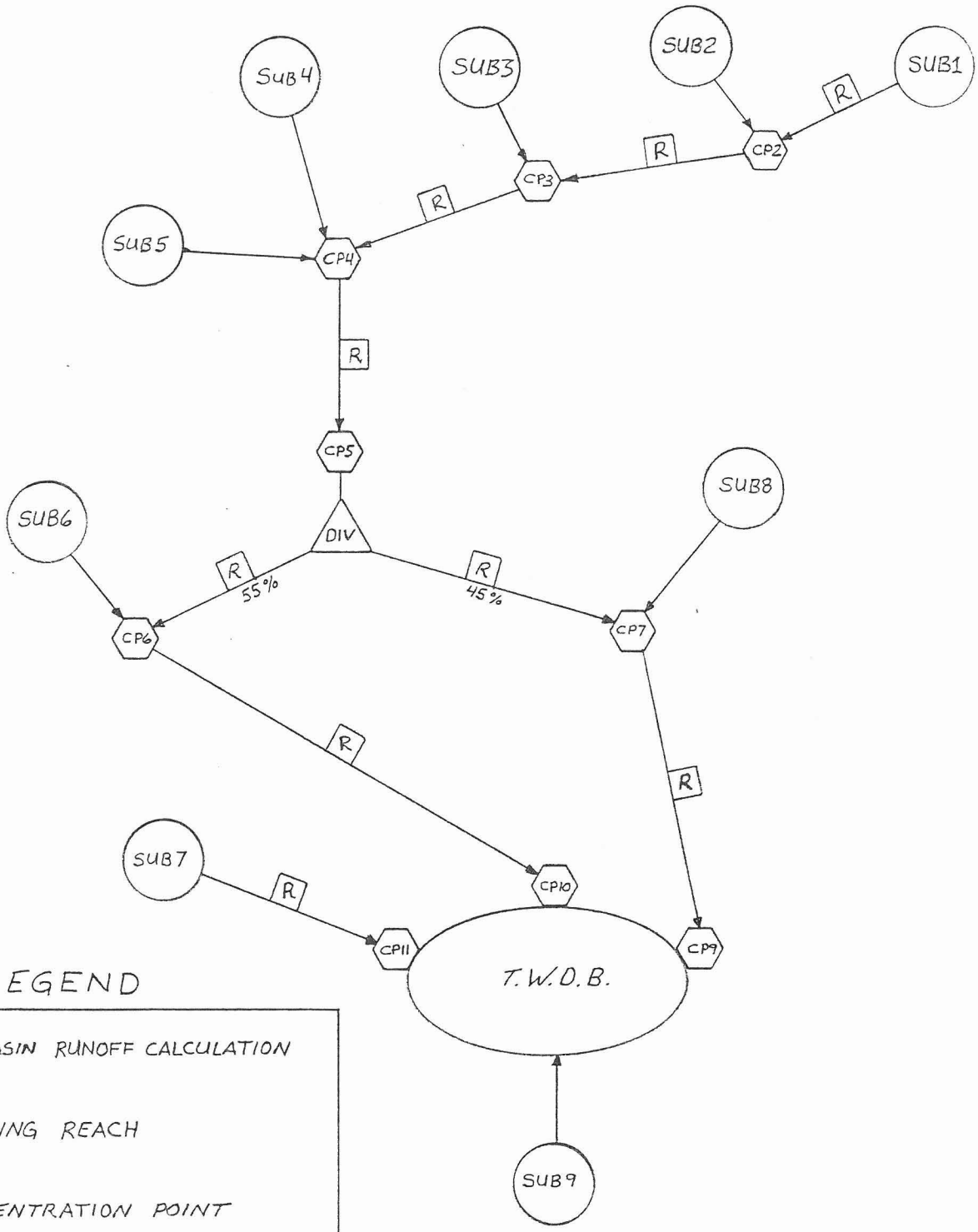
RAINFALL MAP
FIG. 4

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE ____ OF ____

DETAIL FIGURE 5 COMPUTED ____ DATE ____

HEC-1 ROUTING SCHEMATIC CHECKED BY ____ DATE ____



LEGEND

SUB6	SUBBASIN RUNOFF CALCULATION
R	ROUTING REACH
CP6	CONCENTRATION POINT
DIV	DIVERSION POINT
T.W.D.B.	TIGER WASH DETENTION BASIN

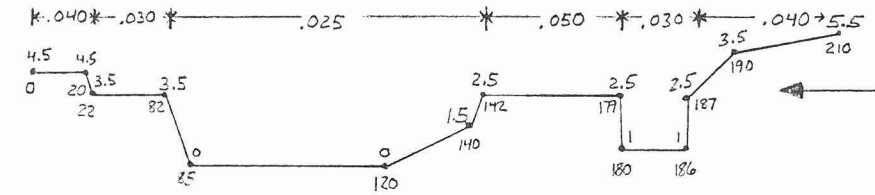
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE ____ OF ____

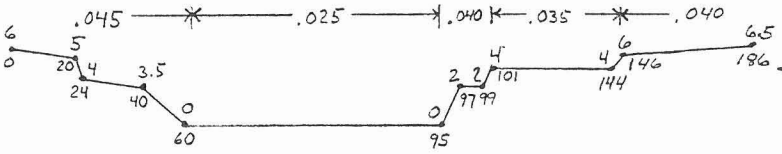
DETAIL FIGURE 6 COMPUTED ____ DATE ____

SPLIT FLOW ANALYSIS CHECKED BY ____ DATE ____

SECTION OF WEST AND EAST FORKS OF TIGER WASH APPROXIMATELY ONE-QUARTER MILE BELOW THE SPLIT IN SEC 34, T4N, R10W



WEST CHANNEL (NTS)



EAST CHANNEL (NTS)

DISCHARGES FOR SELECTED DEPTHS USING MANNINGS EQN.

SLOPE = .0091 ft/ft

DEPTH	WEST Q (cfs)	EAST Q (cfs)
1	214 (53%)	191 (47%)
2	774 (56%)	597 (44%)
3	1387 (54%)	1164 (46%)
4	2316 (57%)	1726 (43%)
5	—	2620
6	—	4092

ASSUME THE FOLLOWING FLOW SPLIT:

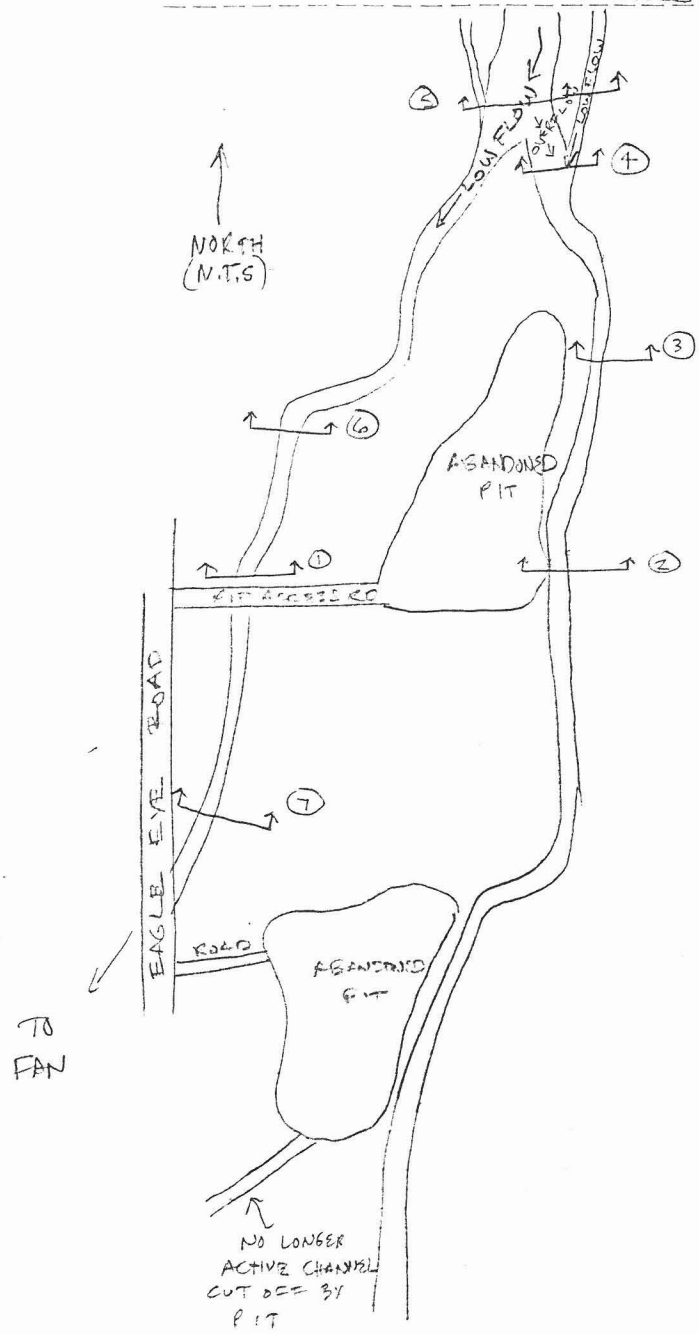
WEST CHANNEL: 55%

EAST CHANNEL: 45%

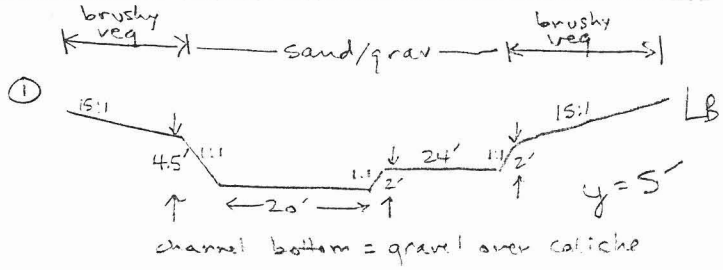
SUBJECT CHANNEL DIMENSIONS AT GRAVEL PIT DIFLUENCE - TIGER WASH BY BF DATE 6/25/01

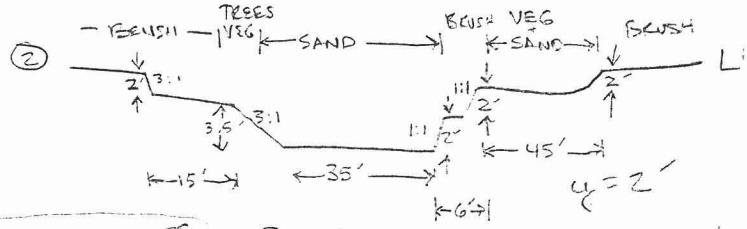
SHEET ___ OF ___

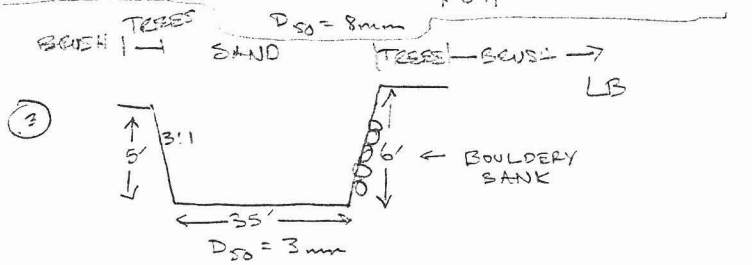
PROJECT NO. PHX3172.A1.01

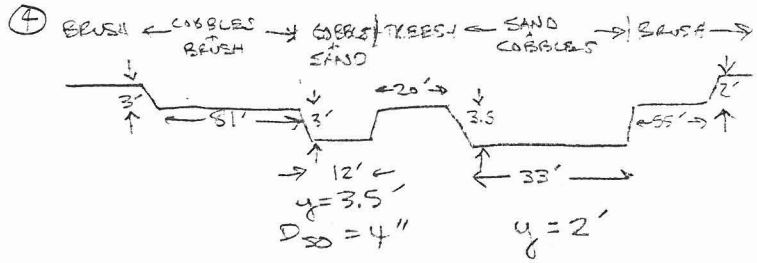


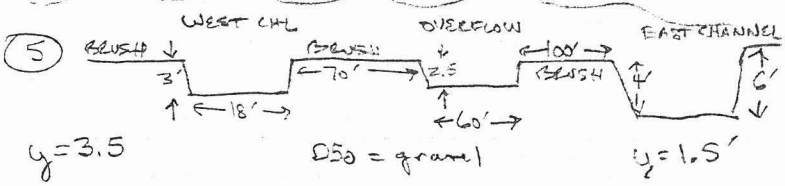
y = Flood Debris Depth



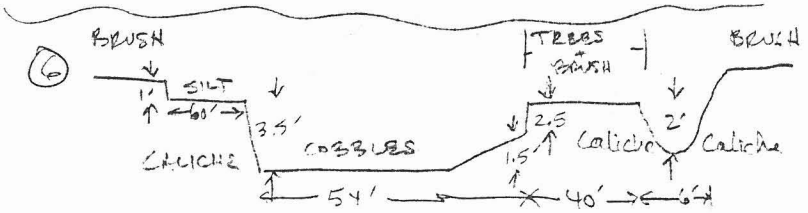


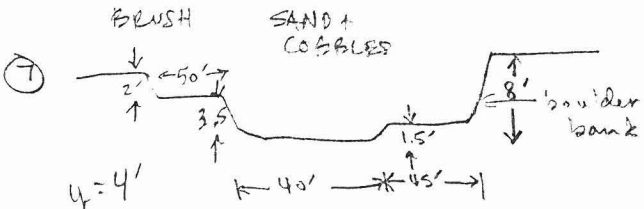






MAJORITY OF Q IN WEST CHANNEL PER FLOOD DEBRIS (>75%)





d_{50} = 6" + sand matrix

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 1 OF 3

DETAIL TABLE 1 COMPUTED _____ DATE _____

SUBBASIN PARAMETERS CHECKED BY _____ DATE _____

AREAS

SUB1 →	$21.893\ in^2 \times (5208.3)^2\ ft^2/in^2 \times (1/5280^2)\ mi^2/ft^2$	$= 21.30\ mi^2$	
SUB2	$14.570\ in^2$	$= 14.18\ mi^2$	
SUB3	$19.283\ in^2$	$= 18.76\ mi^2$	
SUB4	$11.245\ in^2$	$= 10.94\ mi^2$	
SUB5	$20.468\ in^2$	$= 19.92\ mi^2$	$85.10\ mi^2$
SUB6	$11.620\ in^2$	$= 11.307\ mi^2$	$96.41\ mi^2$
SUB7	$21.310\ in^2$	$= 20.73\ mi^2$	
SUB8	$10.048\ in^2$	$= 9.777\ mi^2$	
SUB9	$35.575\ in^2$	$= 34.61\ mi^2$	
		$161.52\ mi^2$	

LAND USE

	RANGELAND	HILLSLOPE	MOUNTAIN	S-GRAPH
SUB1 →	88.6%	0	11.4%	PHX VAL
SUB2	30.0%	70.0%	0	PHX MTN
SUB3	42.7%	0	57.3%	PHX MTN
SUB4	22.9%	77.1%	0	PHX MTN
SUB5	0	0	100%	PHX MTN
SUB6	0	26.7%	73.3%	PHX MTN
SUB7	22.6%	49.9%	27.5%	PHX MTN
SUB8	88.7%	11.3%	0	PHX VAL
SUB9	100%	0	0	PHX VAL

LENGTHS

	IN.	L (mi)	IN.	Lca (mi)
SUB1 →	7.03 →	6.94	2.25 →	2.22
SUB2	8.25	8.14	4.06	4.01
SUB3	9.44	9.31	3.31	3.27
SUB4	6.69	6.60	3.81	3.76
SUB5	9.00	8.88	4.13	4.07
SUB6	6.31	6.22	2.81	2.77
SUB7	6.94	6.84	3.31	3.27
SUB8	5.40	5.33	2.28	2.25
SUB9	6.88	6.78	3.75	3.70

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 2 OF 3

DETAIL TABLE 1 (cont.) COMPUTED _____ DATE _____

SUBBASIN PARAMETERS CHECKED BY _____ DATE _____

SLOPES (S)

PIMA COUNTY SLOPE ADJUSTMENT EQUATION:

$$I = \left(\frac{\Delta L_1^3}{\Delta H_1}\right)^{1/2} + \left(\frac{\Delta L_2^3}{\Delta H_2}\right)^{1/2} + \left(\frac{\Delta L_3^3}{\Delta H_3}\right)^{1/2} \ldots, \quad S = \left(L/I\right)^2 \quad \text{where} \quad L = \sum_{i=1}^{n} \Delta L_i$$

SUB 1

$\Delta L_1 = 1215'$ $\Delta L_2 = 5370'$ $\Delta L_3 = 30{,}925$

$\Delta H_1 = 2800 - 2560 = 240'$ $\Delta H_2 = 2560 - 2360 = 200'$ $\Delta H_3 = 2360 - 2140 = 220'$

$I = [(1215)^3/240]^{1/2} + [(5370)^3/200]^{1/2} + [(30{,}925)^3/220]^{1/2} = 397{,}211$

$S = (37510/397211)^2 = .0089$ ft/ft = **47.1 ft/mi**

SUB 2

$\Delta L_1 = 1215'$ $\Delta L_2 = 16{,}925'$ $\Delta L_3 = 25{,}550$

$\Delta H_1 = 2760 - 2600 = 160'$ $\Delta H_2 = 2600 - 2320 = 280'$ $\Delta H_3 = 2320 - 2090 = 230'$

$I = [(1215)^3/160]^{1/2} + [(16925)^3/280]^{1/2} + [(25550)^3/230]^{1/2} = 404227$

$S = (43960/404227)^2 = .0117$ ft/ft = **61.7 ft/mi**

SUB 3

$\Delta L_1 = 12{,}860'$ $\Delta L_2 = 15{,}300$ $\Delta L_3 = 21{,}645$

$\Delta H_1 = 4600 - 2800 = 1800'$ $\Delta H_2 = 2800 - 2320 = 480'$ $\Delta H_3 = 2320 - 2060 = 260'$

$I = [(12860)^3/1800]^{1/2} + [(15300)^3/480]^{1/2} + [(21465)^3/260]^{1/2} = 315{,}788$

$S = (49805/315{,}788)^2 = .0249$ ft/ft = **131.3 ft/mi**

SUB 4

$\Delta L_1 = 3905'$ $\Delta L_2 = 30{,}935$

$\Delta H_1 = 2600 - 2320 = 280'$ $\Delta H_2 = 2320 - 1870 = 450'$

$I = [(3905)^3/280]^{1/2} + [(30{,}935)^3/450]^{1/2} = 271{,}073$

$S = (34840/271{,}073)^2 = .0165$ ft/ft = **87.2 ft/mi**

SUB 5

$\Delta L_1 = 12695$ $\Delta L_2 = 19855$ $\Delta L_3 = 14{,}650$

$\Delta H_1 = 5400 - 3200 = 2200'$ $\Delta H_2 = 3200 - 2200 = 1000'$ $\Delta H_3 = 2200 - 1870 = 330'$

