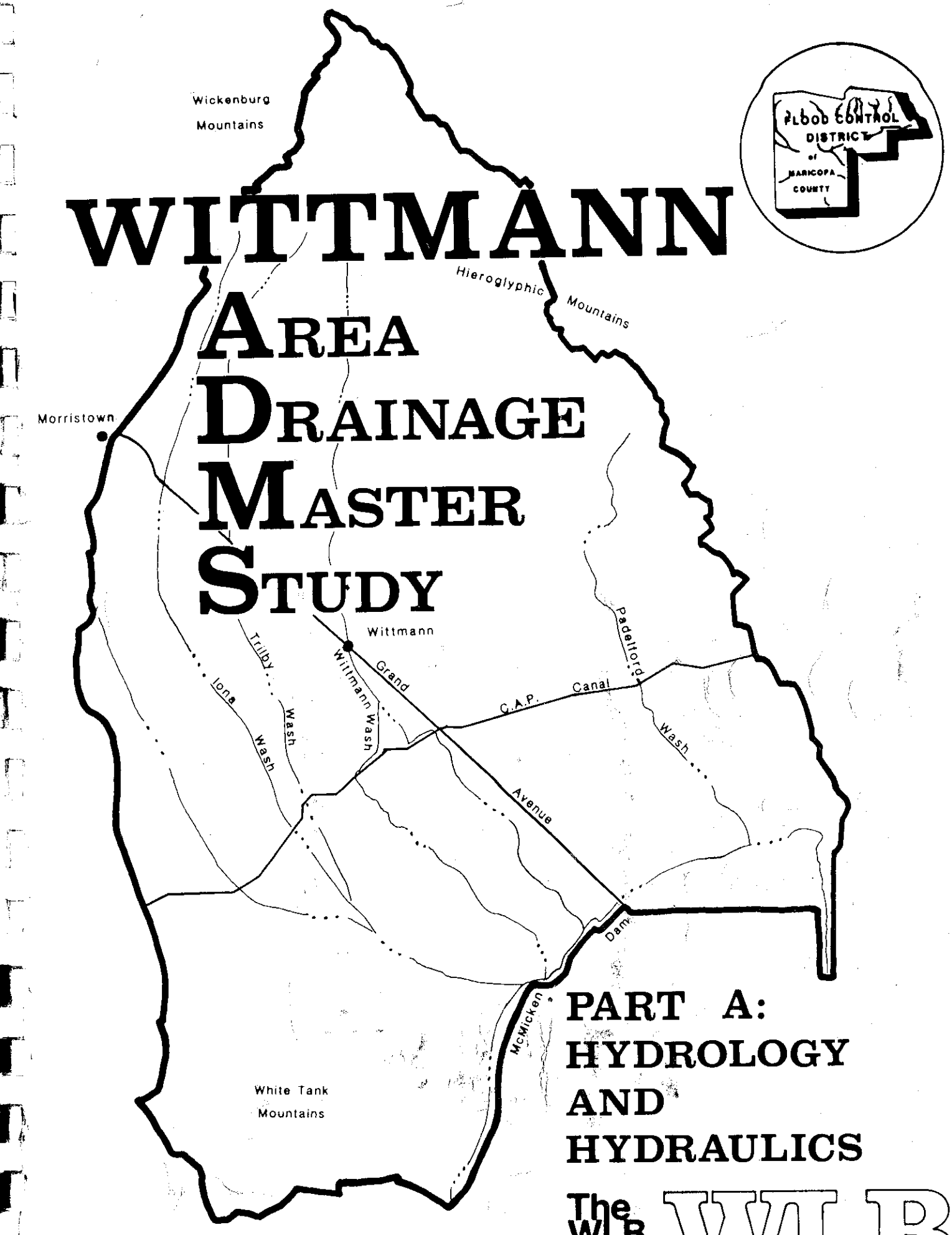

WITTMANN AREA DRAINAGE MASTER STUDY

PART A: HYDROLOGY AND HYDRAULICS

The WLB Group Inc.