$I = [(12695)^3/2200]^{1/2} + [(19855)^3/1000]^{1/2} + [(14650)^3/330]^{1/2} = 216579$

$S = (47200/216579)^2 = .0475$ ft/ft = **250.8 ft/mi**

SUB 6

$\Delta L_1 = 19205'$ $\Delta L_2 = 13835$

$\Delta H_1 = 4000 - 2200 = 1800$ $\Delta H_2 = 2200 - 1820 = 380'$

$I = [(19205)^3/1800]^{1/2} + [(13835)^3/380]^{1/2} = 146{,}210$

$S = (33040/146{,}210)^2 = .0511$ ft/ft = **269.6 ft/mi**

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 3 OF 3

DETAIL TABLE 1 (cont.) COMPUTED _____ DATE _____

SUBBASIN PARAMETERS CHECKED BY _____ DATE _____

SUB7

$\Delta L_1 = 5860'$ $\Delta L_2 = 13185$ $\Delta L_3 = 18065$

$\Delta H_1 = 2660 - 2080 = 580'$ $\Delta H_2 = 2080 - 1760 = 320'$ $\Delta H_3 = 1760 - 1600 = 160'$

$I = [(5860)^3/580]^{1/2} + [(13185)^3/320]^{1/2} + [(18065)^3/160]^{1/2} = 295,214$

$S = (37110/295214)^2 = .0158$ ft/ft = 83.4 ft/mi

SUB8

$\Delta L_1 = 4230$ $\Delta L_2 = 23600$

$\Delta H_1 = 2120 - 1800 = 320'$ $\Delta H_2 = 1800 - 1600 = 200'$

$I = [(4230)^3/320]^{1/2} + [(23600)^3/200]^{1/2} = 271,741$

$S = (27830/271,741)^2 = .0105$ = 55.4 ft/mi

SUB9

$\Delta L_1 = 35800$

$\Delta H_1 = 1600 - 1395 = 205'$ $S = 205/35800 = .0057$ ft/ft = 30.2 ft/mi

BASIN FACTORS (Kn)

ASSUME BASIN FACTORS FOR THE FOLLOWING LAND USES:

MOUNTAINS: .060
RANGELAND: .070
HILLSLOPES: .040

SUB1 → .886 (.07) + .114(.060) = .069
SUB2 → .30(.07) + .70 (.040) = .049
SUB3 → .427 (.07) + .573(.060) = .058
SUB4 → .229(.07) + .771 (.040) = .047
SUB5 → 1.0 (.060) = .060
SUB6 → .267(.040) + .773 (.060) = .057
SUB7 → .226(.070) + .499 (.040) + .275(.060) = .052
SUB8 → .887 (.07) + .113(.040) = .067
SUB9 → 1.0 (.070) = .070

LAG TIMES

FROM BASIC PROGRAM USING THE FOLLOWING EQUATION:

$$LAG = 24\,Kn\,[(L \times L_{ca})/S^{1/2}]^{.38}$$

SUBBASIN No.	Kn	L (mi)	Lca (mi)	S (ft/mi)	LAG (min)
1	.069	7.10	2.22	47.1	136
2	.049	8.33	4.01	61.7	122
3	.058	9.43	3.27	131.3	122
4	.047	6.60	3.76	87.2	98
5	.060	8.94	4.07	250.8	119
6	.057	6.26	2.77	269.6	84
7	.052	7.03	3.27	83.4	106
8	.067	5.27	2.25	55.4	115
9	.070	6.78	3.70	30.2	179

TABLE 2
TIGER WASH HYDROLOGY
HEC-1 DISCHARGE SUMMARY

Return Period (yrs)	Duration (hours)	Drainage Area (sq.mi)	(1) Gauge Discharge (cfs)	(2) Apex Discharge (cfs)	(3) TWDB Discharge (cfs)	TWDB WSEL (ft)
2	24	161.52	2,009	1,295	2,717	NA
10	24	161.52	8,667	5,452	13,017	NA
100	24	161.52	20,820	12,867	32,645	1406.08
2	24	96.41	2,283	1,447		
10	24	96.41	9,161	5,756		
100	24	96.41	21,562	13,323		
2	24	85.10	2,350			
10	24	85.10	9,517			
100	24	85.10	22,120			
2	6	96.41	1,535	1,019		
10	6	96.41	6,140	4,052		
100	6	96.41	16,465	10,549		
2	6	85.10	1,579			
10	6	85.10	6,564			
100	6	85.10	17,286			
2	6	49.99	2,965	2,065		
10	6	49.99	9,619	6,376	(Subbasins 3,5,&6)	
100	6	49.99	19,269	12,716		

(1) - Aerial reduction of rainfall depth based on drainage area above the USGS gauge

(2) - Aerial reduction of rainfall depth based on drainage area above the Alluvial Fan Apex

(3) - Aerial reduction of rainfall depth based on drainage area above the Tiger Wash Detention Basin

TABLE 3
RECOMMENDED DISCHARGES FOR USE
IN DELINEATING THE APPROXIMATE
TIGER WASH FLOODPLAIN

CP No.	HEC-1 File Name	Storm Duration (hrs)	Peak Discharge (cfs)
1	GA24.OUT	24	6,600
2	GA24.OUT	24	8,900
3	GA24.OUT	24	14,600
4	GA24.OUT	24	22,100
5	APEX24.OUT	24	24,800
6	APEX24.OUT	24	13,300
7	TW24.OUT	24	12,700
9	TW24.OUT	24	12,100
10	TW24.OUT	24	12,300

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 1 OF 4

DETAIL APPENDIX A COMPUTED _____ DATE _____

RAINFALL CHECKED BY _____ DATE _____

DEPTHS (in)

SUBBASINS 3, 5, AND 6

DURATION	RETURN PERIOD (YR) → 2	10	100
24-Hour	1.70	2.73	4.20
6-Hour	1.42	2.28	3.50

SUBBASINS 1, 2, 4, 7, 8, & 9

24-HOUR	1.56	2.62	4.15
6-HOUR	1.30	2.12	3.35

AREAL REDUCTION

24-HOUR

SOURCE: NWS HYDRO 40

DRAINAGE AREA (mi^2)	AREAL REDUCTION FACTOR
85	.864
96	.850
162	.831

6-HOUR

SOURCE: HYDROLOGIC DESIGN MANUAL FOR MARICOPA COUNTY

	DRAINAGE AREA	AREAL REDUCTION FACTOR
SUBBASINS 3, 5, & 6	51.7	.862
SUBBASINS 1-6	96.41	.800
SUBBASIN 1-5	85.1	.814

24-HOUR DURATION → △
6-HOUR DURATION → ⊙

SUBBASINS 1, 2, 4, 7, 8, & 9

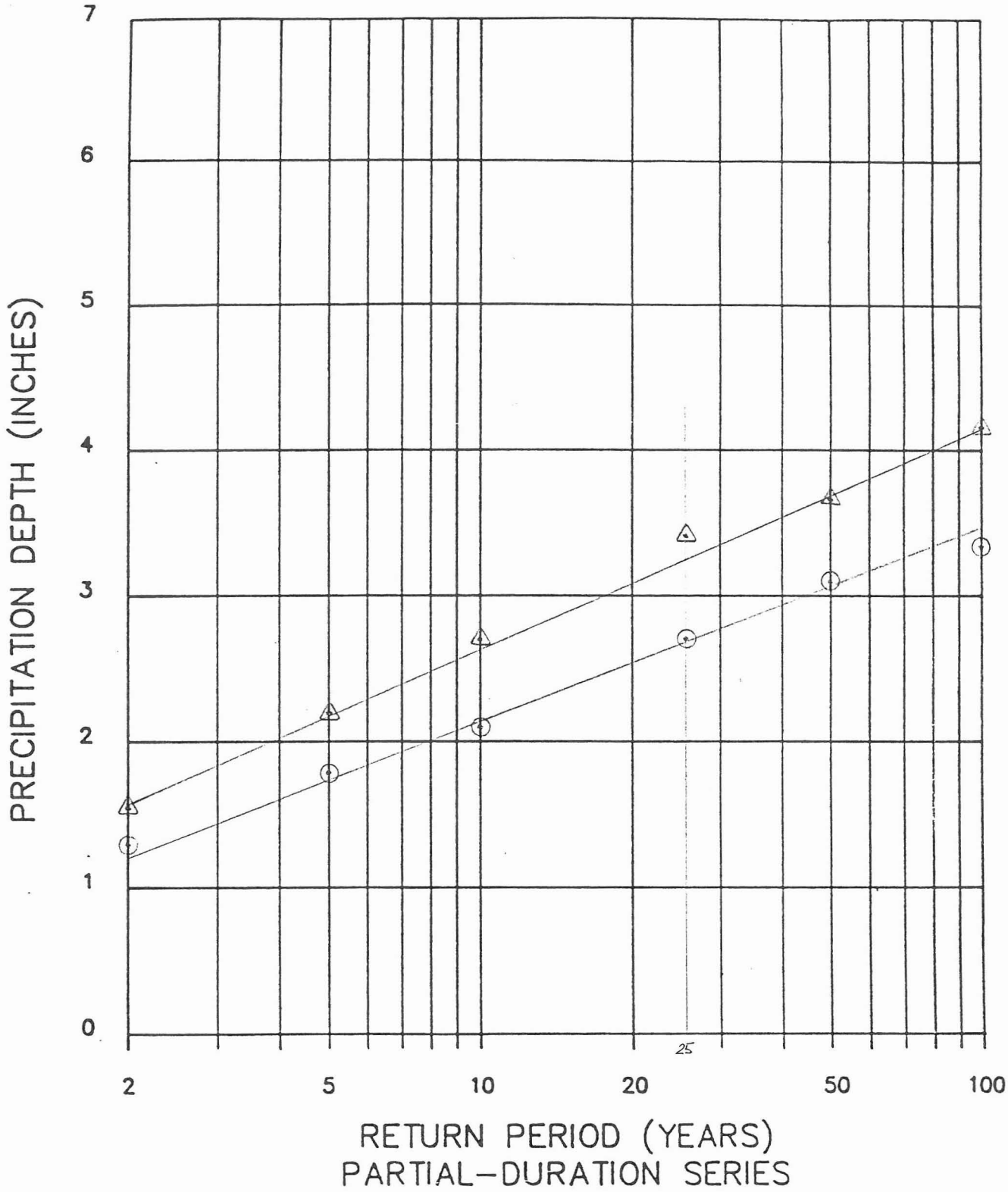


Figure 2.14
Precipitation Depth versus Return Period for Partial-Duration Series

APPENDIX A p. 2 of 4

24-Hour Duration → △
6-Hour Duration → ⊙
Subbasins 3, 5, & 6

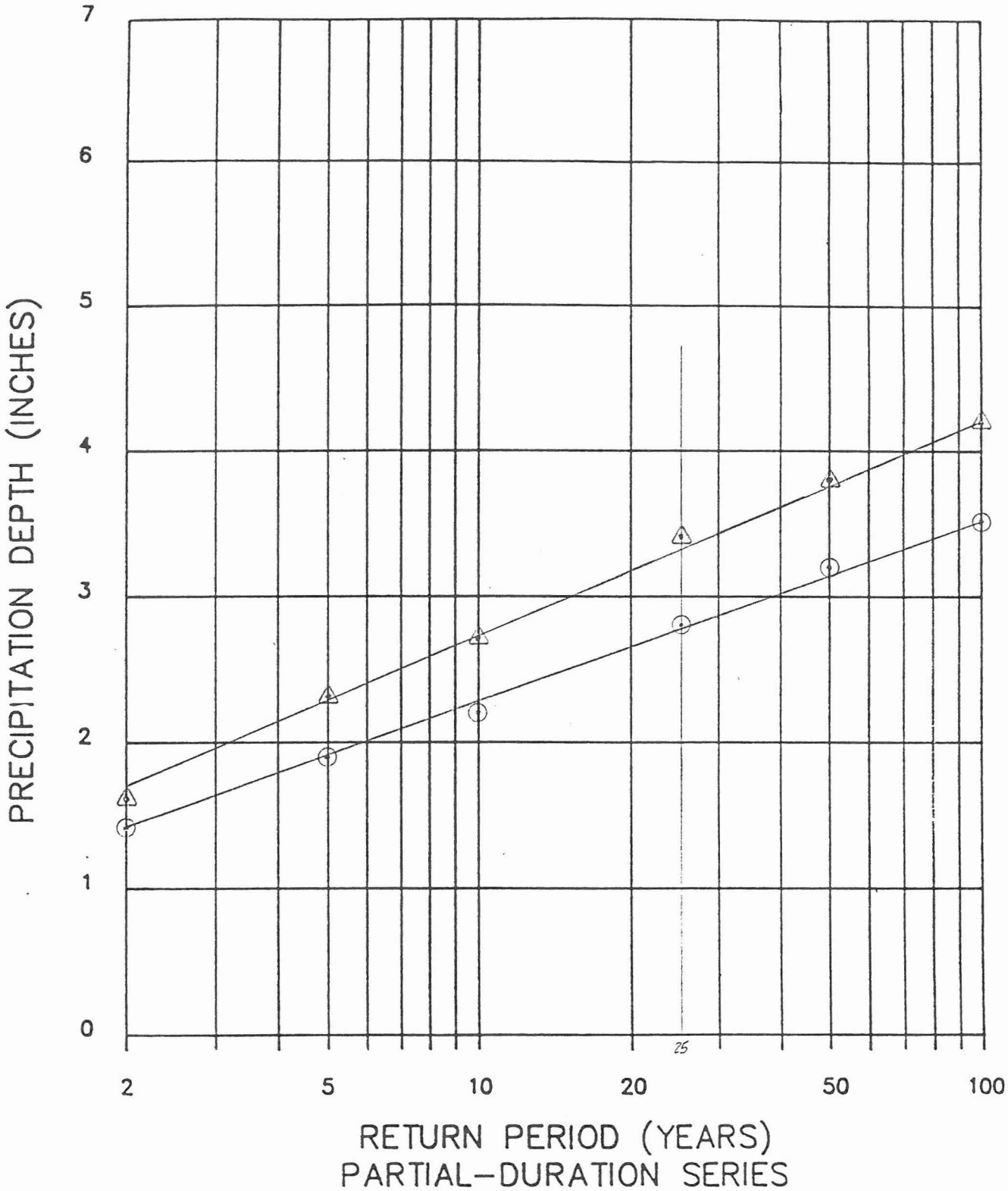


Figure 2.14
Precipitation Depth versus Return Period for Partial-Duration Series

APPENDIX A p. 3 of 4

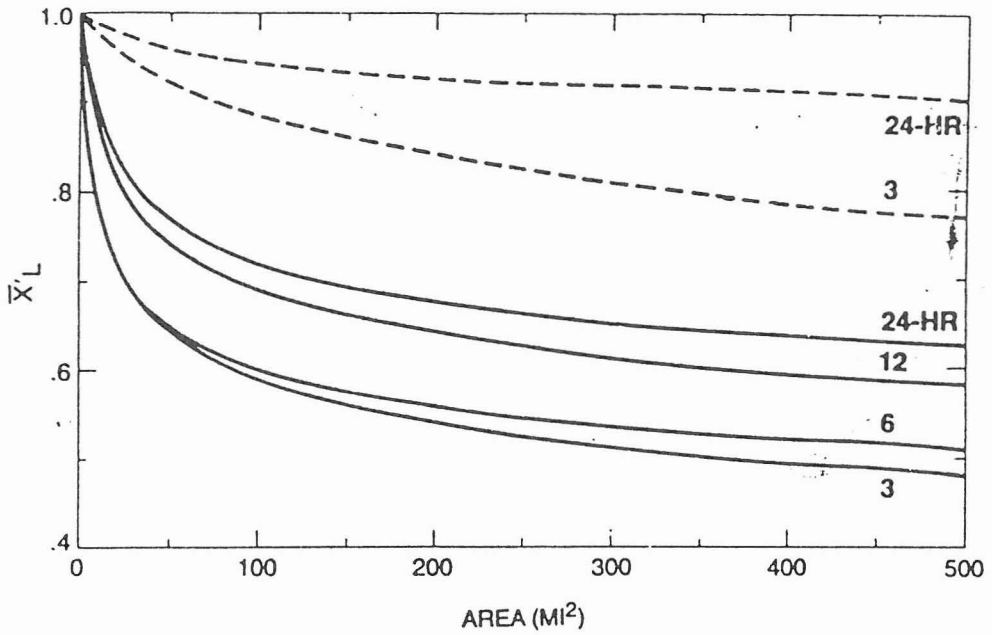


Figure 14.--$\bar{X}'_L$ (2.54-yr depth-area ratio, see sec. 4.3) for 3-, 6-, 12-, and 24-hr in southeast Arizona. Dashed lines are 3-hr and 24-hr Chicago $\bar{X}'_L$ (from TR 24)

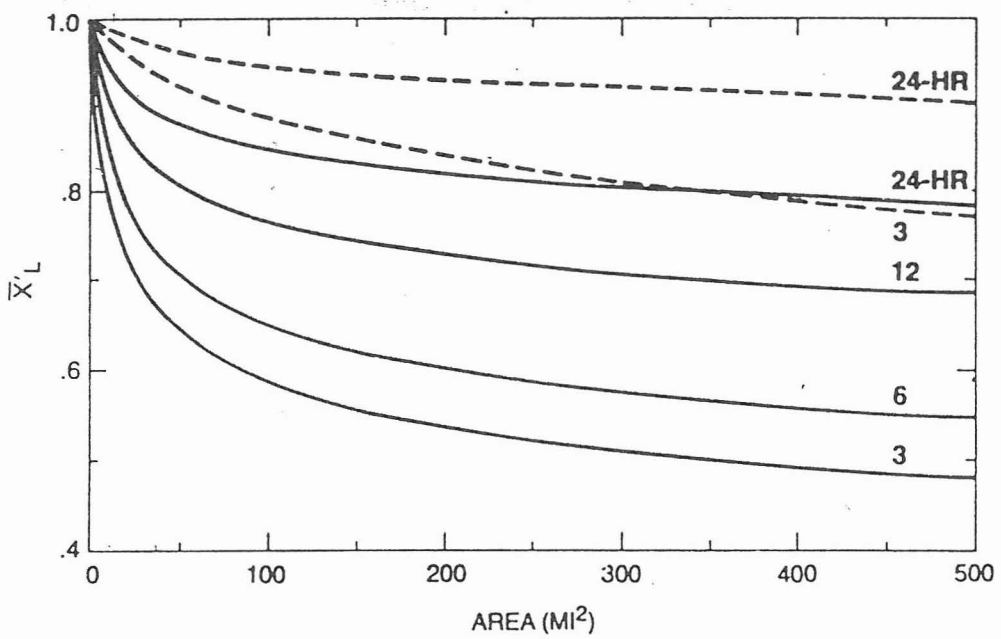


Figure 15.--Same as figure 14, but for central Arizona.

be attributed to a mixture of storm types, but still different from these found in the central Plains.

The recorder-pair data for distances greater than 15 mi contain little information on the structure of 1- and 2-hr storms. This is supported by the low

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 1 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SOIL DESCRIPTIONS CHECKED BY _____ DATE _____

MAP UNIT NO.	DESCRIPTION
16,17	CELLAR - ROCK OUTCROP, 10-70% SLOPES

65% CELLAR VERY GRAVELLY FINE SANDY LOAM (0-3 in)
15% Rock Outcrop
20% Nickel, Eba, & ARIZO SOILS [SANDY LOAMS]

The Cellar soil warrents special attention because it is very shallow (only an average of 3 inches to bedrock) sandy loam over bedrock. If we assume that the porosity of the soil is 30%, then the depth of water that can infiltrate into the upper 3 inches of soil is (.30)(3 in) = 0.9 inches. This will occur at some rate greater than .40 in/hr (the XKSAT value for sandy loam), which means that the soil layer will be saturated after about 2 hours, assuming that the rainfall rate is less than .40 in/hr for the first 2 hours of the 6-hour and 24-hour design storms. At saturation, the values of DTHETA and XKSAT are essentially zero.
To simulate this scenario using the Green & Ampt method, we will combine an initial infiltration VALUE (0.7 inches for sandy loam from Table 4.3 in the HDM) with a surface retention loss value (.25 in. for Mountains, TABLE 4.1) under the variable IA IN the HEC-1 model. The XKSAT VALUE IS 0.05 inches from TABLE 4.4 for hydrologic soil group "D", and DTHETA will be set to zero for saturated conditions.