The WLB Group Inc.

WITTMANN AREA DRAINAGE MASTER STUDY

Part A: Hydrology and Hydraulics

PREPARED FOR

The Flood Control District
of Maricopa County

March 10, 1989

PREPARED BY

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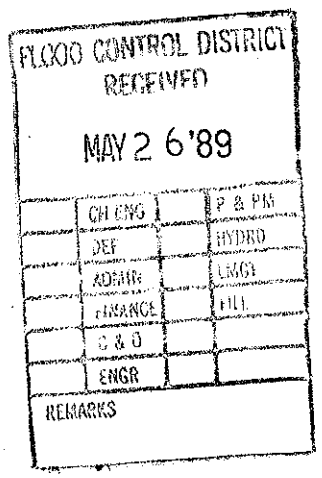

The WLB Group Inc.

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The WLB Group Inc.

LIST OF EXHIBITS

1.0 INTRODUCTION

The Wittmann Area Drainage Master Study (ADMS) covers the largely undeveloped 322 square mile basin that drains to McMicken Dam and the McMicken Dam Outlet Channel. It is one of a number of basin-wide master drainage studies that are being carried out by the Flood Control District of Maricopa County. The purpose of these studies is to identify existing drainage problems and to plan for future development and stormwater management.

This study includes the development of a rainfall-runoff model for the entire 322 square mile study area using the Corps of Engineers HEC-1 computer program. The area was divided into over 200 subbasins in order to derive flood hydrographs for a series of locations throughout the basin. The resulting 100-year peak discharges were used to delineate floodplains for approximately 90 stream miles in areas that are considered prone for development.

The results of the Wittmann Area Drainage Master Study are published as two separate reports. This report, Part A: Hydrology and Hydraulics, summarizes the results of the hydrology study and explains the methods and assumptions used in developing the hydrologic model. In addition, the basic assumptions and methodology used to define the floodplains and floodways are covered in this report.

The second report, Part B: Stormwater Management Plans, addresses future development and identifies existing drainage problems in the study area. Included are solutions for each identified drainage problem along with cost estimates.

WITTMANN ADMS

STUDY AREA MAP

LEGEND

- DRAINAGE AREA BOUNDARY
- C.A.P. CANAL
- CONCRETE PIPE OVERCHUTE
- CONCRETE OVERCHUTE
- BRIDGE

0 1000' 2000' 4000' 8000'

The WLB Group WLB

R 4 W — R 3 W — R 2 W — R 1 W

T 8 N — T 7 N — T 6 N — T 5 N — T 4 N — T 3 N

WICKENBURG MOUNTAINS
YAVAPAI COUNTY
MARICOPA COUNTY
BITTER CREEK
HIEROGLYPHIC MOUNTAINS
GRAND AVE.
A. T. & S. F. R.R.
MORRISTOWN
TRILBY WASH
IONA WASH
MORRISTOWN HIGHWAY (S.R. 74)
CIRCLE CITY
CHRYSLER PROVING GROUNDS
DOVE VALLEY RD.
WITTMANN
CROZIER RD.
PATTON RD.
203rd AVE.
PADELFORD
C.A.P. CANAL
WASH
BUNKER PEAK
LAKE BONITA
JOMAX RD.
LUKE A.F.B. AUXILIARY FIELD #1
HAPPY VALLEY ROAD
LUKE A.F.B. AUXILIARY FIELD #2
163rd AVE.
BEARDSLEY CANAL
MCMICKEN DAM OUTLET CHANNEL
MCMICKEN DAM OUTLET WASH
195th AVE.
PINNACLE PEAK ROAD
TRILBY WASH
DEER VALLEY ROAD
NORTHWEST LANDFILL
BASIN
SARIVAL AVE.
REEMS RD.
BULLARD AVE.
LITCHFIELD RD.
DYSART RD.
MCMICKEN DAM OUTLET RIVER
BEARDSLEY RD.
COTTON LN.
BEARDSLEY
ATCHISON, TOPEKA & SANTA FE RAILROAD (U.S. 60 & U.S. 89)
SUN CITY WEST
SUN VALLEY PARKWAY
UNION HILLS DR.
CITRUS RD.
SURPRISE
EL MIRAGE RD.
AGUA FRIA
BELL RD.
GREENWAY RD.
WHITE TANK MOUNTAINS
WADDELL RD.
CACTUS RD.
PERRYVILLE RD.
PEORIA AVE.
OLIVE AVE.
JACKRABBIT RD.
MCMICKEN DAM
TRILBY WASH

1.1 Scope of Work

Data Search

The first task was to assemble available information and data that pertained to the study area. Various agencies were involved in the process of determining existing flooding problems and providing information. A list of these agencies are as follows:

Flood Control District of Maricopa County (FCDMC)
Maricopa County Highway Department (MCHD)
Maricopa County Planning Department (MCPD)
United States Bureau of Reclamation (USBR)
Arizona Department of Transportation (ADOT)
Arizona Department of Water Resources (ADWR)
Atchison, Topeka & Santa Fe Railway (AT&SF)
Maricopa Water District (MWD)
U.S. Army Corps of Engineers (COE)
Federal Emergency Management Agency (FEMA)

Studies, plans, and other background information are listed in the References section at the end of this report.

Topographic Mapping

The following detailed topographic mapping was prepared as part of this study.

A. Morristown Highway

Coverage: Community of Morristown to the eastern study boundary

Scale: 1" = 400'

Contour Interval: 4'

B. Circle City (Aerial Photograph Background)

Coverage: Section 33 and the E 1/2 Section 32, T6N, R3W.

Scale: 1" = 200'

Contour Interval: 2'

C. Wittmann (Aerial Photograph Background)

Coverage: Section 13 and the S 1/2 of Section 12, T5N, R3W.

Scale: 1" = 200'

Contour Interval: 2'

D. Grand Avenue (Aerial Photograph Background)

Coverage: Community of Morristown to the Beardsley Canal.

Scale: 1" = 400'

Contour Interval: 2'

E. Trilby Wash

Coverage: Central Arizona Project (CAP) Canal to McMicken Dam

Scale: 1" = 200'

Contour Interval: 2'

F. McMicken Dam Outlet Wash

Coverage: McMicken Dam Outlet Channel to the Agua Fria River.

Scale: 1" = 200'

Contour Interval: 2'

G. Area at the CAP Canal and Patton Road

Coverage: 2 mile stretch on the north side of the CAP Canal west of Grand Avenue.

Scale: 1" = 400'

Contour Interval: 2'

H. Area between the CAP Canal and McMicken Dam

Coverage: All washes downstream of the CAP overchutes to McMicken Dam and Outlet Channel.

Scale: 1" = 400'

Contour Interval: 4'

I. Wittmann Wash

Coverage: Community of Wittmann to the CAP Canal

Scale: 1" = 400'

Contour Interval: 2'

Elevation reference marks are designated on this mapping and descriptions can be found in Appendix B.

Hydrologic Model

A HEC-1 computer model was developed for the Wittmann ADMS to compute peak discharges and volumes for the 2, 5, 10, 50 and 100-year floods plus the Standard Project Flood (SPF) and Probable Maximum Flood (PMF). Hydrologic storage routing was performed for the wash crossings on the AT&SF Railroad and Grand Avenue; the overchutes on the CAP Canal; the wash crossings on the Beardsley Canal, and McMicken Dam.

Delineations of Floodplains, Floodways and Ponding Areas

Floodplains and floodways were computed for Trilby Wash from the CAP Canal to McMicken Dam and for the wash from the McMicken Dam Outlet Channel to the Agua Fria River along the east side of Sun City West. In addition, floodplains and floodways were computed in the communities of Wittmann and Circle City. Wittmann Wash was delineated from the CAP Canal to the unincorporated community of Wittmann.

Floodplains were also delineated on 22 washes downstream of the CAP Canal overchutes from the CAP Canal to McMicken Dam and Outlet Channel.