NORMALIZE SOILS: CELLAR → 65/85 = 76.5% (XKSAT = .05)
SANDY LOAMS → 20/85 = 23.5% (XKSAT = .40)

SINCE SOIL TEXTURES (XKSAT VALUES) ARE SIGNIFICANTLY DIFFERENT, USE LOGARITHMIC AVERAGING FOR THE MAP UNIT PARAMETERS:

XKSAT = ALOG [.765 (log .05) + .235 (log .40)] = 0.08 in/hr, RTIMP = 15%

DTHETA = .767(0) + .235 (.35) = .08 in
IA = .765(.95) + .235(.25) = 0.77 in

MAP UNIT NO.	DESCRIPTION
19,20	CHUCKAWALLA - GUNSIGHT COMPLEX, 1-8% SLOPES

45% CHUCKAWALLA VERY GRAVELLY SANDY CLAY LOAM (2-14 in)
35% GUNSIGHT VERY GRAVELLY LOAM (0-3 in)
20% SAL, PINAMT, TREMANT SOILS ON FAN TERRACES
RILLITO SOILS ON SIDE SLOPES
ANTHO, GILMAN, & MARIPO SOILS ON FLOODPLAINS

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 2 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SOIL DESCRIPTIONS CHECKED BY _____ DATE _____

MAP UNIT #19, 20, CONT.

SOIL TEXTURES (XKSAT)

45% CHUCKAWALLA - SANDY CLAY LOAM (.06)
35% GUNSIGHT - SANDY CLAY LOAM (.06)
11.5% ANTHO, TREMANT, RILLITO, MARIPO SANDY LOAMS (.40)
2.9% GILMAN LOAM (.25)
5.6% SAL, PINAMT SANDY CLAY LOAM (.06)

XKSAT = ALOG [.856 (log .06) + .115 (log .40) + .029 (log .25) = .08 in/hr
DTHETA (DRY) = 0.32 in , IA = .15 in (HILLSLOPES)

MAP UNIT # 30 DESCRIPTION

DENURE - MOMOLI - CARRIZO COMPLEX, LOW PRECIPITATION

40% DENURE GRAVELLY SANDY LOAM (2-60 in)
30% MOMOLI GRAVELLY SANDY LOAM (0-10 in)
20% CARRIZO GRAVELLY SANDY LOAM (0-10 in)
10% GILLMAN, MARIPO, & CARRIZO

} ALL SANDY LOAMS

XKSAT = .40 in/hr , DTHETA = .35 in, IA = .35 in (RANGELAND)

MAP UNIT #59 DESCRIPTION

GILMAN - MOMOLI - DENURE COMPLEX, LOW PRECIPITATION

40% GILMAN LOAM (0-60)
25% MOMOLI GRAVELLY SANDY LOAM (0-22 in)
20% DENURE GRAVELLY SANDY LOAM (0-9 in)
15% ANTHO, CARRIZO, ESTRELLA, MARIPO
(SL) (S) (L) (SL)

SOIL TEXTURES (XKSAT)

40% GILMAN LOAM (.25)
25% MOMOLI SANDY LOAM (.40)
20% DENURE SANDY LOAM (.40)
15% SANDY LOAM (.40), SAND (1.2), LOAM (.25) and SANDY LOAM (.40)

XKSAT = ALOG [.4375 (log .25) + .525 (log .40) + .0375 (log 1.2) = .34 in/hr

DTHETA = .35 in , IA = .35 in (RANGELAND)

MAP AREA 30, 59

AVERAGE PARAMETERS FROM BOTH MAP UNITS

XKSAT = .5 (.40) + .5 (.34) = 0.37 in/hr
DTHETA = .35 in
IA = .35 in

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 3 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SOIL DESCRIPTIONS CHECKED BY _____ DATE _____

MAP UNIT No. 65 — DESCRIPTION

GREYEAGLE - CONTINENTAL - NICKEL ASSOCIATION, 1-40% SLOPES

45% GREYEAGLE VERY GRAVELLY LOAM (0-5 in) [SANDY LOAM]
25% CONTINENTAL CLAY (2-60 in) [CLAY LOAM - UPPER 3" of subsoil]
15% NICKEL VERY GRAVELLY LOAM (0-5 in) [SANDY LOAM]
15% OHACO, SUNCITY VARIANT ON TOE SLOPES, SWALES, AND FAN TERRACES [Clay, CLAY LOAM]
CAVE, MOHAVE ON TOPS OF TERRACES [LOAM, CLAY LOAM]
ARIZO IN DRAINAGEWAYS [SANDY LOAM]

XKSAT = ALOG [.63 (log .40) + .31 (log .06) + .03 (log .01) + .03 (log .25)] = .20 in/hr
DTHETA = .37 in IA = .35 in (RANGELAND)

MAP UNIT NO. 92 — DESCRIPTION

MOMOLI - CARRIZO COMPLEX, LOW PRECIPITATION

45% MOMOLI (1-60) Very Gravelly Loam [SANDY LOAM]
35% CARRIZO (0-11) Very Gravelly Sandy Loam [LOAMY SAND]
20% MOHALL, TREMANT, GUNSIGHT ON TERRACES
DENURE, GILMAN, MARIPO, CARRIZO ON FLOODPLAINS } [Sandy Loam]

XKSAT = ALOG [.35 [log 1.2] + .65 (log .40)] = 0.59 in/hr
DTHETA = .35 in , IA = .35 inches

MAP UNIT No. 100 — DESCRIPTION

QUILOTOSA - VAIVA - ROCK OUTCROP COMPLEX, 20-65% SLOPES

50% QUILOTOSA EXTREMELY GRAVELLY LOAM (2-14 in) [LOAMY SAND]
20% VAIVA EXTREMELY GRAVELLY SANDY LOAM [SANDY LOAM]
20% ROCK OUTCROP
10% SCHENCO [SANDY CLAY LOAM]

NORMALIZE SOIL PERCENTAGES

QUILOTOSA : 50/80 = 62.5%
VAIVA : 20/80 = 25%
SCHENCO : 10/80 = 12.5%

XKSAT = ALOG [.625 (log 1.2) + .25 (log .40) + .125 (log .06)] = 0.63 in/hr
DTHETA = .35 in, IA = .15 (HILLSLOPES), RTIMP = 20%

MAP UNIT No. 106 — DESCRIPTION

SAL - CIPRIANO COMPLEX, 1-10% SLOPES

50% SAL VERY GRAVELLY CLAY LOAM (2-20) [SANDY CLAY LOAM]
30% CIPRIANO VERY GRAVELLY SANDY LOAM (0-20) [Sandy Loam]
20% GUNSIGHT & RILLITO ON SIDE SLOPES [Sandy Loam]
BRIOS & CARRIZO IN DRAINAGEWAYS [Loamy Sand]

XKSAT = ALOG [.50 (log .06) + .40 (log .40) + .10 (log 1.2)] = .17 in/hr
DTHETA = .39 in IA = .35 inches in SUB 9, .15 inches in SUB 7

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 4 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SOIL DESCRIPTIONS CHECKED BY _____ DATE _____

MAP UNIT LOSS SUMMARY

MAP UNIT No.	XKSAT (in/hr)	DTHETA (in)	IA (in)	RTIMP (%)
16, 17	.08	.08	.77	15
19, 20	.08	.32	.15	0
30	.40	.35	.35	0
30, 59	.37	.35	.35	0
65	.20	.37	.35	0
92	.59	.35	.35	0
100	.63	.35	.15	20
106	.17	.39	.35 (SUB 9) .15 (SUB 6,7)	0

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 5 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SUBBASIN LOSSES CHECKED BY _____ DATE _____

SUB 1

#16,17 → 11.4%

#65 → 88.6%

(IGNORE #100, < 5%)

XKSAT = ALOG [.114 (log .08) + .886 (log .20) = 0.18 in/hr

PSIF = 5.6 in

DTHETA = ALOG [.114 (log .08) + .886 (log .37) = .31 in

RTIMP = .114 (15) = 1.7%

IA = ALOG [.114 log (.77) + .886 (log .35) = .38 in

* VEG. ADJ. → RANGELAND: 88.6%
MTN. 11.4%

VAF = .886 (1.055) + .114 (1.165) = 1.068

XKSAT = 1.068 (.18) = .19

SUB 2

#65 → 30.0%

#100 → 70.0%

XKSAT = ALOG [.3 (log .20) + .7 (log .63)] = 0.45 in/hr

PSIF = 3.7 in

DTHETA = .3 (.37) + .7 (.35) = .36 in

RTIMP = .7 (20) = 14%

IA = .3 (.35) + .7 (.15) = .21 in

VEG ADJ → RANGELAND 30%
HILLSLOPES 70%

VAF = .3 (1.055) + .7 (1.165) = 1.132

XKSAT = 1.132 (.45) = .51 in/hr

SUB 3

#16,17 → 57.3%

#65 → 42.7%

XKSAT = ALOG [.573 (log .08) + .427 (log .20)] = 0.12 in/hr

PSIF = 6.5 in

DTHETA = ALOG [.573 (log .08) + .427 (log .37)] = .15 in

RTIMP = .573 (15) = 8.6%

IA = ALOG [.573 (log .77) + .427 (log .35)] = .55 in

VEG. ADJ. → 42.7% RANGELAND
57.3% MTN.

VAF = .427 (1.055) + .573 (1.165) = 1.118

XKSAT = 1.118 (.12) = .13

SUB 4

#65 → 22.9%

#100 → 77.1%

XKSAT = ALOG [.229 (log .20) + .771 (log .63)] = .48 in/hr

PSIF = 3.6 in

DTHETA = .229 (.37) + .771 (.35) = .36 in

RTIMP = .771 (20) = 15.4%

IA = ALOG [.229 (log .35) + .771 (log .15) = .18 in

VEG. ADJ: 22.9% RANGELAND
77.1% HILLSLOPES

VAF = .229 (1.055) + .771 (1.165) = 1.140

XKSAT = 1.140 (.48) = .55 in/hr

* For VEGETATION COVER, ASSUME: HILLSLOPES & Mtn. 25% (1.165)
RANGELAND 15% (1.055)

VAF ≡ VEGETATION ADJUSTMENT FACTOR

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 6 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SUBBASIN LOSSES CHECKED BY _____ DATE _____

SUB 5 # 16,17 → 100%

VEG. ADJ → 100% MTN
XKSAT = 1.165 (.08) = .09 in/hr

XKSAT = .08 in/hr, PSIF = 7.5 in, DTHETA = .08 in
RTIMP = 15%, IA = .77 in

SUB 6

16,17 → 73.3 %
100 → 3.2 %
106 → 23.5 %

VEG. ADJ. → 23.5% RANGLAND
76.5% MTN. HILLSLOPES
VAF = .235 (1.055) + .765 (1.165) = 1.139
XKSAT = 1.139 (.10) = .11

XKSAT = ALOG [.733 (log .08) + .032 (log .63) + .235 (log .17)] = .10 in/hr
PSIF = 6.9 in
DTHETA = ALOG [.733 (log .08) + .032 (log .35) + .235 (log .37)] = .12 in
RTIMP = .733 (15) + .032 (20) = 11.6 %
IA = ALOG [.733 (log .77) + .032 (log .15) + .235 (log .15)] = .50 in

SUB 7

16,17 → 27.5 %
106 → 72.5 %

XKSAT = ALOG [.275 (log .08) + .725 (log .17) = .14 in/hr
PSIF = 6.2 in
DTHETA = ALOG [.275 (log .08) + .725 (log .39) = .25 in
RTIMP = .275 (15) = 4.1 %
IA = ALOG [(.275 (log .77) + .725 (log .15)] = .24 in

VEG. ADJ → 27.5% MTN
72.5% RANGELAND
VAF = .275 (1.165) + .725 (1.055) = 1.085
XKSAT = 1.085 (.14) = .15 in/hr

SUB 8

19,20 → 38.6 % # 100 → 11.3 %
92 → 50.1 %

XKSAT = ALOG [.386 (log .08) + .501 (log .59) + .113 (log .63)] = .28 in/hr
PSIF = 4.7 in
DTHETA = ALOG [.386 (log .32) + .501 (log .35) + .113 (log .35)] = .34 in
RTIMP = .113 (20) = 2.3 %
IA = ALOG [(.386 (log .15) + .501 (log .35) + .113 (log .15)] = .23 in

VEG. ADJ → 11.3% MTN.
88.7% RANGE
VAF = .113 (1.165) + .887 (1.055) = 1.067
XKSAT = 1.067 (.28) = .30 in/hr

SUB 9

30 → 13.7 % # 92 → 39.2 %
30,59 → 15.2 % # 106 → 31.9 %

XKSAT = ALOG [.137 (log .40) + .152 (log .37) + .392 (log .59) + .319 (log .17)] = .35 in/hr
PSIF = 4.2 in
DTHETA = ALOG [.137 (log .35) + .152 (log .35) + .392 (log .35) + .319 (log .39)] = .36 in
RTIMP = 0
IA = ALOG [(.137 (log .35) + .152 (log .35) + .392 (log .35) + .319 (log .35)] = .35 in

VEG ADJ. → 100% RANGELAND
XKSAT = 1.055 (.35) = .37 in/hr

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 7 OF 7

DETAIL APPENDIX B COMPUTED _____ DATE _____

SUBBASIN LOSSES CHECKED BY _____ DATE _____

SUMMARY OF SUBBASIN LOSS PARAMETERS

SUBBASIN No.	IA (in)	DTHETA (in)	PSIF (in)	XKSAT (in/hr)	RTIMP (%)
1	.38	.31	5.6	.19	1.7
2	.21	.36	3.7	.51	14.
3	.55	.15	6.5	.13	8.6
4	.18	.36	3.6	.55	15.4
5	.77	.08	7.5	.09	15.
6	.50	.12	6.9	.11	11.6
7	.24	.25	6.2	.15	4.1
8	.23	.34	4.7	.30	2.3
9	.35	.36	4.2	.37	0

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 1 OF 2

DETAIL APPENDIX C COMPUTED _____ DATE _____

CHANNEL ROUTING CHECKED BY _____ DATE _____

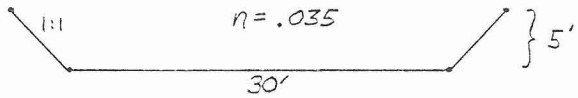
REACH

CP1 - CP2

LENGTH : 8075 ft

SLOPE = (2140 - 2090) / 8075 = .0062

SECTION : ASSUME MAJORITY OF THE FLOODWAVE IS TRANSMITTED BY THE MAIN CHANNEL (ALL SECTIONS)



Q = 1465 cfs
V = 8.4 ft/s

FLOODWAVE VELOCITY : USE Vm / V = 1.67 FROM 7.6.0 IN THE HDM

$V_m = 1.67\,V = 1.67\,(8.4) = 14.0$ ft/s

$K = 8075 \text{ ft} \times 1/14 \text{ s/ft} \times 1/3600 \text{ hr/s} = .160 \text{ hr} = 9.6 \text{ min}$

$X = .25$

$NSTPS : \frac{1}{2(1-X)} \le \frac{K}{NSTPS * NMIN} \le \frac{1}{2X}$

For X = .25 & NMIN = 10 : $.667 \le \frac{9.6}{10\,(NSTPS)} \le 2$

FOR NSTPS = 2, $.667 \le .48 \le 2$ ⟶ No Good!

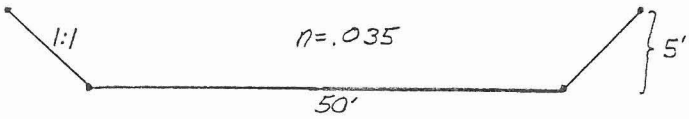
FOR NSTPS = 1, $.667 \le .96 \le 2$ ⟶ OK $NSTPS_{10} = 1$

CP2 - CP3

LENGTH = 5535 ft

SLOPE = (2090 - 2060) / 5535 = .0054 ft/ft

SECTION :



Q = 2264 cfs
V = 8.2 ft/s

$V_m = 1.67\,V = 1.67\,(8.2) = 13.7$ ft/s

$K = 5535 \text{ ft} \times \frac{1}{13.7} \text{ s/ft} \times 1/3600 \text{ hr/s} = .112 \text{ hrs} = 6.7 \text{ min}$, $X = .25$

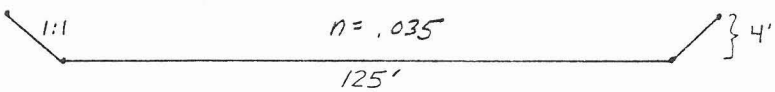
For NSTPS = 1, $.667 \le 6.7/10 \le 2$ OK $NSTPS_{10} = 1$

CP3 - CP4

LENGTH = 23,100 ft

SLOPE = (2060 - 1870) / 23100 = .0082 ft/ft

SECTION :



Q = 4818 cfs
V = 9.3 ft/s

$V_m = 1.67\,V = 1.67\,(9.3) = 15.5$ ft/s

$K = 23{,}100 \text{ ft} \times 1/15.5 \text{ s/ft} \times 1/3600 \text{ hr/s} = .414 \text{ hr} = 24.8 \text{ min}$

FOR NSTPS = 2, $.667 \le \frac{24.8}{20} \le 2$ OK

$NSTPS_{10} = 2$

$NSTPS_5 = 4$

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 2 OF 2

DETAIL APPENDIX C COMPUTED _____ DATE _____

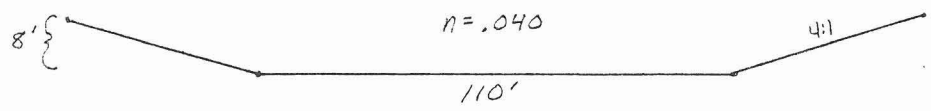
CHANNEL ROUTING CHECKED BY _____ DATE _____

CP4 - CP5

LENGTH = 5470'

SLOPE = (1870 - 1820) / 5470 = .0091 ft/ft

SECTION:



Q = 13,957 cfs

V = 12.3 ft/s

$V_m = 1.67V = 1.67(12.3) = 20.5$ ft/s

$K = 5470 \text{ ft} \times 1/20.5 \text{ s/ft} \times 1/3600 \text{ hr/s} = .074 \text{ hrs} = 4.4 \text{ mi}$, $X = .25$

FOR NSTPS = 1, $.667 \le 4.4/10(1) \le 2$ OK

$NSTPS_{10} = 1$

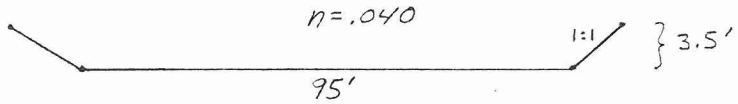
$NSTPS_5 = 1$

CP5 - CP6

LENGTH = 25,715 ft

SLOPE = (1820 - 1600) / 25715 = .0086 ft/ft

SECTION:



Q = 2625 cfs

V = 7.6 ft/s

$V_m = 1.67(7.6) = 12.7$ ft/s

$K = 25{,}715 \text{ ft} \times 1/12.7 \text{ s/ft} \times 1/3600 \text{ hr/s} = .562 \text{ hrs} = 33.7 \text{ min}$, $X = .25$

FOR NSTPS = 3, $.667 \le 33.7/3(10) \le 2$ OK

$NSTPS_{10} = 3$

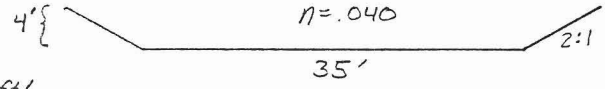
$NSTPS_5 = 6$

CP5 - CP7

LENGTH = 24,750 ft

SLOPE = (1820 - 1600) / 24750 = .0089 ft/ft

SECTION:



Q = 1323 cfs

V = 7.7 ft/s

$V_m = 1.67(7.7) = 12.9$ ft/s

$K = 24{,}750 \text{ ft} \times 1/12.9 \text{ s/ft} \times 1/3600 \text{ hr/s} = .533 \text{ hrs} = 32.0 \text{ min}$

For NSTPS = 3, $.667 \le 32/3 \le 2$ OK

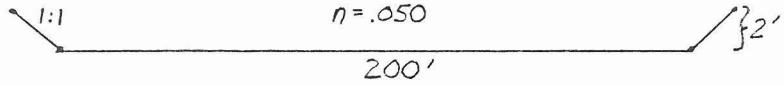
$NSTPS_{10} = 3$, $NSTPS_5 = 6$

CP6 - CP10 , CP7 - CP9 , CP8 - CP11

AVE LENGTH : 31750 ft

AVE SLOPE: (1600 - 1395) / 31750 = .0065 ft/ft

AVE. SECTION :



Q = 1518 cfs

V = 3.7 ft/s

$V_m = 1.67(3.7) = 6.2$ ft/s

$K = 31750 \text{ ft} \times 1/6.2 \text{ s/ft} \times 1/3600 \text{ hr/s} = 1.42 \text{ hr} = 85.3 \text{ min}$

For NSTPS = 8, $.667 \le 85.3/8(10) \le 2$ OK

$NSTPS_{10} = 8$

$NSTPS_5 = 16$

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 1 OF 5

DETAIL APPENDIX D COMPUTED _____ DATE _____

RESERVOIR OUTFLOW & STORAGE CALCS CHECKED BY _____ DATE _____

PRINCIPAL SPILLWAY

2 ea. 72" RCPs, INVERT ELEVATION : 1390.0

RATING FROM CULVERT NOMOGRAPH IN THIS APPENDIX

ELEV (ft)	HW/D	Q (cfs)	Q × 2 (cfs)
1390	0	0	0
1394	.67	112	224
1396	1.0	220	440
1398	1.33	320	640
1400	1.67	390	780
1405	2.5	540	1,080
1410	3.33	660	1,320
1413	3.83	720	1,440

EMERGENCY SPILLWAY

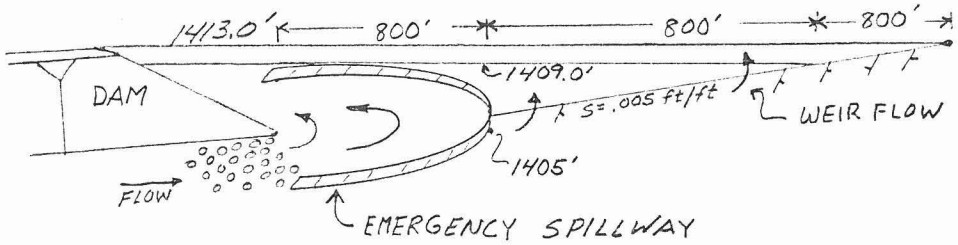
$Q = CLH^{1.5}$

C = 3.0 (C = 2.7 for a broad-crested weir, add .03 for bend losses)

L = 800 ft, H ranges from 1405 to 1409 ft

ELEV.	H (ft)	Q (cfs)
1405	0	0
1406	1	2400
1407	2	6788
1408	3	12,471
1409	4	19,200

WEIR FLOW



SCHEMATIC NOT TO SCALE

SW CARD → NON-LEVEL TOP OF DAM RECORD

ELEV. (FT. MSL)	WIDTH (FT)
1405	0
1407	200
1409	400
1413	1200
1414	5280

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 2 OF 5

DETAIL APPENDIX D COMPUTED _____ DATE _____

DETENTION BASIN STORAGE CALCS. CHECKED BY _____ DATE _____

VOLUME CALCULATIONS* (TWDB)

SEC. No.	ELEV. (MSL)	AREA (in²)	AREA (ac)
22	1390 - 1394	.17	15.6
	1394 - 1396	.31	28.5
	1396 - 1398	.65	59.7
	1398 - 1400	.65	59.7
	1400 - 1405	2.17	199.3
	1405 - 1410	1.19	109.3
23	1390 - 1394	.23	21.1
	1394 - 1396	1.52	46.5
	1396 - 1398		46.5
	1398 - 1400		46.5
	1400 - 1405	1.58	145.1
	1405 - 1410	1.24	113.9
24	1394 - 1396	1.63	49.9
	1396 - 1398		49.9
	1398 - 1400		49.9
	1400 - 1405	1.22	112.0
	1405 - 1410	1.21	111.1
19	1396 - 1398	.93	42.7
	1398 - 1400		42.7
	1400 - 1405	1.18	108.4
	1405 - 1410	1.17	107.4
20	1396 - 1398	1.10	50.5
	1398 - 1400		50.5
	1400 - 1405	.96	88.2
	1405 - 1410	.97	89.1
21	1396 - 1398	.93	42.7
	1398 - 1400		42.7
	1400 - 1405	1.02	93.7
	1405 - 1410	.88	80.8
22	1396 - 1398	.22	10.1
	1398 - 1400		10.1
	1400 - 1405	.48	44.1
	1405 - 1410	.40	36.7
ALL	1410 - 1413	3.02	
		2.29	
		5.31	486

* FROM USGS 7½ min. topographic maps

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT TIGER WASH HYDROLOGY PAGE 3 OF 5

DETAIL APPENDIX D COMPUTED _____ DATE _____

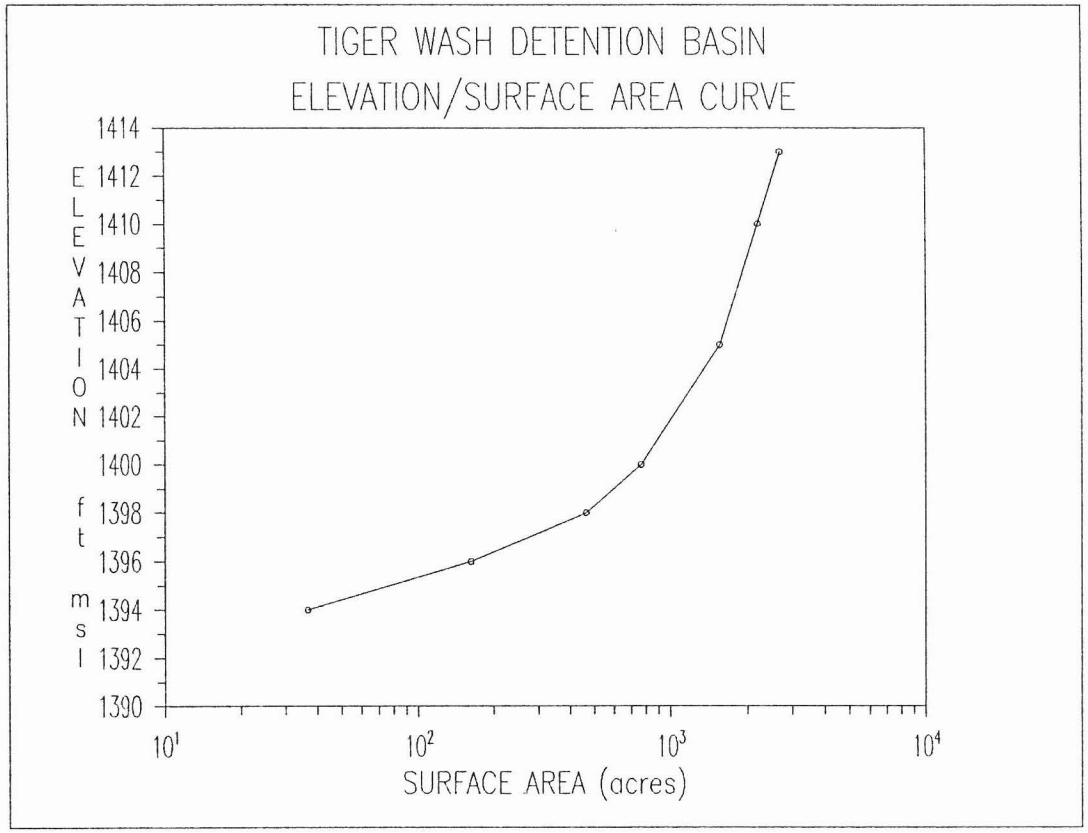
DETENTION BASIN CALCS. CHECKED BY _____ DATE _____

ELEVATION – SURFACE AREA TABLE:

ELEV (MSL) (ft)	INCREMENTAL AREA (ac)	SUM OF INCREMENTAL AREAS (ac)
1390	0	0
1394	15.6	
	21.1	36.7
1396	28.5	
	46.5	
	49.9 = 124.9	161.6
1398	59.7	
	46.5	
	49.9	
	42.7	
	50.5	
	42.7	
	10.1 = 302	464
1400	59.7	
	46.5	
	49.9	
	42.7	
	50.5	
	42.7	
	10.1 = 302	766
1405	199.3	
	145.1	
	112.0	
	108.4	
	88.2	
	93.7	
	44.1 = 791	1,557
1410	109.3	
	113.9	
	111.1	
	107.4	
	89.1	
	80.8	
	36.7 = 648	2,205
1413	486	2,691

FROM ELEVATION/SURFACE AREA CURVE:

ELEV.	AREA (ac)
1406	1610
1407	1795
1408	1920
1409	2080
1414	2880

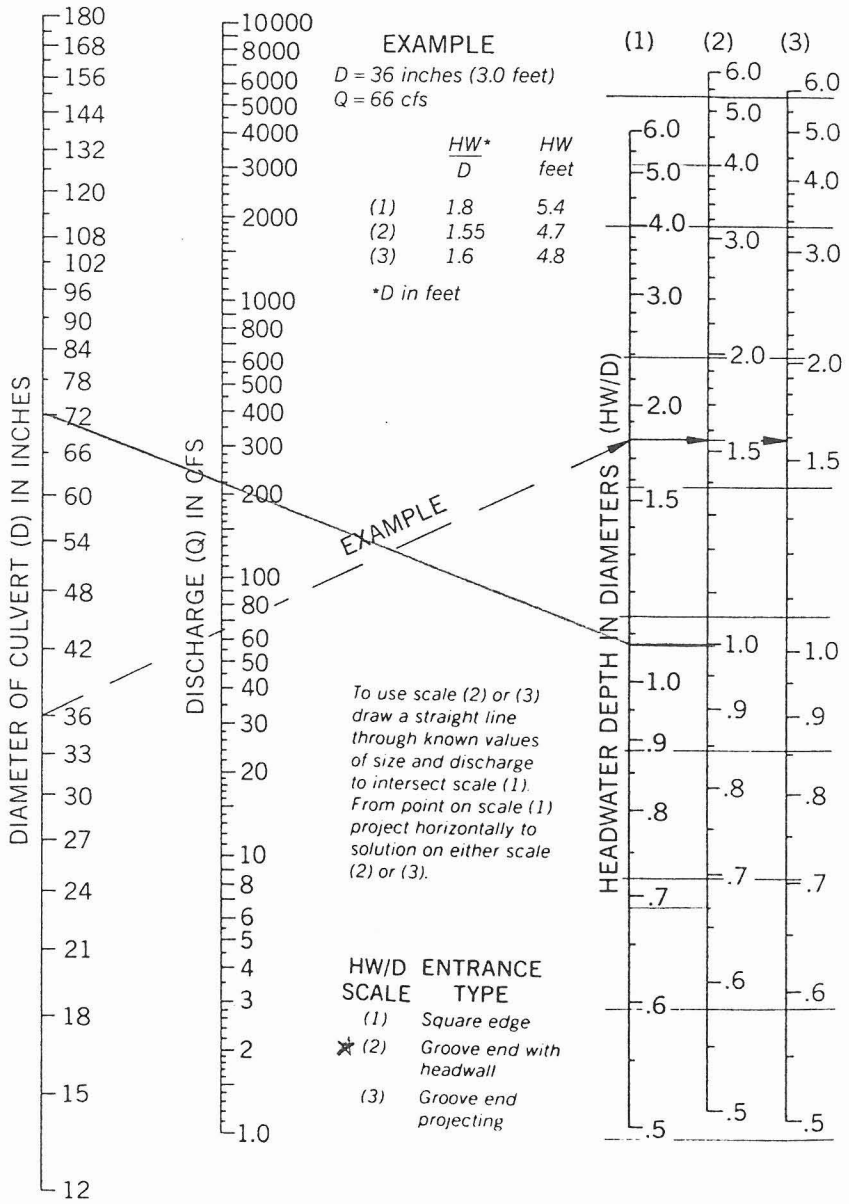


APPENDIX D
p. 4 of 5

APPENDIX D
p. 5 of 5
REF. 3

FIGURE 33

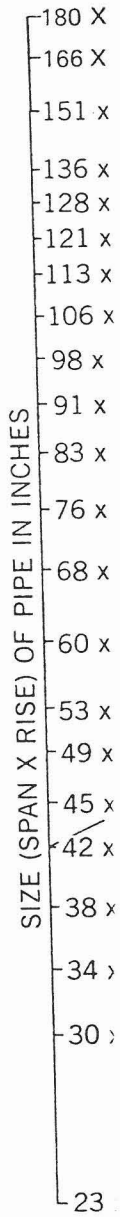
HEADWATER DEPTH FOR CIRCULAR CONCRETE PIPE CULVERTS WITH INLET CONTROL



BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER SCALES 2&3
REVISED MAY 1964

FIGURE 34



BUREAU

APPENDIX E

```
*********************************        ************************************
*            HECWRC             *        * *
* FLOOD FLOW FREQUENCY ANALYSIS *        *   U.S. ARMY CORPS OF ENGINEERS    *
* PROGRAM DATE:    1 APRIL 1978 *        * THE HYDROLOGIC ENGINEERING CENTER *
* VERSION DATE:    1 APRIL 1987 *        *         609 SECOND STREET         *
* RUN  DATE     AND     TIME:   *        *      DAVIS, CALIFORNIA 95616      *
*     7/17/91          9:59:31  *        * (916) 551-1748 OR (FTS) 460-1748  *
*********************************        ************************************


 INPUT FILE NAME: TIGER.IN
OUTPUT FILE NAME: TIGER.OUT2



**TITLE CARD(S)**
TT      TIGER WASH FREQUENCY ANALYSIS
TT      USING CUNNANE PLOTTING POSITION

**JOB CARD(S)**
     IPPC   ISKFX  IPROUT    IFMT    IWYR   IUNIT   ISMRY   IPNCH    IREG
J1     4       0       0       0       0       0       3       0       0

       A       B  CLIMIT
J2   .40     .40     .00

**STATION IDENTIFICATION**
ID              09512780         DA = 85.2 SQ MI

**GENERALIZED SKEW**
     ISTN   GGMSE    SKEW
GS  51728    .000    -.06

**SYSTEMATIC EVENTS**
     17 EVENTS TO BE ANALYZED

**END OF INPUT DATA**
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

FINAL RESULTS

-PLOTTING POSITIONS- 09512780 DA = 85.2 SQ MI

.....EVENTS ANALYZED.....				.....	ORDERED EVENTS.....			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	SPECIAL PLOT POS	
0	0	1963	910.	1	1970	4550.	.0349	
0	0	1964	400.	2	1976	3000.	.0930	
0	0	1965	1680.	3	1972	2770.	.1512	
0	0	1966	1450.	4	1971	2000.	.2093	
0	0	1967	620.	5	1973	1750.	.2674	
0	0	1968	440.	6	1965	1680.	.3256	
0	0	1969	441.	7	1966	1450.	.3837	
0	0	1970	4550.	8	1978	1400.	.4419	
0	0	1971	2000.	9	1963	910.	.5000	
0	0	1972	2770.	10	1977	870.	.5581	
0	0	1973	1750.	11	1967	620.	.6163	
0	0	1974	45.	12	1969	441.	.6744	
0	0	1975	100.	13	1968	440.	.7326	
0	0	1976	3000.	14	1964	400.	.7907	
0	0	1977	870.	15	1975	100.	.8488	
0	0	1978	1400.	16	1979	60.	.9070	
0	0	1979	60.	17	1974	45.	.9651	

-OUTLIER TESTS -

LOW OUTLIER TEST

BASED ON 17 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.309

0 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF 31.8

HIGH OUTLIER TEST

BASED ON 17 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.309

0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF 16703.

-SKEW WEIGHTING -

BASED ON 17 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .378
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

FINAL RESULTS

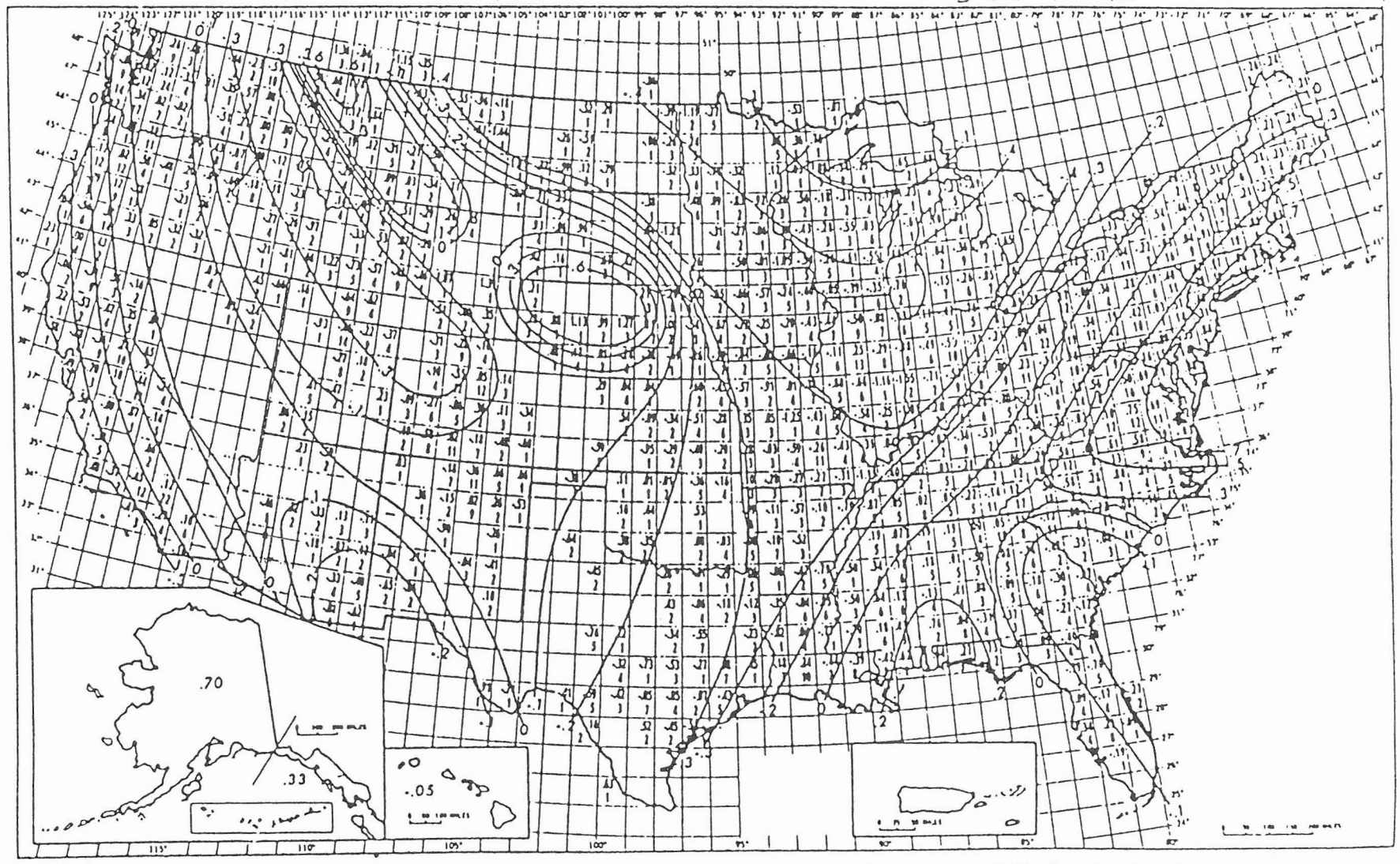
-FREQUENCY CURVE- 09512780 DA = 85.2 SQ MI

FLOW, CFS COMPUTED	FLOW, CFS EXPECTED PROBABILITY	EXCEEDANCE PROBABILITY	CONFIDENCE LIMITS .05 LIMIT	CONFIDENCE LIMITS .95 LIMIT
18900.	30300.	.002	82800.	7850.
14400.	21000.	.005	57300.	6300.
11400.	15500.	.010	41700.	5200.
8770.	11100.	.020	29100.	4170.
5760.	6750.	.050	16600.	2930.
3870.	4290.	.100	9810.	2080.
2320.	2460.	.200	5080.	1320.
798.	798.	.500	1420.	457.
241.	224.	.800	423.	112.
122.	105.	.900	231.	47.
68.	53.	.950	140.	21.
21.	11.	.990	53.	4.

FREQUENCY CURVE STATISTICS		STATISTICS BASED ON	
MEAN LOGARITHM	2.8628	HISTORIC EVENTS	0
STANDARD DEVIATION	.5890	HIGH OUTLIERS	0
COMPUTED SKEW	-.8871	LOW OUTLIERS	0
GENERALIZED SKEW	-.0600	ZERO OR MISSING	0
ADOPTED SKEW	-.4000	SYSTEMATIC EVENTS	17