Ponding areas for the 100-year flood were defined behind McMicken Dam; Beardsley Canal; Atchison, Topeka and Santa Fe Railway; Morristown Highway; and the CAP Canal. Further, the ponding area for the Standard Project Flood was delineated behind McMicken Dam.

Floodplain delineations were prepared by approximate methods for Trilby Wash, Iona Wash and Padelford Wash between Morristown Highway and the CAP Canal. In addition, the floodplain for the McMicken Dam Outlet Channel was delineated using approximate methods.

1.2 Study Area and Prominent Features

The drainage area for the Wittmann ADMS is approximately 322 square miles and is that area which drains to McMicken Dam and Outlet Channel. The basin is bounded on the south by McMicken Dam and the White Tank Mountains; on the west by the ridge line between the Agua Fria River and the Hassayampa River basins; on the north by the Wickenburg and Hieroglyphic Mountains; and by a ridge line in the mountains on the east (see Study Area Map).

The communities of Wittmann and Circle City are located within the study area and Sun City West is located at the southeastern corner. In addition, the community of Morristown is located on the western study boundary and a portion of the northern part of the Town of Surprise is located in the study area near Grand Avenue and McMicken Dam.

Some of the prominent features in the study area are the CAP Canal, McMicken Dam and the Outlet Channel, Beardsley Canal, Bunker Peak, Lake Bonita, the White Tank Mountains, the Hieroglyphic Mountains, the Wickenburg Mountains, Luke Air Force Base Auxiliary Field Number 2 (closed), Luke Air Force Base Auxiliary Field Number 1, the Sun Valley Parkway, Northwest Landfill, Chrysler Proving Grounds, Trilby Wash, Iona Wash, Padelford Wash, Me Wash and Picacho Wash. (Refer to Study Area Map).

The Estrella Freeway is in the planning stage at this time. There is an alternative alignment for the proposed freeway that is located in the study area, north of Beardsley Canal, between Grand Avenue and the Agua Fria River. This alignment would cross several major washes and therefore the more likely alignment is south of McMicken Dam Outlet Channel where it would be protected from flooding.

R 4 W — R 3 W — R 2 W — R 1 W

T 8 N — T 7 N — T 6 N — T 5 N — T 4 N — T 3 N

WICKENBURG MOUNTAINS

YAVAPAI COUNTY
MARICOPA COUNTY

BITTER CREEK

HIEROGLYPHIC MOUNTAINS

DRAINAGE AREA BOUNDARY

GRAND AVE.

A. T. & S.F. R.R.

MORRISTOWN

S.U. MOBILE HOME PARK

C-2

S.U. AUTO PARK

KONA

S.U. AMUSEMENT PARK

R-3
R-5
C-2
R1-6

CIRCLE CITY

S.U. CHRYSLER PROVING GROUNDS

R-5
C-2

WITTMANN

R1-6
C-2

S.U. EXPERIMENTAL FACILITY

R-5
C-2

R1-6

IND -1

CROZER RD.

203rd AVE.

PATTON RD.

S.U. MICROWAVE RECEIVER/ TRANSMITTER

S.U. MOBILE HOME PARK

C-2

JOMAX RD.

PADELFORD

C.A.P. CANAL

WASH

BUNKER PEAK

LAKE BONITA

JOMAX RD.

HAPPY VALLEY ROAD

LUKE A.F.B. AUXILIARY FIELD #2

163rd AVE.

S.U. TRAVEL TRAILER PARK

C-2

BEARDSLEY

CANAL

CHANNEL

DAM OUTLET

C-2

PINNACLE PEAK ROAD

C.A.P. CANAL

TRILBY

195th AVE.

DEER VALLEY

NORTHWEST LANDFILL

WASH

BASIN

SARIVAL AVE.

REEMS RD.

BULLARD AVE.

LITCHFIELD RD.

DYSART RD.

AGUA FRIA RIVER

BEARDSLEY RD.

COTTON LN.

UNION HILLS DR.

CITRUS RD.