```
+++++++++++++++++++++++++
+ END OF RUN            +
+ NORMAL STOP IN HECWRC +
+++++++++++++++++++++++++
```

TIGER WASH GAGE: LAT 33°44'30" Long 113°16'43"



GENERALIZED SKEW COEFFICIENTS OF LOGARITHMS OF ANNUAL MAXIMUM STREAMFLOW

AVERAGE SKEW COEFFICIENT BY ONE DEGREE QUADRANGLES

Lower number in each quadrangle is number of stream gaging stations for which the average shown above it was computed

FIGURE 14.5.1

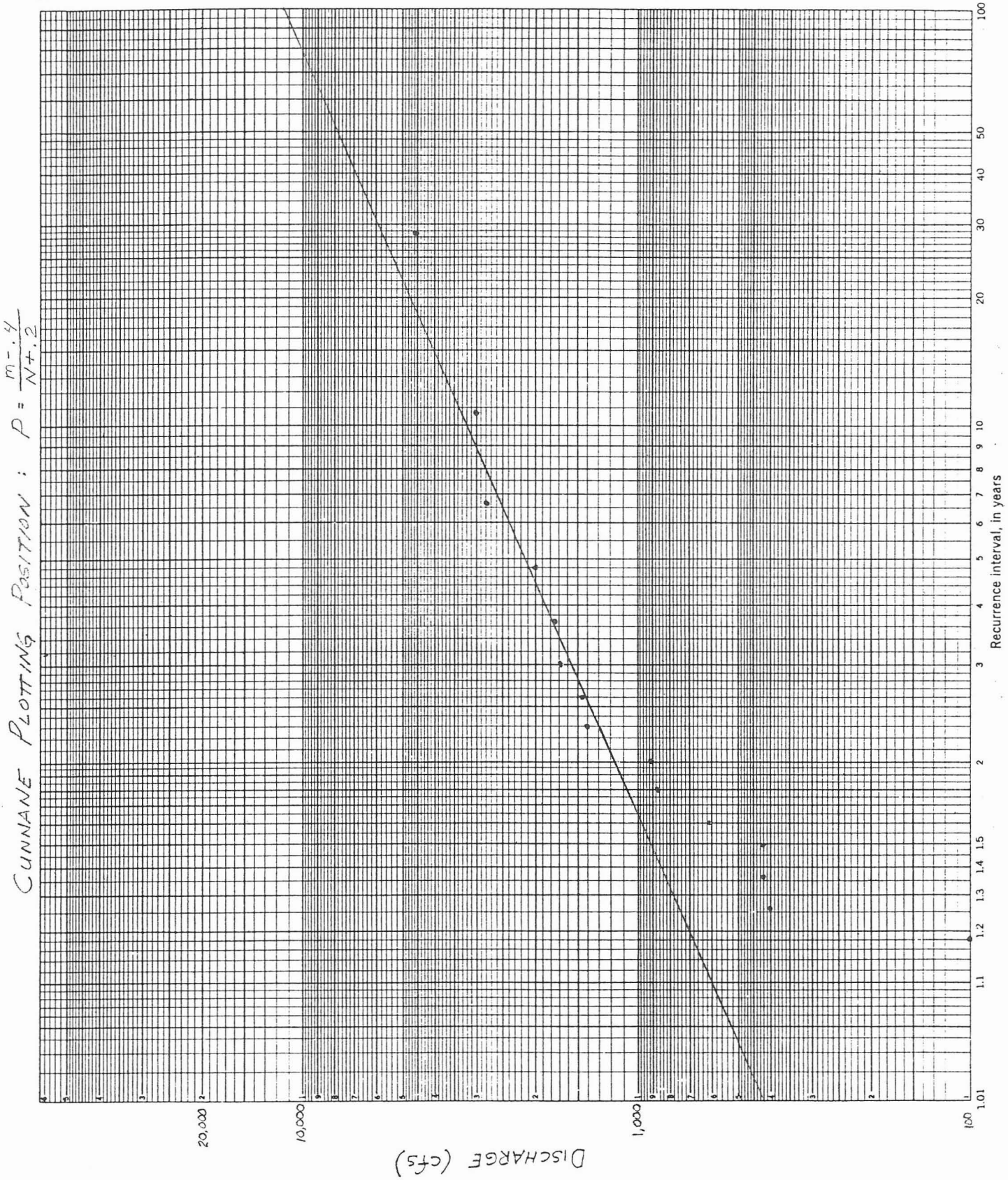
Extreme log data plot
April 1955

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File

Magnitude and frequency of 09512780 on TIGER WASH

Drainage area 85.2 sq. mi. Period 1963 - 1979

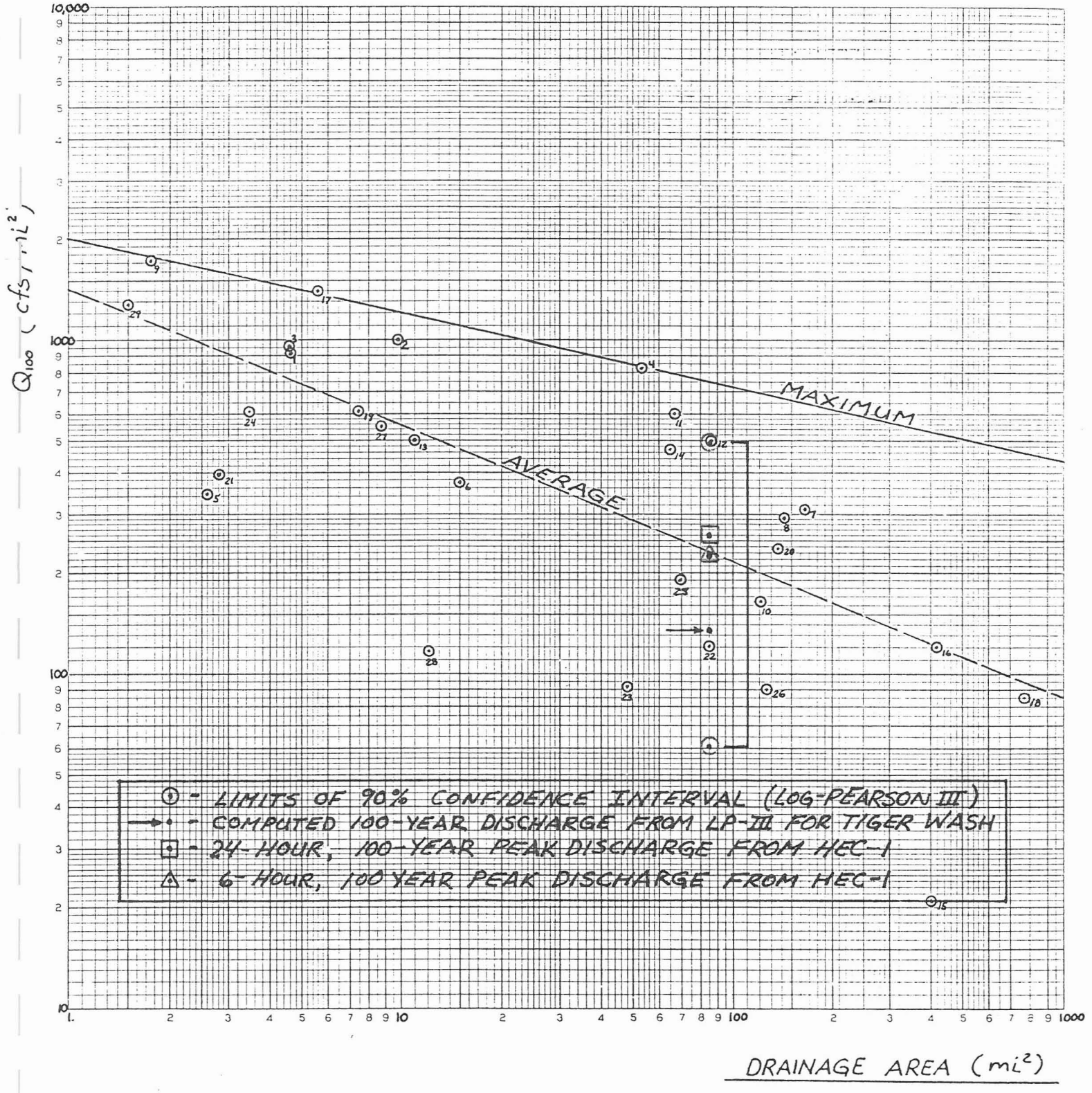


Sheet No. 5 of 7 Sheets. Prepared by _____ Date _____ Checked by _____ Date

GPO 863751

PLOT OF 100-YEAR DISCHARGE, FROM LOG PEARSON III ANALYSIS, FOR STREAMFLOW STATIONS IN MARICOPA COUNTY *

TIGER WASH HYDROLOGY



Full Logarithmic, 3 × 3 Cycles

* ORIGINAL FIGURE BY R. GRUFF, FCDMC, 1990.

09517280 TIGER WASH NEAR AGUILA, AZ

LOCATION.--Lat 33°44'30", long 113°16'43", in SW¼SW¼ sec. 26, T. 5 N., R. 10 W., Maricopa County, Hydrologic Unit 15070104, on left bank 17 mi south of Aguila.

DRAINAGE AREA.--85.5 mi^2.

GAGE.--Crest-stage gage. Elevation of gage is 1,870 ft (from topographic map).

REMARKS.--No storage or diversion above station.

ANNUAL PEAK DISCHARGE

DATE	STREAM STAGE (FT ABOVE DATUM)	STREAM STAGE CODE	DIS-CHARGE, IN CUBIC FEET PER SECOND	STREAM-FLOW CODE
AUG , 1963				
16...	--		910	2
OCT 1964				
19...	--		400	2
AUG , 1965				
18...	7.50		1680	
SEP , 1966				
13...	7.96		1450	
AUG , 1967				
14...	6.94		620	
DEC 1968				
19...	6.67		440	
SEP , 1969				
14...	6.67		441	
AUG , 1970				
20...	10.20		4550	
AUG , 1971				
20...	8.50		2000	
AUG , 1972				
...	9.10	2	2770	
OCT 1973				
06...	8.28		1750	
AUG , 1974				
03...	5.39		45	2
JUL , 1975				
30...	5.66		100	2
SEP , 1976				
25...	9.28		3000	
AUG , 1977				
16...	6.40		870	
MAR , 1978				
01...	7.95		1400	
DEC 1979				
18...	4.71		60	2

FROM REF. No. 3

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
*  RUN DATE  07/30/1991  TIME  09:17:52 *
*                                      *
****************************************
```

APPENDIX F

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

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

HEC-1 INPUT PAGE 1

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

  1           ID   TIGER WASH HYDROLOGY
  2           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, JULY, 1991
  3           ID   100-YEAR, 24-HOUR STORM OVER THE ENTIRE WATERSHED (162 SQ.MI)
  4           ID   INCREASED RAINFALL DEPTH ON THE PB RECORD FOR SUBBASINS 3,5,&6
              * ******************************************************************************
              *DIAGRAM
  5           IT      10                    300
  6           IO       5
              * ************************************

  7           KK    SUB1
  8           KM   RUNOFF FROM SUBBASIN 1
  9           KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
 10           KM    L=      7.1  Lca=      2.2   S=   47.1  Kn= .069
 11           BA   21.30
 12           IN      30
 13           KM   RAINFALL DEPTH OF 4.15 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 14           PB    3.45
 15           KM   THE FOLLOWING PC RECORD USED A 24-HOUR SCS TYPE II RAINFALL
 16           PC    .000    .005    .011    .016    .022    .028    .035    .041    .048    .056
 17           PC    .068    .071    .080    .089    .098    .109    .120    .133    .147    .163
 18           PC    .181    .204    .235    .283    .663    .735    .772    .799    .820    .838
 19           PC    .854    .868    .880    .891    .902    .912    .921    .929    .937    .945
 20           PC    .952    .959    .965    .972    .978    .984    .989    .995   1.000
 21           LG     .38     .31    5.60     .19    1.70
 22           UI     527     527     527    1578    2040    2491    2796    3074    3420    3872
 23           UI    4338    5447    6608    6378    5373    4729    4278    3826    3368    3013
 24           UI    2648    2311    1780    1288     933     891     866     623     527     527
 25           UI     311     162     162     162     162     162     162     162     162     162
 26           UI      0.
              * ************************************
```

APPENDIX F

FILE NAME : TW24.OUT

```
KK     CP2
KM   ROUTE SUB1 FROM CP1 TO CP2
RM       1    .160     .25
* ************************************

KK    SUB2
KM   RUNOFF FROM SUBBASIN 2
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      8.3  Lca=      4.0   S=   61.7  Kn= .049
PB    3.45
BA   14.18
LG     .21     .36    3.70     .51   14.00
UI     391     391     534    1207    1646    2240    2573    2904    3221    3981
UI    4652    3149    2624    2346    2194    2004    1858    1700    1551    1402
UI    1241    1052     969     917     861     794     643     582     500     483
UI     429     429     342     300     300     299     192     192     192     192
UI     192     159      75      75      75      75      75      75      75      75
UI      75      75      75      75      75      75      0.
* ************************************

KK     CP2
KM     COMBINE SUB1 + SUB2 AT CP2
HC       2
* ************************************

KK     CP3
KM    ROUTE (SUB1 & 2) FROM CP2 TO CP3
RM       1    .112     .25
* ************************************

KK    SUB3
KM   RUNOFF FROM SUBBASIN 3
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      9.4  Lca=      3.3   S=  131.3  Kn= .058
BA   18.76
PB    3.49
LG     .55     .15    6.50     .13    8.60
UI     518     518     706    1597    2178    2964    3404    3841    4261    5267
UI    6154    4166    3471    3104    2903    2651    2459    2250    2052    1855
UI    1641    1391    1283    1214    1139    1051     851     770     662     640
UI     567     567     453     397     397     395     253     253     253     253
UI     253     211      99      99      99      99      99      99      99      99
UI      99      99      99      99      99      99      0.
* ************************************

KK     CP3
KM    COMBINE (SUB1&2) + SUB3 AT CP3
HC       2
* ************************************

KK     CP4
KM    ROUTE SUB 1,2,&3 FROM CP3 TO CP4
RM       2    .414     .25
* ************************************

KK    SUB4
KM   RUNOFF FROM SUBBASIN 4
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      6.6  Lca=      3.8   S=   87.2  Kn= .047
BA   10.94
PB    3.45
LG     .18     .36    3.60     .55   15.40
UI     376     376     902    1535    2182    2589    2942    3684    4306    2797
UI    2347    2137    1918    1743    1550    1375    1185     979     904     841
UI     748     617     501     474     412     408     288     288     279     184
UI     184     184     184     130      72      72      72      72      72      72
UI      72      72      72      72      72      0.
* ************************************
```

```
KK    SUB5
KM   RUNOFF FROM SUBBASIN 5
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      8.9  Lca=      4.1   S=  250.8  Kn= .060
BA   19.92
PB    3.49
LG     .77     .08    7.50     .09   15.00
UI     564     564     842    1788    2420    3344    3795    4252    4819    6056
UI    6285    4217    3615    3311    3053    2801    2595    2338    2158    1879
UI    1641    1447    1357    1287    1178     984     904     720     720     621
UI     617     531     432     432     432     292     276     276     276     276
UI     225     108     108     108     108     108     108     108     108     108
UI     108     108     108     108      0.
* ************************************

KK     CP4
KM    COMBINE (SUB1,2,&3) + SUB4 + SUB5 AT CP4
HC       3
* ************************************

KK     CP5
KM    ROUTE SUB1-5 FROM CP4 TO CP5
RM       1    .074     .25
* ************************************

KK    SUB6
KM   RUNOFF FROM SUBBASIN 6
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L= 6.26   Lca= 2.77  S=269.6   Kn= .057
BA   11.31
PB    3.49
LG     .50     .12     6.9     .11    11.6
UI     453     511    1475    2312    2999    3517    4556    4736    3116    2666
UI    2374    2119    1850    1603    1308    1132    1034     909     742     579
UI     537     496     386     347     320     222     222     222     185      87
UI      87      87      87      87      87      87      87      87      0.
* ************************************

KK     CP5
KM   COMBINE SUB1-5 + SUB6 AT CP5
HC       2
* ************************************

KK   DWEST
KM   DIVERT 55% OF FLOW TO CP6, 45% TO CP7
DT   DEAST
DI       0  100000
DQ       0   45000
* ************************************

KK     CP6
KM   ROUTE DWEST FROM CP5 TO CP6 (FAN APEX)
RM       3    .562     .25
* ************************************

KK    CP10
KM   ROUTE DWEST FROM CP6 TO CP10
RM       8    1.42     .25
* ************************************************************