McMICKEN DAM

BELL RD.

ATCHISON TOPEKA & SANTA FE RAILROAD
GRAND AVENUE (U.S. 60 & U.S. 89)

SUN CITY WEST

EL MIRAGE RD.

GREENWAY RD.

WADDELL RD.

CACTUS RD.

PEORIA AVE.

OLIVE AVE.

JACKRABBIT RD.

PERRYVILLE RD.

WHITE TANK MOUNTAIN REGIONAL PARK

WHITE TANK MOUNTAINS

DRAINAGE AREA BOUNDARY

0' 1000' 2000' 4000' 8000'

The WLB Group WLB

CURRENT LAND USE

WITTMANN ADMS

LEGEND

- COUNTY PARK AND OUTDOOR RECREATION AREA
- BLM LAND
- STATE LAND
- ZONING CLASSIFICATION OTHER THAN R1-43
- MILITARY RESERVATIONS AND WITHDRAWLS
- ZONING CLASSIFICATION R-5

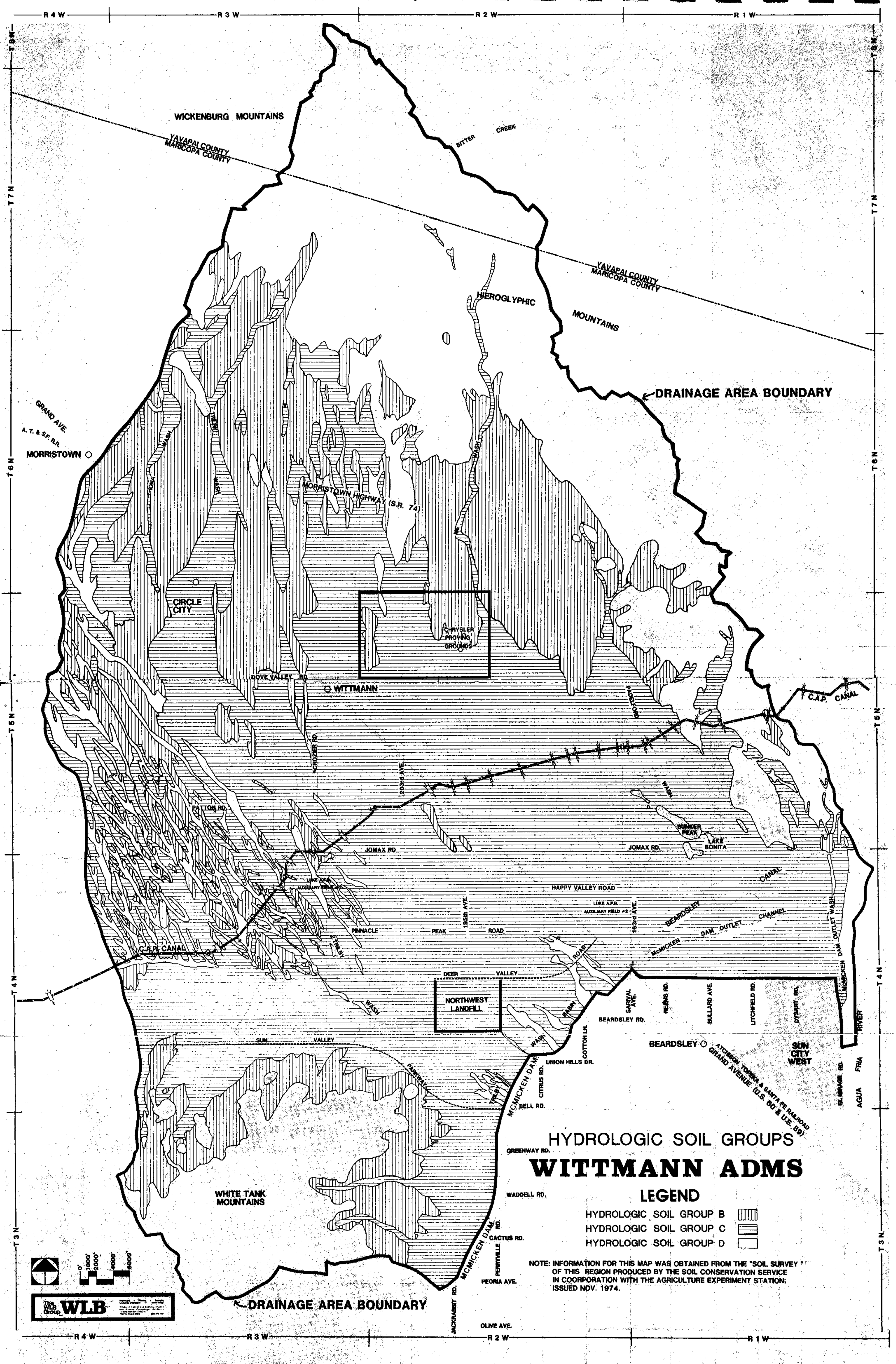
2.0 EXISTING CONDITIONS

2.1 Drainage Characteristics

The majority of the study area drains south to southeast toward McMicken Dam and the McMicken Dam Outlet Channel except for the White Tank Mountains area which drain northeast to Trilby Wash or east to McMicken Dam. The vast majority of the study area is undeveloped with some scattered housing below the CAP Canal and strip commercial development along Grand Avenue. In addition, there are the unincorporated residential areas of Circle City and Wittmann.

The drainage area covers a wide range of slopes from mountainous areas with slopes greater than 10% to alluvial fans with slopes of 1.5% to 10% to flat desert regions with slopes ranging from .3% to 1.5%.

Hydrologic soil groups in the Wittmann area are classified as B, C, and D, which correspond to lower desert, alluvial fan, and mountainous areas respectively. Soil group B is a porous soil including sand, silt and loam. Soil group C is less porous