KK   DEAST
KM   REINSTALL 45% OF FLOW AT CP5 FOR ROUTING
DR   DEAST
* ************************************
```

```
KK     CP7
KM   ROUTE DEAST FROM CP5 TO CP7
RM       3    .533     .25
* ************************************

KK    SUB8
KM   RUNOFF FROM SUBBASIN 8
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      5.3  Lca=      2.3   S=   55.4  Kn= .067
BA    8.04
PB    3.45
LG     .23     .34    4.70     .30    2.30
UI     286     286     519    1027    1310    1516    1700    1944    2225    2731
UI    3581    3402    2805    2446    2172    1862    1630    1405    1175     824
UI     506     487     470     299     286     229      88      88      88      88
UI      88      88      88      88      0.
* ************************************

KK     CP7
KM   COMBINE DEAST + SUB8 AT CP7
HC       2
* ************************************

KK     CP9
KM   ROUTE DEAST & SUB8 FROM CP7 TO CP9
RM       8    1.42     .25
* ********************************************************

KK    SUB7
KM   RUNOFF FROM SUBBASIN 7
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      7.0  Lca=      3.3   S=   83.4  Kn= .052
BA   20.73
PB    3.45
LG     .24     .25    6.20     .15    4.10
UI     658     658    1352    2383    3469    4229    4875    5566    7146    6874
UI    4694    4035    3726    3368    3091    2749    2506    2163    1841    1643
UI    1538    1419    1221    1071     841     825     721     721     524     505
UI     505     372     322     322     322     322     176     126     126     126
UI     126     126     126     126     126     126     126     126      0.
* ************************************

KK    CP11
KM   ROUTE SUB7 FROM CP8 TO CP11
RM       8    1.42     .25
* ********************************************************

KK    SUB9
KM   RUNOFF FROM SUBBASIN SUB9
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      6.8  Lca=      3.7   S=   30.2  Kn= .070
BA   34.61
PB    3.45
LG     .35     .36    4.20     .37     .00
UI     651     651     651     651    1965    2364    2773    3121    3437    3711
UI    3968    4353    4783    5151    5934    7252    8135    8203    7103    6333
UI    5785    5357    4985    4513    4083    3808    3382    3123    2779    2272
UI    1872    1205    1152    1103    1070    1031     651     651     651     651
UI     211     200     200     200     200     200     200     200     200     200
UI     200     200     200      0.
* ********************************************************

KK    TWDB
KM   COMBINE DWEST, DEAST, SUB7, AND SUB9 AT TWDB
HC       4
* ********************************************************
```

```
178          KK    RESV
179          KM   ROUTE ALL FLOWS THROUGH TIGER WASH DETENTION BASIN
180          RS       1    STOR      0.
181          SV       0       0       0       0  899.54 6591.36 8174.79  9876.4 11733.6 13733.1
182          SV   15875 23207.2 25992.1
183          SE    1390    1394    1396    1398    1400    1405    1406    1407    1408    1409
184          SE    1410    1413    1414
185          SQ       0     224     440     640     780    1080    3530    7968   13701   20485
186          SQ   20520   20640   20680
187          ST   1405.
188          SW       0     200     400    1200    5280
189          SE    1405    1407    1409    1413    1414
190          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

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

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

   7         SUB1
               V
               V
  27          CP2
               .
               .
  30           .        SUB2
               .           .
               .           .
  43          CP2............
               V
               V
  46          CP3
               .
               .
  49           .        SUB3
               .           .
               .           .
  62          CP3............
               V
               V
  65          CP4
               .
               .
  68           .        SUB4
               .           .
               .           .
  80           .           .        SUB5
               .           .           .
               .           .           .
  93          CP4........................
               V
               V
  96          CP5
               .
               .
  99           .        SUB6
               .           .
               .           .
 110          CP5............
```

```
              .
              .
115           .-------->   DEAST
113       DWEST
              V
              V
118         CP6
              V
              V
121        CP10
              .
              .
126           .           .<-------   DEAST
124           .       DEAST
              .           V
              .           V
127           .         CP7
              .           .
              .           .
130           .           .        SUB8
              .           .           .
              .           .           .
141           .         CP7............
              .           V
              .           V
144           .         CP9
              .           .
              .           .
147           .           .        SUB7
              .           .           V
              .           .           V
159           .           .        CP11
              .           .           .
              .           .           .
162           .           .           .        SUB9
              .           .           .           .
              .           .           .           .
175        TWDB.................................
              V
              V
178        RESV
```

TIGER WASH HYDROLOGY
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, JULY, 1991
100-YEAR, 24-HOUR STORM OVER THE ENTIRE WATERSHED (162 SQ.MI)
INCREASED RAINFALL DEPTH ON THE PB RECORD FOR SUBBASINS 3,5,&6

```
 6 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT          HYDROGRAPH TIME DATA
                      NMIN         10  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1    0  STARTING DATE
                     ITIME        0000  STARTING TIME
                        NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      3    0  ENDING DATE
                    NDTIME        0150  ENDING TIME
                     ICENT         19  CENTURY MARK

               COMPUTATION INTERVAL     .17 HOURS
                    TOTAL TIME BASE   49.83 HOURS
```

ENGLISH UNITS

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

**** WARNING ***** POSSIBLE INSTABILITIES IN THE MUSKINGUM ROUTING FOR REACH CP5.
REDUCE NSTPS OR DECREASE YOUR COMPUTATION INTERVAL (FIRST FIELD OF THE IT RECORD).

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	HYDROGRAPH AT									
+		SUB1	6202.	13.83	2315.	595.	286.	21.30		
	ROUTED TO									
		CP2	6076.	14.00	2314.	595.	286.	21.30		
	HYDROGRAPH AT									
		SUB2	3467.	13.50	1408.	421.	204.	14.18		
	2 COMBINED AT									
+		CP2	8331.	14.00	3723.	1016.	490.	35.48		
	ROUTED TO									
		CP3	8263.	14.17	3721.	1016.	490.	35.48		
	HYDROGRAPH AT									
		SUB3	6565.	13.50	2584.	719.	347.	18.76		
	2 COMBINED AT									
+		CP3	13697.	13.50	6305.	1735.	838.	54.24		
	ROUTED TO									
		CP4	13161.	14.00	6293.	1735.	838.	54.24		
	HYDROGRAPH AT									
		SUB4	3125.	13.17	1118.	331.	160.	10.94		
	HYDROGRAPH AT									
+		SUB5	7785.	13.33	3130.	897.	434.	19.92		
	3 COMBINED AT									
		CP4	20820.	13.67	10506.	2962.	1431.	85.10		
	ROUTED TO									
		CP5	20692.	13.67	10506.	2962.	1431.	85.10		
	HYDROGRAPH AT									
+		SUB6	5585.	12.83	1765.	481.	232.	11.31		
	2 COMBINED AT									
		CP5	23927.	13.67	12248.	3443.	1664.	96.41		
	DIVERSION TO									
		DEAST	10767.	13.67	5512.	1549.	749.	96.41		
	HYDROGRAPH AT									
+		DWEST	13160.	13.67	6736.	1894.	915.	96.41		

	ROUTED TO								
+		CP6	12867.	14.17	6719.	1894.	915.	96.41	
	ROUTED TO								
		CP10	12286.	15.67	6678.	1893.	915.	96.41	
	HYDROGRAPH AT								
+		DEAST	10767.	13.67	5512.	1549.	749.	.00	
	ROUTED TO								
+		CP7	10560.	14.17	5499.	1549.	749.	.00	
	HYDROGRAPH AT								
		SUB8	3031.	13.67	989.	253.	122.	8.04	
	2 COMBINED AT								
+		CP7	12727.	14.00	6452.	1803.	871.	8.04	
	ROUTED TO								
+		CP9	12132.	15.50	6414.	1802.	871.	8.04	
	HYDROGRAPH AT								
		SUB7	7575.	13.17	2630.	697.	336.	20.73	
	ROUTED TO								
+		CP11	6300.	14.67	2614.	697.	336.	20.73	
	HYDROGRAPH AT								
+		SUB9	6311.	14.67	2877.	748.	360.	34.61	
	4 COMBINED AT								
		TWDB	32645.	15.33	18217.	5141.	2482.	159.79	
	ROUTED TO								
+		RESV	4047.	19.17	3504.	1957.	1264.	159.79	1406.08 19.17

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION RESV
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1394.00	1405.00	1405.00
STORAGE	0.	6591.	6591.
OUTFLOW	224.	1080.	1080.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1406.08	1.08	8319.	4047.	14.83	19.17	.00

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

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            SEPTEMBER 1990             *
*             VERSION 4.0               *
*                                       *
*  RUN DATE  07/30/1991  TIME  09:54:01 *
*                                       *
*****************************************
```

APPENDIX G

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

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

HEC-1 INPUT PAGE 1

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

  1           ID   TIGER WASH HYDROLOGY
  2           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, JULY, 1991
  3           ID   FILE NAME: APEX6.DAT
  4           ID   100-YEAR,  6-HOUR STORM OVER THE WATERSHED ABOVE THE APEX (96.41 SQ.MI)
  5           ID   INCREASED RAINFALL DEPTH ON THE PB RECORD FOR SUBBASINS 3,5,&6
              * ****************************************************************************
              *DIAGRAM
  6           IT       5                    300
  7           IO       3
              * ************************************

  8           KK    SUB1
  9           KM   RUNOFF FROM SUBBASIN 1
 10           KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
 11           KM    L=      7.1  Lca=      2.2   S=   47.1  Kn= .069
 12           BA   21.30
 13           IN      15
 14           KM   RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD
 15           PB    2.68
 16           PC       0    .021    .035    .051    .071    .088    .106    .126    .144    .161
 17           PC    .181    .203    .234    .283    .366    .501    .656    .771    .840    .887
 18           PC    .926    .944    .963    .982   1.00
 19           LG     .38     .31    5.60     .19   1.70
 20           UI     527     527     527     527     527     527    1424    1733    1975    2105
 21           UI    2426    2557    2717    2876    3001    3148    3319    3521    3763    3981
 22           UI    4142    4534    5065    5829    6188    7028    6702    6054    5575    5172
 23           UI    4866    4592    4382    4174    3962    3690    3463    3272    3110    2915
 24           UI    2716    2581    2434    2188    2021    1538    1516    1061     933     933
 25           UI     917     866     866     866     718     527     527     527     527     527
 26           UI     461     162     162     162     162     162     162     162     162     162
 27           UI     162     162     162     162     162     162     162     162     162     162
 28           UI     162      0.
              * ************************************
```

APPENDIX G
FILE NAME : APEX6. OUT

```
29          KK     CP2
30          KM   ROUTE SUB1 FROM CP1 TO CP2
31          RM       1    .160     .25
            * ************************************

32          KK    SUB2
33          KM   RUNOFF FROM SUBBASIN 2
34          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
35          KM    L=      8.3  Lca=      4.0   S=   61.7  Kn= .049
36          BA   14.18
37          PB    2.68
38          LG     .21     .36    3.70     .51   14.00
39          UI     391     391     391     391     391     676    1125    1289    1500    1792
40          UI    2139    2342    2480    2666    2845    2962    3109    3333    3749    4214
41          UI    4797    4507    3369    2929    2713    2534    2383    2309    2246    2142
42          UI    2046    1962    1890    1827    1743    1657    1579    1522    1461    1343
43          UI    1265    1216    1069    1035     981     958     935     900     900     822
44          UI     818     771     643     643     643     521     500     500     500     467
45          UI     429     429     429     429     385     300     300     300     300     300
46          UI     300     298     192     192     192     192     192     192     192     192
47          UI     192     192     191     127      75      75      75      75      75      75
48          UI      75      75      75      75      75      75      75      75      75      75
49          UI      75      75      75      75      75      75      75      75      75      75
50          UI      75      75      0.
            * ************************************

51          KK     CP2
52          KM     COMBINE SUB1 + SUB2 AT CP2
53          HC       2
            * ************************************

54          KK     CP3
55          KM    ROUTE (SUB1 & 2) FROM CP2 TO CP3
56          RM       1    .112     .25
            * ************************************

57          KK    SUB3
58          KM   RUNOFF FROM SUBBASIN 3
59          KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
60          KM    L=      9.3  Lca=      3.3   S=  131.3  Kn= .058
61          BA   18.76
62          PB    2.80
63          LG     .55     .15    6.50     .13    8.60
64          UI     518     518     518     518     518     894    1488    1705    1985    2370
65          UI    2829    3099    3281    3527    3764    3919    4113    4410    4959    5575
66          UI    6347    5962    4457    3875    3590    3352    3152    3055    2972    2834
67          UI    2706    2596    2501    2417    2307    2193    2089    2014    1932    1777
68          UI    1673    1609    1414    1369    1298    1267    1237    1191    1191    1087
69          UI    1083    1019     851     851     851     689     662     662     662     618
70          UI     567     567     567     567     509     397     397     397     397     397
71          UI     397     394     253     253     253     253     253     253     253     253
72          UI     253     253     253     168      99      99      99      99      99      99
73          UI      99      99      99      99      99      99      99      99      99      99
74          UI      99      99      99      99      99      99      99      99      99      99
75          UI      99      99      0.
            * ************************************

76          KK     CP3
77          KM    COMBINE (SUB1&2) + SUB3 AT CP3
78          HC       2
            * ************************************

79          KK     CP4
80          KM    ROUTE SUB 1,2,&3 FROM CP3 TO CP4
81          RM       2    .414     .25
            * ************************************
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```
KK    SUB4
KM   RUNOFF FROM SUBBASIN 4
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      6.6  Lca=      3.8   S=   87.2  Kn= .047
BA   10.94
PB    2.68
LG     .18     .36    3.60     .55   15.40
UI     376     376     376     376     723    1081    1413    1656    2061    2303
UI    2477    2701    2852    3032    3423    3945    4652    3960    2956    2638
UI    2435    2258    2188    2086    1969    1868    1786    1700    1587    1213
UI    1441    1309    1222    1149     994     964     920     889     864     817
UI     786     710     617     617     521     480     480     468     412     412
UI     412     404     288     288     288     288     288     269     184     184
UI     184     184     184     184     184     184     184      76      72      72
UI      72      72      72      72      72      72      72      72      72      72
UI      72      72      72      72      72      72      72      72      72      72
UI      0.
* ************************************

KK    SUB5
KM   RUNOFF FROM SUBBASIN 5
KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM    L=      8.9  Lca=      4.1   S=  250.8  Kn= .060
BA   19.92
PB    2.80
LG     .77     .08    7.50     .09   15.00
UI     564     564     564     564     564    1119    1620    1956    2244    2595
UI    3250    3439    3662    3927    4145    4358    4562    5076    5664    6449
UI    7031    5540    4421    4014    3730    3500    3356    3266    3125    2981
UI    2856    2747    2650    2540    2401    2275    2202    2114    1935    1823
UI    1752    1529    1490    1404    1379    1334    1296    1277    1178    1178
UI    1041     926     926     882     720     720     720     720     625     617
UI     617     617     617     445     432     432     432     432     432     432
UI     309     276     276     276     276     276     276     276     276     276
UI     276     174     108     108     108     108     108     108     108     108
UI     108     108     108     108     108     108     108     108     108     108
UI     108     108     108     108     108     108     108     108     108      0.
* ************************************

KK     CP4
KM    COMBINE (SUB1,2,&3) + SUB4 + SUB5 AT CP4
HC       3
* ************************************

KK     CP5
KM    ROUTE SUB1-5 FROM CP4 TO CP5
RM       1    .074     .25
* ************************************

KK    SUB6
KM   RUNOFF FROM SUBBASIN 6
KM   THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
KM   L=  6.26   Lca=  2.77   S=  269.6   Kn=  .057
BA   11.31
PB    2.80
LG     .50     .12     6.9     .11    11.6
UI     453     453     453     569    1303    1647    2010    2614    2845    3154
UI    3399    3634    4177    4934    5517    3955    3276    2955    2716    2617
UI    2442    2306    2184    2055    1901    1799    1679    1527    1409    1208
UI    1154    1109    1048    1020     948     870     745     739     579     579
UI     578     496     496     496     425     347     347     347     347     292
UI     222     222     222     222     222     222     222     148      87      87
UI      87      87      87      87      87      87      87      87      87      87
UI      87      87      87      87      87      87      87      0.
* ************************************
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138          KK     CP5
139          KM   COMBINE SUB1-5 + SUB6 AT CP5
140          HC       2
             * ************************************

141          KK   DWEST
142          KM   DIVERT 55% OF FLOW TO CP6, 45% TO CP7
143          DT   DEAST
144          DI       0  100000
145          DQ       0   45000
             * ************************************

146          KK     CP6
147          KM   ROUTE DWEST FROM CP5 TO CP6 (FAN APEX)
148          RM       3    .562     .25
             * ************************************
149          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

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

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

  8        SUB1
             V
             V
 29         CP2
             .
             .
 32          .        SUB2
             .           .
             .           .
 51         CP2............
             V
             V
 54         CP3
             .
             .
 57          .        SUB3
             .           .
             .           .
 76         CP3............
             V
             V
 79         CP4
             .
             .
 82          .        SUB4
             .           .
             .           .
 99          .           .        SUB5
             .           .           .
             .           .           .
117         CP4........................
             V
             V
120         CP5
             .
             .
123          .        SUB6
             .           .
             .           .
138         CP5............
             .
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              .
 143          .------->   DEAST
 141       DWEST
              V
              V
 146         CP6

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION


                        TIGER WASH HYDROLOGY
                        FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, JULY, 1991
                        FILE NAME: APEX6.DAT
                        100-YEAR,  6-HOUR STORM OVER THE WATERSHED ABOVE THE APEX (96.41 SQ.MI)
                        INCREASED RAINFALL DEPTH ON THE PB RECORD FOR SUBBASINS 3,5,&6

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

    IT          HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      2    0  ENDING DATE
                     NDTIME        0055  ENDING TIME
                     ICENT          19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.92 HOURS

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


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


          **************
          *            *
  8 KK    *      SUB1  *
          *            *
          **************
                        RUNOFF FROM SUBBASIN 1
                         THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                         L=      7.1  Lca=      2.2   S=   47.1  Kn= .069
                        RAINFALL DEPTH OF 3.35 WAS SPACIALLY REDUCED AS SHOWN BY THE PB RECORD

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

             SUBBASIN RUNOFF DATA

 12 BA          SUBBASIN CHARACTERISTICS
                      TAREA       21.30  SUBBASIN AREA
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                PRECIPITATION DATA

 15 PB                STORM        2.68  BASIN TOTAL PRECIPITATION

 16 PI             INCREMENTAL PRECIPITATION PATTERN
                      .01       .01       .01       .00       .00       .00       .01       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                      .03       .03       .04       .05       .04       .05       .05       .05       .04       .04
                      .04       .02       .02       .02       .02       .02       .02       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                      .01       .01

 19 LG           GREEN AND AMPT LOSS RATE
                      STRTL         .38  STARTING LOSS
                        DTH         .31  MOISTURE DEFICIT
                       PSIF        5.60  WETTING FRONT SUCTION
                      XKSAT         .19  HYDRAULIC CONDUCTIVITY
                      RTIMP        1.70  PERCENT IMPERVIOUS AREA

 19 UI           INPUT UNITGRAPH,  81 ORDINATES,  VOLUME = 1.00
                    527.0     527.0     527.0     527.0     527.0     527.0    1424.0    1733.0    1975.0    2105.0
                   2426.0    2557.0    2717.0    2876.0    3001.0    3148.0    3319.0    3521.0    3763.0    3981.0
                   4142.0    4534.0    5065.0    5829.0    6188.0    7028.0    6702.0    6054.0    5575.0    5172.0
                   4866.0    4592.0    4382.0    4174.0    3962.0    3690.0    3463.0    3272.0    3110.0    2915.0
                   2716.0    2581.0    2434.0    2188.0    2021.0    1538.0    1516.0    1061.0     933.0     933.0
                    917.0     866.0     866.0     866.0     718.0     527.0     527.0     527.0     527.0     527.0
                    461.0     162.0     162.0     162.0     162.0     162.0     162.0     162.0     162.0     162.0
                    162.0     162.0     162.0     162.0     162.0     162.0     162.0     162.0     162.0     162.0
                    162.0

                                                                    ***

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

                       HYDROGRAPH AT STATION     SUB1

   TOTAL RAINFALL =    2.68, TOTAL LOSS =    1.93, TOTAL EXCESS =     .75

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
  (CFS)        (HR)
                         (CFS)
   4234.       6.08                1695.        432.        416.         416.
                       (INCHES)     .740        .754        .754         .754
                        (AC-FT)     841.        857.        857.         857.