and includes clay, loam and rocks. Soil group D is generally not very course and is usually a rocky type ground with some gravel. These soil groupings were classified by the Soil Conservation Service and are found in their Soil Survey Maps (References 26 and 27).


HYDROLOGIC SOIL GROUPS
WITTMANN ADMS
LEGEND
HYDROLOGIC SOIL GROUP B
HYDROLOGIC SOIL GROUP C
HYDROLOGIC SOIL GROUP D
NOTE: INFORMATION FOR THIS MAP WAS OBTAINED FROM THE "SOIL SURVEY" OF THIS REGION PRODUCED BY THE SOIL CONSERVATION SERVICE IN COORPORATION WITH THE AGRICULTURE EXPERIMENT STATION; ISSUED NOV. 1974.
R 4 W
R 3 W
R 2 W
R 1 W
T 8 N
T 7 N
T 6 N
T 5 N
T 4 N
T 3 N
WICKENBURG MOUNTAINS
YAVAPAI COUNTY
MARICOPA COUNTY
BITTER CREEK
HIEROGLYPHIC MOUNTAINS
DRAINAGE AREA BOUNDARY
GRAND AVE.
A. T. & S.F. R.R.
MORRISTOWN
IONA WASH
TRILBY WASH
MORRISTOWN HIGHWAY (S.R. 74)
CIRCLE CITY
CHRYSLER PROVING GROUNDS
DOVE VALLEY RD.
WITTMANN
CROZIER RD.
203rd AVE.
PATTON RD.
JOMAX RD.
LUKE A.F.B. AUXILIARY FIELD #1
PINNACLE PEAK ROAD
195th AVE.
C.A.P. CANAL
TRILBY WASH
DEER VALLEY ROAD
NORTHWEST LANDFILL
SUN VALLEY PARKWAY
WHITE TANK MOUNTAINS
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163rd AVE.
BEARDSLEY CANAL
McMICKEN DAM OUTLET CHANNEL
McMICKEN DAM OUTLET WASH
SARIVAL AVE.
REEMS RD.
BULLARD AVE.
LITCHFIELD RD.
DYSART RD.
BEARDSLEY RD.
BASIN
WASH
COTTON LN.
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CITRUS RD.
BELL RD.
TRILBY
GREENWAY RD.
WADDELL RD.
CACTUS RD.
PERRYVILLE RD.
PEORIA AVE.
JACKRABBIT RD.
OLIVE AVE.
0' 1000' 2000' 4000' 6000'
The WLB Group
DRAINAGE AREA BOUNDARY

The mountainous regions have a large variety of desert vegetation composed primarily of cacti species, creosote bushes, mesquite trees, and palo verde trees. Cover density is approximately 30 to 40 percent. The alluvial fans also have a variety of desert brush and cactus. Palo verde, mesquite and other large desert trees heavily vegetate the sides and banks of the washes. Cover density is approximately 20 to 30 percent outside of the washes. The flat desert regions are sparsely vegetated except along the washes where large desert trees and desert brush grow. Generally the cover density outside of the washes is 10 to 20 percent.

2.2 Existing Drainage Systems

The watershed has many natural washes that convey stormwater runoff to McMicken Dam. Morristown Highway, the AT&SF Railroad, and Grand Avenue have culverts and bridges at nearly every wash crossing. Refer to the hydrology model and Drainage Area Map for sizes and locations. The following are descriptions of the major existing drainage structures.

CAP Canal

The CAP Canal has a number of overchutes to convey flows across it. East of Grand Avenue, it acts as a dam with a series of 17, 72-inch diameter pipe overchutes that release the stormwater across the CAP Canal. West of Grand Avenue, large concrete overchute structures convey flows across the CAP at 5 major wash locations including Trilby and Iona Wash. The following table describes the locations of the overchutes in their respective order east and west of Grand Avenue along with their corresponding sizes. For example, CAP4EAST is the fourth overchute east of Grand Avenue.

Location	Description
CAP1EAST (CAP Sta. 36+12, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP2EAST (CAP Sta. 52+80, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP3EAST (CAP Sta. 85+70, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP4EAST (CAP Sta. 119+70, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP5EAST (CAP Sta. 159+70, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP6EAST (CAP Sta. 180+50, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP7EAST (CAP Sta. 190+60, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP8EAST (CAP Sta. 216+80, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP9EAST (CAP Sta. 240+00, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP10EAST (CAP Sta. 253+00, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP11EAST (CAP Sta. 272+35, REACH 9)	3 - 72" Dia. Pipe Overchute
CAP12EAST (CAP Sta. 279+00, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP13EAST (CAP Sta. 298+70, REACH 9)	1 - 72" Dia. Pipe Overchute
CAP14EAST (CAP Sta. 315+00, REACH 9)	3 - 72" Dia. Pipe Overchute
CAP15EAST (CAP Sta. 342+40, REACH 9)	1 - 72" Dia. Culvert
CAP16EAST (CAP Sta. 376+80, REACH 9)	4DBL 84" Dia. Culvert
CAP17EAST (CAP Sta. 433+85, REACH 9)	1 - 72" Dia. Culvert
CAP1WEST (CAP Sta. 804+50, REACH 8)	67'-6" x 8'-6" Overchute
CAP2WEST (CAP Sta. 688+00, REACH 8)	87'-2" x 6'-6" Overchute
TRILBY (CAP3WEST) (CAP Sta. 609+00, REACH 8)	135'-10" x 8'-6" Overchute
IONA (CAP4WEST) (CAP Sta. 572+50, REACH 8)	47'-4" x 7'-0" Overchute
CAP5WEST (CAP Sta. 466+00, REACH 8)	67'-0" x 9'-6" Wash Siphon

Circle City

Circle City's drainage system consists of a man-made channel that collects and conveys stormwater along the east side of the community. This channel crosses the entrance into Circle City in a roadway dip section that interrupts traffic during floods.

Wittmann

There is a divided wash that flows through the community of Wittmann (Wittmann Wash). Six 48" concrete pipe culverts are located under Center Street at both channel crossings. There is also a channel, parallel to the AT&SF Railroad, that continues under Center Street in 1 - 48" and 2 - 30" concrete pipe culverts. Wittmann Wash then flows to the overchute at CAP1WEST on the CAP Canal.