                       CUMULATIVE AREA =   21.30 SQ MI

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


          **************
          *            *
 29 KK    *       CP2  *
          *            *
          **************
                         ROUTE SUB1 FROM CP1 TO CP2

             HYDROGRAPH ROUTING DATA

 31 RM           MUSKINGUM ROUTING
                      NSTPS          1 NUMBER OF SUBREACHES
                      AMSKK        .16 MUSKINGUM K
                          X        .25 MUSKINGUM X
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                                                                  ***

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

                      HYDROGRAPH AT STATION      CP2

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
   (CFS)       (HR)
                            (CFS)
   4167.       6.25                1695.        432.        416.         416.
                         (INCHES)    .740        .754        .754         .754
                          (AC-FT)    840.        857.        857.         857.

                         CUMULATIVE AREA =   21.30 SQ MI


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


          **************
          *            *
 32 KK    *      SUB2  *
          *            *
          **************
                         RUNOFF FROM SUBBASIN 2
                          THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                          L=      8.3  Lca=      4.0   S=   61.7  Kn= .049

             SUBBASIN RUNOFF DATA

 36 BA          SUBBASIN CHARACTERISTICS
                      TAREA       14.18  SUBBASIN AREA

                PRECIPITATION DATA

 37 PB                STORM        2.68  BASIN TOTAL PRECIPITATION

 16 PI            INCREMENTAL PRECIPITATION PATTERN
                      .01       .01       .01       .00       .00       .00       .01       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                      .03       .03       .04       .05       .04       .05       .05       .05       .04       .04
                      .04       .02       .02       .02       .02       .02       .02       .01       .01       .01
                      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                      .01       .01

 38 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .21  STARTING LOSS
                        DTH         .36  MOISTURE DEFICIT
                       PSIF        3.70  WETTING FRONT SUCTION
                      XKSAT         .51  HYDRAULIC CONDUCTIVITY
                      RTIMP       14.00  PERCENT IMPERVIOUS AREA
```

```
 38 UI          INPUT UNITGRAPH, 112 ORDINATES,  VOLUME = 1.00
                   391.0     391.0     391.0     391.0     391.0     676.0    1125.0    1289.0    1500.0    1792.0
                  2139.0    2342.0    2480.0    2666.0    2845.0    2962.0    3109.0    3333.0    3749.0    4214.0
                  4797.0    4507.0    3369.0    2929.0    2713.0    2534.0    2383.0    2309.0    2246.0    2142.0
                  2046.0    1962.0    1890.0    1827.0    1743.0    1657.0    1579.0    1522.0    1461.0    1343.0
                  1265.0    1216.0    1069.0    1035.0     981.0     958.0     935.0     900.0     900.0     822.0
                   818.0     771.0     643.0     643.0     643.0     521.0     500.0     500.0     500.0     467.0
                   429.0     429.0     429.0     429.0     385.0     300.0     300.0     300.0     300.0     300.0
                   300.0     298.0     192.0     192.0     192.0     192.0     192.0     192.0     192.0     192.0
                   192.0     192.0     191.0     127.0      75.0      75.0      75.0      75.0      75.0      75.0
                    75.0      75.0      75.0      75.0      75.0      75.0      75.0      75.0      75.0      75.0
                    75.0      75.0      75.0      75.0      75.0      75.0      75.0      75.0      75.0      75.0
                    75.0      75.0

                                                                  ***

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

                       HYDROGRAPH AT STATION     SUB2

   TOTAL RAINFALL =    2.68, TOTAL LOSS =    2.08, TOTAL EXCESS =     .60

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
   (CFS)       (HR)
                          (CFS)
+   1804.      5.58                814.        229.        221.        221.
                        (INCHES)    .534        .601        .601        .601
                         (AC-FT)    404.        455.        455.        455.

                        CUMULATIVE AREA =   14.18 SQ MI


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


           **************
           *            *
 51 KK     *       CP2  *
           *            *
           **************
                       COMBINE SUB1 + SUB2 AT CP2

 53 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

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

                       HYDROGRAPH AT STATION      CP2

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
   (CFS)       (HR)
                          (CFS)
+   5459.      6.17                2506.        661.        637.        637.
                        (INCHES)    .657        .693        .693        .693
                         (AC-FT)   1243.       1312.       1312.       1312.

                        CUMULATIVE AREA =   35.48 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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```
              **************
              *            *
 54 KK        *       CP3  *
              *            *
              **************
                              ROUTE (SUB1 & 2) FROM CP2 TO CP3

                 HYDROGRAPH ROUTING DATA

 56 RM             MUSKINGUM ROUTING
                        NSTPS         1 NUMBER OF SUBREACHES
                        AMSKK       .11 MUSKINGUM K
                            X       .25 MUSKINGUM X

                                                                  ***

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

                       HYDROGRAPH AT STATION      CP3

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+  (CFS)      (HR)
                         (CFS)
   5436.      6.25                2506.        661.        637.         637.
                        (INCHES)    .657        .693        .693         .693
                         (AC-FT)   1243.       1312.       1312.        1312.

                        CUMULATIVE AREA =   35.48 SQ MI

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

              **************
              *            *
 57 KK        *      SUB3  *
              *            *
              **************
                              RUNOFF FROM SUBBASIN 3
                               THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                               L=      9.3  Lca=      3.3   S=  131.3  Kn= .058

                 SUBBASIN RUNOFF DATA

 61 BA             SUBBASIN CHARACTERISTICS
                        TAREA       18.76  SUBBASIN AREA

                   PRECIPITATION DATA

 62 PB                  STORM        2.80  BASIN TOTAL PRECIPITATION

 16 PI               INCREMENTAL PRECIPITATION PATTERN
                        .01       .01       .01       .00       .00       .00       .01       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                        .03       .03       .04       .05       .04       .05       .05       .05       .04       .04
                        .04       .02       .02       .02       .02       .02       .02       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                        .01       .01

 63 LG             GREEN AND AMPT LOSS RATE
                        STRTL         .55  STARTING LOSS
                          DTH         .15  MOISTURE DEFICIT
                         PSIF        6.50  WETTING FRONT SUCTION
                        XKSAT         .13  HYDRAULIC CONDUCTIVITY
                        RTIMP        8.60  PERCENT IMPERVIOUS AREA
```

```
 63 UI          INPUT UNITGRAPH, 112 ORDINATES,  VOLUME = 1.00
                   518.0     518.0     518.0     518.0     518.0     894.0    1488.0    1705.0    1985.0    2370.0
                  2829.0    3099.0    3281.0    3527.0    3764.0    3919.0    4113.0    4410.0    4959.0    5575.0
                  6347.0    5962.0    4457.0    3875.0    3590.0    3352.0    3152.0    3055.0    2972.0    2834.0
                  2706.0    2596.0    2501.0    2417.0    2307.0    2193.0    2089.0    2014.0    1932.0    1777.0
                  1673.0    1609.0    1414.0    1369.0    1298.0    1267.0    1237.0    1191.0    1191.0    1087.0
                  1083.0    1019.0     851.0     851.0     851.0     689.0     662.0     662.0     662.0     618.0
                   567.0     567.0     567.0     567.0     509.0     397.0     397.0     397.0     397.0     397.0
                   397.0     394.0     253.0     253.0     253.0     253.0     253.0     253.0     253.0     253.0
                   253.0     253.0     253.0     168.0      99.0      99.0      99.0      99.0      99.0      99.0
                    99.0      99.0      99.0      99.0      99.0      99.0      99.0      99.0      99.0      99.0
                    99.0      99.0      99.0      99.0      99.0      99.0      99.0      99.0      99.0      99.0
                    99.0      99.0
                                                                    ***
     ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION     SUB3

   TOTAL RAINFALL =    2.80, TOTAL LOSS =    1.50, TOTAL EXCESS =    1.30

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
   5513.       5.58                2444.        657.        633.        633.
                       (INCHES)     1.211       1.302       1.302       1.302
                        (AC-FT)     1212.       1303.       1303.       1303.

                       CUMULATIVE AREA =   18.76 SQ MI

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

            **************
            *            *
 76 KK      *       CP3  *
            *            *
            **************
                         COMBINE (SUB1&2) + SUB3 AT CP3

 78 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                    ***

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

                       HYDROGRAPH AT STATION      CP3

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
   10040.      5.75                4949.       1318.       1269.       1269.
                       (INCHES)      .848        .904        .904        .904
                        (AC-FT)     2454.       2614.       2614.       2614.

                       CUMULATIVE AREA =   54.24 SQ MI

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

            **************
            *            *
 79 KK      *       CP4  *
            *            *
            **************
                         ROUTE SUB 1,2,&3 FROM CP3 TO CP4
```

```
            HYDROGRAPH ROUTING DATA

 81 RM          MUSKINGUM ROUTING
                     NSTPS         2 NUMBER OF SUBREACHES
                     AMSKK       .41 MUSKINGUM K
                         X       .25 MUSKINGUM X

                                                          ***
**** WARNING *****  POSSIBLE INSTABILITIES IN THE MUSKINGUM ROUTING FOR REACH     CP4.
     REDUCE NSTPS OR DECREASE YOUR COMPUTATION INTERVAL (FIRST FIELD OF THE IT RECORD).

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

                       HYDROGRAPH AT STATION      CP4

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
  (CFS)       (HR)
                         (CFS)
   9865.      6.25                4943.       1318.       1269.        1269.
                     (INCHES)      .847        .904        .904         .904
                      (AC-FT)     2451.       2614.       2614.        2614.

                      CUMULATIVE AREA =   54.24 SQ MI

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

          **************
          *            *
 82 KK    *      SUB4  *
          *            *
          **************
                         RUNOFF FROM SUBBASIN 4
                          THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                          L=      6.6  Lca=      3.8   S=   87.2  Kn= .047

            SUBBASIN RUNOFF DATA

 86 BA          SUBBASIN CHARACTERISTICS
                     TAREA       10.94  SUBBASIN AREA

                PRECIPITATION DATA

 87 PB               STORM        2.68  BASIN TOTAL PRECIPITATION

 16 PI            INCREMENTAL PRECIPITATION PATTERN
                     .01       .01       .01       .00       .00       .00       .01       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                     .03       .03       .04       .05       .04       .05       .05       .05       .04       .04
                     .04       .02       .02       .02       .02       .02       .02       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                     .01       .01

 88 LG          GREEN AND AMPT LOSS RATE
                     STRTL         .18  STARTING LOSS
                       DTH         .36  MOISTURE DEFICIT
                      PSIF        3.60  WETTING FRONT SUCTION
                     XKSAT         .55  HYDRAULIC CONDUCTIVITY
                     RTIMP       15.40  PERCENT IMPERVIOUS AREA
```

```
 88 UI          INPUT UNITGRAPH,  90 ORDINATES,  VOLUME = 1.00
                   376.0     376.0     376.0     376.0     723.0    1081.0    1413.0    1656.0    2061.0    2303.0
                  2477.0    2701.0    2852.0    3032.0    3423.0    3945.0    4652.0    3960.0    2956.0    2638.0
                  2435.0    2258.0    2188.0    2086.0    1969.0    1868.0    1786.0    1700.0    1587.0    1213.0
                  1441.0    1309.0    1222.0    1149.0     994.0     964.0     920.0     889.0     864.0     817.0
                   786.0     710.0     617.0     617.0     521.0     480.0     480.0     468.0     412.0     412.0
                   412.0     404.0     288.0     288.0     288.0     288.0     288.0     269.0     184.0     184.0
                   184.0     184.0     184.0     184.0     184.0     184.0     184.0      76.0      72.0      72.0
                    72.0      72.0      72.0      72.0      72.0      72.0      72.0      72.0      72.0      72.0
                    72.0      72.0      72.0      72.0      72.0      72.0      72.0      72.0      72.0      72.0
                                                                   ***

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

                      HYDROGRAPH AT STATION     SUB4

   TOTAL RAINFALL =    2.68, TOTAL LOSS =    2.07, TOTAL EXCESS =     .61

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
  (CFS)        (HR)
                          (CFS)
+   1581.      5.25                 647.        178.        171.         171.
                        (INCHES)    .550        .604        .604         .604
                         (AC-FT)    321.        352.        352.         352.

                        CUMULATIVE AREA =   10.94 SQ MI

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

           **************
           *            *
 99 KK     *      SUB5  *
           *            *
           **************
                         RUNOFF FROM SUBBASIN 5
                          THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                          L=      8.9  Lca=      4.1   S=  250.8  Kn= .060

             SUBBASIN RUNOFF DATA

103 BA          SUBBASIN CHARACTERISTICS
                      TAREA       19.92  SUBBASIN AREA

                PRECIPITATION DATA

104 PB                STORM        2.80  BASIN TOTAL PRECIPITATION

 16 PI            INCREMENTAL PRECIPITATION PATTERN
                     .01       .01       .01       .00       .00       .00       .01       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                     .03       .03       .04       .05       .04       .05       .05       .05       .04       .04
                     .04       .02       .02       .02       .02       .02       .02       .01       .01       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                     .01       .01

105 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .77  STARTING LOSS
                        DTH         .08  MOISTURE DEFICIT
                       PSIF        7.50  WETTING FRONT SUCTION
                      XKSAT         .09  HYDRAULIC CONDUCTIVITY
                      RTIMP       15.00  PERCENT IMPERVIOUS AREA
```

```
105 UI          INPUT UNITGRAPH, 109 ORDINATES,  VOLUME = 1.00
                   564.0     564.0     564.0     564.0     564.0    1119.0    1620.0    1956.0    2244.0    2595.0
                  3250.0    3439.0    3662.0    3927.0    4145.0    4358.0    4562.0    5076.0    5664.0    6449.0
                  7031.0    5540.0    4421.0    4014.0    3730.0    3500.0    3356.0    3266.0    3125.0    2981.0
                  2856.0    2747.0    2650.0    2540.0    2401.0    2275.0    2202.0    2114.0    1935.0    1823.0
                  1752.0    1529.0    1490.0    1404.0    1379.0    1334.0    1296.0    1277.0    1178.0    1178.0
                  1041.0     926.0     926.0     882.0     720.0     720.0     720.0     720.0     625.0     617.0
                   617.0     617.0     617.0     445.0     432.0     432.0     432.0     432.0     432.0     432.0
                   309.0     276.0     276.0     276.0     276.0     276.0     276.0     276.0     276.0     276.0
                   276.0     174.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0
                   108.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0
                   108.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0     108.0

                                                                   ***

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

                        HYDROGRAPH AT STATION     SUB5

   TOTAL RAINFALL =    2.80, TOTAL LOSS =    1.27, TOTAL EXCESS =    1.53

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                          (CFS)
   6655.       5.50                3028.        821.        791.         791.
                         (INCHES)  1.413       1.533       1.533        1.533
                          (AC-FT)  1501.       1629.       1629.        1629.

                         CUMULATIVE AREA =   19.92 SQ MI

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

            **************
            *            *
117 KK      *       CP4  *
            *            *
            **************
                           COMBINE (SUB1,2,&3) + SUB4 + SUB5 AT CP4

119 HC          HYDROGRAPH COMBINATION
                      ICOMP           3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                   ***

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

                        HYDROGRAPH AT STATION      CP4

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
  (CFS)       (HR)
                          (CFS)
.  16465.      5.92                8578.       2317.       2231.        2231.
                         (INCHES)   .937       1.012       1.012        1.012
                          (AC-FT)  4254.       4595.       4595.        4595.

                         CUMULATIVE AREA =   85.10 SQ MI

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

            **************
            *            *
120 KK      *       CP5  *
            *            *
            **************
                           ROUTE SUB1-5 FROM CP4 TO CP5
```

```
                HYDROGRAPH ROUTING DATA

122 RM            MUSKINGUM ROUTING
                        NSTPS          1 NUMBER OF SUBREACHES
                        AMSKK        .07 MUSKINGUM K
                            X        .25 MUSKINGUM X

                                                                  ***

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

                          HYDROGRAPH AT STATION      CP5

 PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR      24.92-HR
   (CFS)        (HR)
                            (CFS)
*  16449.       5.92                   8578.        2317.        2231.         2231.
                        (INCHES)       .937        1.012        1.012         1.012
                         (AC-FT)      4253.        4595.        4595.         4595.

                         CUMULATIVE AREA =   85.10 SQ MI
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
            **************
            *            *
123 KK      *      SUB6  *
            *            *
            **************
                           RUNOFF FROM SUBBASIN 6
                           THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
                           L=  6.26   Lca=  2.77   S=  269.6   Kn=  .057

                SUBBASIN RUNOFF DATA

127 BA            SUBBASIN CHARACTERISTICS
                        TAREA       11.31  SUBBASIN AREA

                  PRECIPITATION DATA

128 PB                  STORM        2.80  BASIN TOTAL PRECIPITATION

 16 PI              INCREMENTAL PRECIPITATION PATTERN
                        .01       .01       .01       .00       .00       .00       .01       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                        .03       .03       .04       .05       .04       .05       .05       .05       .04       .04
                        .04       .02       .02       .02       .02       .02       .02       .01       .01       .01
                        .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
                        .01       .01

129 LG            GREEN AND AMPT LOSS RATE
                        STRTL         .50  STARTING LOSS
                          DTH         .12  MOISTURE DEFICIT
                         PSIF        6.90  WETTING FRONT SUCTION
                        XKSAT         .11  HYDRAULIC CONDUCTIVITY
                        RTIMP       11.60  PERCENT IMPERVIOUS AREA

129 UI            INPUT UNITGRAPH,  77 ORDINATES,  VOLUME = 1.00
                     453.0     453.0     453.0     569.0    1303.0    1647.0    2010.0    2614.0    2845.0    3154.0
                    3399.0    3634.0    4177.0    4934.0    5517.0    3955.0    3276.0    2955.0    2716.0    2617.0
                    2442.0    2306.0    2184.0    2055.0    1901.0    1799.0    1679.0    1527.0    1409.0    1208.0
                    1154.0    1109.0    1048.0    1020.0     948.0     870.0     745.0     739.0     579.0     579.0
                     578.0     496.0     496.0     496.0     425.0     347.0     347.0     347.0     347.0     292.0
                     222.0     222.0     222.0     222.0     222.0     222.0     222.0     148.0      87.0      87.0
                      87.0      87.0      87.0      87.0      87.0      87.0      87.0      87.0      87.0      87.0
                      87.0      87.0      87.0      87.0      87.0      87.0      87.0
```

```
                                                                    ***
    ***             ***             ***             ***             ***
                       HYDROGRAPH AT STATION     SUB6

   TOTAL RAINFALL =    2.80, TOTAL LOSS =    1.32, TOTAL EXCESS =    1.48

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
  (CFS)        (HR)
                          (CFS)
   4684.       5.08                1732.        451.        434.         434.
                        (INCHES)   1.423       1.482       1.482        1.482
                         (AC-FT)    859.        894.        894.         894.

                        CUMULATIVE AREA =   11.31 SQ MI

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

           **************
           *            *
 138 KK    *       CP5  *
           *            *
           **************
                          COMBINE SUB1-5 + SUB6 AT CP5

 140 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                    ***

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

                       HYDROGRAPH AT STATION      CP5

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+  (CFS)        (HR)
                          (CFS)
  19572.       5.75                10286.       2767.       2666.        2666.
                        (INCHES)    .992       1.068       1.068        1.068
                         (AC-FT)   5100.       5489.       5489.        5489.

                        CUMULATIVE AREA =   96.41 SQ MI

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

           **************
           *            *
 141 KK    *     DWEST  *
           *            *
           **************
                          DIVERT 55% OF FLOW TO CP6, 45% TO CP8

    DT          DIVERSION
                       ISTAD       DEAST  DIVERSION HYDROGRAPH IDENTIFICATION

    DI             INFLOW          .00 100000.00

    DQ      DIVERTED FLOW          .00  45000.00

                                                                    ***

    ***             ***             ***             ***             ***
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                    DIVERSION HYDROGRAPH    DEAST

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
   8807.       5.75                4629.       1245.       1200.        1200.
                       (INCHES)      .446        .480        .480         .480
                        (AC-FT)     2295.       2470.       2470.        2470.

                       CUMULATIVE AREA =   96.41 SQ MI

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

                    HYDROGRAPH AT STATION    DWEST

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+  (CFS)       (HR)
                         (CFS)
  10765.       5.75                5657.       1522.       1466.        1466.
                       (INCHES)      .546        .587        .587         .587
                        (AC-FT)     2805.       3019.       3019.        3019.

                       CUMULATIVE AREA =   96.41 SQ MI

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

          **************
          *            *
 146 KK   *       CP6  *
          *            *
          **************
                        ROUTE DWEST FROM CP5 TO CP6 (FAN APEX)

             HYDROGRAPH ROUTING DATA

 148 RM        MUSKINGUM ROUTING
                     NSTPS         3 NUMBER OF SUBREACHES
                     AMSKK       .56 MUSKINGUM K
                         X       .25 MUSKINGUM X

                                                          ***
***** WARNING *****  POSSIBLE INSTABILITIES IN THE MUSKINGUM ROUTING FOR REACH     CP6.
     REDUCE NSTPS OR DECREASE YOUR COMPUTATION INTERVAL (FIRST FIELD OF THE IT RECORD).

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

                    HYDROGRAPH AT STATION      CP6

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
  (CFS)       (HR)
                         (CFS)
+  10549.       6.33                5647.       1522.       1466.        1466.
                       (INCHES)      .545        .587        .587         .587
                        (AC-FT)     2800.       3019.       3019.        3019.

                       CUMULATIVE AREA =   96.41 SQ MI
```

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	HYDROGRAPH AT									
+		SUB1	4234.	6.08	1695.	432.	416.	21.30		
	ROUTED TO									
		CP2	4167.	6.25	1695.	432.	416.	21.30		
	HYDROGRAPH AT									
		SUB2	1804.	5.58	814.	229.	221.	14.18		
	2 COMBINED AT									
+		CP2	5459.	6.17	2506.	661.	637.	35.48		
	ROUTED TO									
		CP3	5436.	6.25	2506.	661.	637.	35.48		
	HYDROGRAPH AT									
		SUB3	5513.	5.58	2444.	657.	633.	18.76		
	2 COMBINED AT									
+		CP3	10040.	5.75	4949.	1318.	1269.	54.24		
	ROUTED TO									
		CP4	9865.	6.25	4943.	1318.	1269.	54.24		
	HYDROGRAPH AT									
		SUB4	1581.	5.25	647.	178.	171.	10.94		
	HYDROGRAPH AT									
+		SUB5	6655.	5.50	3028.	821.	791.	19.92		
	3 COMBINED AT									
		CP4	16465.	5.92	8578.	2317.	2231.	85.10		
	ROUTED TO									
		CP5	16449.	5.92	8578.	2317.	2231.	85.10		
	HYDROGRAPH AT									
+		SUB6	4684.	5.08	1732.	451.	434.	11.31		
	2 COMBINED AT									
		CP5	19572.	5.75	10286.	2767.	2666.	96.41		
	DIVERSION TO									
		DEAST	8807.	5.75	4629.	1245.	1200.	96.41		
	HYDROGRAPH AT									
+		DWEST	10765.	5.75	5657.	1522.	1466.	96.41		
	ROUTED TO									
		CP6	10549.	6.33	5647.	1522.	1466.	96.41		

** NORMAL END OF HEC-1 ***

APPENDIX H

USBR
Nov. 1974

HYDROLOGIC DESIGN DATA
FOR
TIGER DETENTION BASIN
REACH 5, GRANITE REEF AQUEDUCT

Reach 5 begins at the outlet of Centenial Wash Siphon and extends about 18.7 miles to the outlet of Burnt Mountain Tunnel.

Tiger Detention Basin will parallel the initial 6.2 miles of Reach 5, between the outlet of Centenial Wash Siphon and a point west of the Buckeye - Salome Road. The remaining 12.1 miles of canal between Buckeye - Salome Road and the inlet to Burnt Mountain Tunnel will be located adjacent to the proposed Harquahala Dike (S.C.S.). Cross drainage for that segment will be established by the dike outlets. Final locations and capacities for Harquahala Dike outlets are presently undetermined.

Tiger Detention Basin, as proposed, will have uncontrolled pipe outlets and an end-around spillway all discharging into Centenial Wash above the project siphon.

Tiger Dike will traverse a gently sloping bajada plain characterized by a network of braided channels with indefinite drainage boundaries. Slopes immediately above the aqueduct route average 0.0051 or 27 ft/mile.

<u>Drainage Basin</u>— Total drainage area above the detention basin is about 166 square miles. Tiger Wash accounts for 120 square miles or 72 percent of the total drainage.

The watershed heads in the Harquahala Mountains, about 23.1 stream miles above the aqueduct route. The mean slope of the stream channel is 78 feet per mile. The centroid of the drainage is about 12.2 stream miles above the proposed dike.

Ravines in the exposed pediments become an erratic network of braided channels in the higher alluvial fans. At the aqueduct route the channels are practically nonexistent, indicating sheet runoff for significant flood events. An overall friction factor of 0.050 (Manning) is indicated.

Alluvial fans and washes account for about 62 percent of the total drainage above the proposed dike. Surface geology and related hydrologic constants are summarized in the following tabulation:

Material	Area		Runoff Curve No.		Sed. Factor
	mi^2	%	II	III	Cs
Andesite KTv	2	1	98	99	0.5
Gneiss gn	40	24	95	98	1.0
Schist sch	10	6	95	98	1.0
Laramine Lgr	7	4	70	85	3.0
Shale Cm	5	3	70	85	2.0
Fans Qfp	102	62	65	82	–
Total	166	100	75	87	0.93

Design Storm - General type, 6-hour storms were used in sizing studies for Tiger Detention Basin. A 3-hour thunderstorm analyzed for spillway design was found to produce less peak and volume than the general type storm due to the 100 square mile limitation on effective area for thunderstorms. Design storm data are presented in Table 1.

Table 1. Design Storms for Tiger Detention Basin, Reach 5

Hour	Percent Inc'l	Percent Acc'l	Recurrence Interval 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Spillway Design
1	11	11	0.12	0.17	0.20	0.25	0.29	0.32	0.39
2	13	24	0.27	0.37	0.44	0.55	0.63	0.69	0.85
3	16	40	0.45	0.62	0.74	0.91	1.06	1.15	1.42
4	30	70	0.79	1.09	1.30	1.60	1.85	2.02	2.48
5	18	88	1.00	1.37	1.63	2.01	2.33	2.54	3.12
6	12	100	1.33	1.56	1.85	2.29	2.64	2.88	3.55
6-hour Point Ppt.			1/ 1.33	1/ 1.83	1/ 2.18	1/ 2.69	1/ 3.11	1/ 3.39	2/ 4.18

Inches:

1/ Precipitation Charts for Arizona, Weather Bureau, March 1967.

2/ Max. probable ppt from Fig 17 Design of Small Dams
Reduction Factor 2.4 from Fig 23 Design of Small Dams.
$5.90 \times (2.4+1) \div 2(2.4) = 4.18$

Point precipitation for the centroid of the drainage area ($\phi = 33°46'$, $\lambda = 113°16'$) was obtained from isohyetal charts. An areal reduction factor of 0.85 was applied to obtain total storm precipitation for the 166 square mile drainage area.

Maximum probable 6-hour precip. for the centroid of the drainage area was found to be 5.90 inches. That value was reduced by a factor of 0.71 to reflect hazard conditions where safety is not a primary consideration.

<u>Lag Time</u> - Lag time was estimated to be 9.5 hours using the relationship;

$$L_g = 24\,\bar{n}\left(\frac{L \cdot L_{ca}}{S^{1/2}}\right)^{0.38}$$

where:

L_g is lag time in hours

$\bar{n}$ is ave. channel friction (Manning) = 0.050

L is channel length to headwaters = 23.1 miles

L_{ca} is channel length to centroid = 12.2 miles

S is average channel slope = 78 ft/mile

Runoff Hydrographs - A one-hour unit hydrograph was prepared for the 166 square mile drainage area using the Paradise Valley Dimensionless Graph (Table 2). Runoff hydrographs were prepared for precipitation excess of each storm using the one-hour graph. A wet antecedent condition was assumed for the spillway design storm. A moist antecedent condition was assumed for the remaining storms. Tables 3-A through 3-G present runoff computation.

Sedimentation - Sediment deposition in Tiger Detention Basin is estimated to be 1150 acrefeet for a 100-year period. The total sediment load for the basin was computed to be 2214 acrefeet using the relationship;

$$Q_S = C_S A^{0.771}$$ where:

Q_S is the annual sediment load in acrefeet.

A is the drainage area in sq. mi. = 166

C_S is the geologic factor for the basin = 0.43

Trap efficiency was estimated to be 52% using the relationship:

$$\text{efficiency} = 100 - \left(10 - \log_{10} \frac{C^2}{I^2 L}\right)^{2.65}$$

where:

C is average reservoir content in ft^3

I is average inflow in c.f.s.

L is reservoir length in feet.

For detention basins:

① Use one half of the 100-year flood for C, $C = 1.70 \times 10^8$

② Use average discharge of the 100-yr flood for I, $I = 4.89 \times 10^3$

③ Use depth ÷ slope for L, $L = 2.94 \times 10^3$

The 100-year depth of sediment at the dike is estimated to be 2.0 feet using the formulae for parabolic distribution:

$$d = \frac{4 Q_s \cdot eff}{W \cdot L}$$

where:

Q_s is 100 year sediment load

W is basin width (dike length)

L is reservoir length. ($d_w = 15$ ft)

Flood Routing Studies - Routing studies were prepared using various combinations of outlets and spillway channels to achieve the following maximum water surface elevations:

(1) Routed 100-year flood _____ 1405±

(2) Combined 100-year flood and spillway design flood, routed _____ 1410±

The Puls method, modified for tabular interpolation, was used for all routing studies. Table 4 presents computations of storage capacity, sedimentation, outflow and combined functions for the basin with double 72 inch pipe outlets. Table 5 is an expansion of Table 4 including spillway discharge functions for an 800 foot spillway.

Routings of 2-year through 100-year floods were begun with the detention basin empty. Routing of the spillway design flood was begun with the basin at the 24-hour

stage of the 100-year flood routing, somewhat below the elevation of the spillway crest. Tables 6A - 6G

Routing data for floods having various recurrence intervals are summarized below:

Flood Frequency	Inflow		Maximum Water Surface Elevation	Outflow	
	Peak cfs	Volume AF	feet	Max cfs	Duration hours
2-year	2100	975	1398.3	980	20
5-year	2900	1660	1399.3	1040	22
10-year	4700	2750	1400.9	1125	33
25-year	8000	4690	1402.6	1210	52
50-year	11100	6460	1404.1	1280	69
100-year	13500	7790	1404.9	1320	81
Spillway Design	32000	27300 1/	1409.9	14300	128 2/

1/ Including Volume of Preceeding 100-year flood
2/ Including 25 hours of Preceeding 100-year flood.

INPUT DATA FOR FLOOD ROUTING
HAYDEN-RHOADES AQUEDUCT REACH 5A

STATION	STRUCT. TYPE	SIZE	INVERT ELEV.	CREST ELEV.	STORAGE CAPACITY DATA ELEV.	AC.FT	ELEV.	AC.FT.
100+00	Dike		1390.0	1413.0	1397	0	1398	168
	2-72" Pipe over Centennial				1400	816	1402	2580
	Wash Siphon.				1404	4831	1406	7765
					1408	11302	1410	15428

INPUT DATA FOR UNIT HYGROGRAPHS
HAYDEN-RHODES AQUEDUCT - REACH 5A

STATION	AREA Sq.Mi.	GRAPH SCS/PV	CHANNEL Miles	CENTROID Miles	SLOPE ft/mi.	CURVE No.	PRECIPITATION 100-yr	50-yr	3-hr
Dike	166	PV	23.1	12.2	78	75	2.88	2.64	

Summary Sheet

TIGER DETENTION BASIN
Reach 5 of Granite Reef Aqueduct
Mile 0.0 to mile 6.25

Dike:

Average height, feet	18.0
Side slopes	3:1
Top width, feet	14.0

Locations:

<u>West end section</u> - along section line 21/22, T.3 N., R.11 W. between elevations 1390 and 1405 feet, about 9,000 feet in length.

<u>Main section</u> - centerline located 141 feet or more north of canal centerline. About 33,000 feet in length.

<u>East end section</u> - along N-S line about 1/4 mile east of section line 21/22, T.3 N., R.10 W. between elevations 1395 and 1413 feet, about 3,000 feet in length.

<u>Outlets</u> - Two 72 inch pipes through the West end section at 1390 feet elevation. About 150 feet in length.

<u>Spillway</u> - End around overflow channel 800 feet wide located at north end of West end section, at elevation 1405 feet.

Elevations:

Lowest point of basin, West end	1390 -
Average centerline of dike	1395
100-yr sediment at dike	1397
Spillway crest	1405
Dike crest	1413

FLOOD CONTROL DISTRICT
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ADMIN		LM'GT	
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C & O		SDW	
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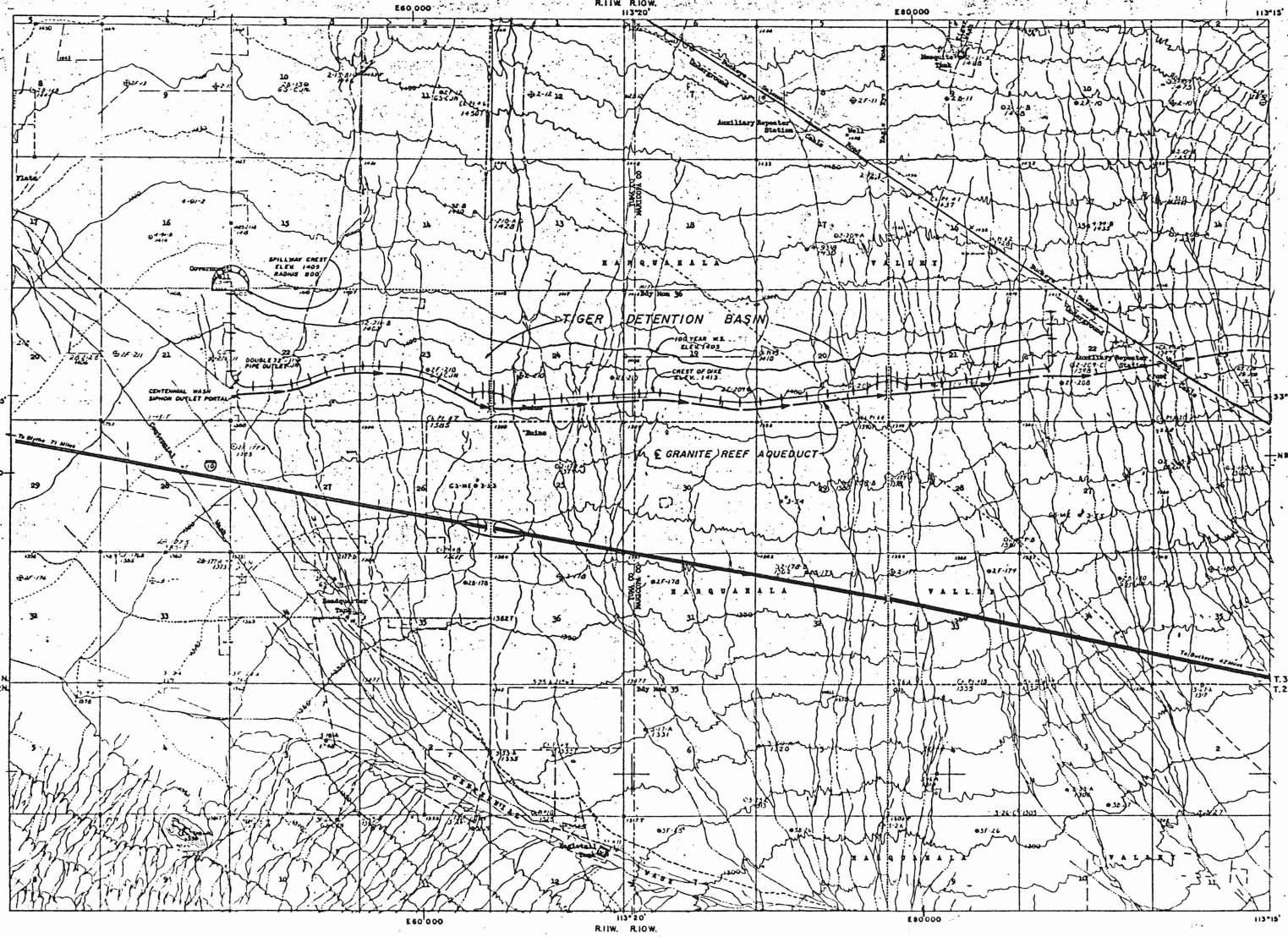
REMARKS



EXPLANATION

- Bridge
- Dike
- Drainage Inlet
- Proposed Canal

NOTE

Arizona state plane coordinates, central zone.

- Base map is a composite of the advance U.S. Geological Survey 7.5 minute quadrangle sheets LONE MTN. SE & SW, ARIZONA.

2000 0 2000 4000 6000
SCALE OF FEET

Contour Interval 10 Feet.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION—ARIZONA

GRANITE REEF AQUEDUCT

REACH 5A
PROTECTIVE WORKS

DESIGNED _____ SUBMITTED _____
DRAWN T.O.M.A. RECOMMENDED _____
CHECKED _____ APPROVED _____

PHOENIX, ARIZONA NOV., 1974 344-330-1124