Chrysler Proving Grounds

Chrysler Proving Grounds has constructed many drainage facilities to protect their buildings and test tracks. These facilities include a number of large box culverts and detention basins to reduce the peak flow through the property. The detention basins were designed to keep the post-development peak discharges at or below the existing peaks.

203rd Avenue provides access to the proving grounds. It collects stormwater flows from the west and conveys them south along the roadway to a large box culvert that crosses under the road just north of the AT&SF Railroad. The drainage continues to flow southeast along the Railroad for about one mile.

163rd Avenue

For the most part, the roadways in the study area cross the desert washes through unstabilized dip sections. However, 163rd Avenue north of Grand Avenue is paved and has box culverts at Happy Valley Road and Jomax Road. The box culvert at Happy Valley Road

passes flow under 163rd Avenue that is collected along a dike on the north side of Luke Air Force Base Auxiliary Field number 2. This dike continues to the east approximately 1-3/4 miles where it flows into an existing wash. The dike is unmaintained and is subject to overtopping. Consequently, there is a strong possibility that the dike could wash out and cause flooding to the south.

Sun Valley Parkway and Deer Valley Road

There are two new roadways, Sun Valley Parkway and Deer Valley Road, in the Wittmann area. Sun Valley Parkway will open soon and will carry traffic from Bell Road west along the north side of the White Tank Mountains to the planned community of Sun Valley. Deer Valley Road has recently been constructed and carries traffic from Grand Avenue to the Northwest Landfill. These roads were both designed with culverts to pass flow under the roadway at the existing wash crossings.

Lake Bonita

Lake Bonita is located below the CAP Canal on Padelford Wash. The dam was constructed to provide a recreation lake for the surrounding residences. However, the lake is normally dry and only fills up as a result of floods on Padelford Wash. There is no low flow outlet from the dam.

Beardsley Canal

The Beardsley Canal collects stormwater and passes it through with canal siphons at three major wash crossings. In addition, there are culverts and a spillway that allow flow into the canal just northeast of Grand Avenue. Several of these culverts are crushed and provide very little conveyance into the canal.

McMicken Dam

The study area drains to McMicken Dam and Outlet Channel. Two 10' x 10' box culverts are used as an uncontrolled outlet for the Trilby Wash Detention Basin behind McMicken Dam. Discharges from the outlet flow through the McMicken Dam Outlet Channel to the McMicken Dam Outlet Wash which in turn flows to the Agua Fria River. An emergency overflow spillway was designed by the Corps of Engineers in 1953 to pass flows that exceed the standard project flood. The crest of the dam was designed for 5 feet of freeboard above the standard project flood elevation of 1356.0 feet. The effect that the probable maximum flood would have on the dam was investigated and the results are presented in section 3.10 of this report.

3.0 HYDROLOGY

A rainfall runoff model was developed to determine the watershed response to storms of various frequency. The following areas were of particular concern in developing the model:

1. Check the adequacy of McMicken Dam and the McMicken Dam Outlet Channel to control the 100-year flood, standard project flood (SPF), and probable maximum flood.

2. Define the ponding areas behind McMicken Dam for the 100-year flood and the SPF.

3. Define the ponding areas behind the Central Arizona Project Canal and evaluate the adequacy of it's dike for the 100-year flood.

4. Determine flood hydrographs for a series of points of concentration for use in the floodplain, floodway, and interim floodplain delineations.

5. Define ponding areas for the 100-year flood upstream of the AT&SF Railroad.

6. Analyze the dam at Lake Bonita to determine its ability to safely pass the 100-year and probable maximum flood.

7. Define ponding areas for the 100-year flood behind Beardsley Canal.

8. Determine peak discharges to evaluate the adequacy of various existing structures in the drainage area including dikes, box culverts, pipe culverts, and dip sections.

3.1 Methodology

The U.S. Army Corps of Engineers HEC-1 computer program was used to simulate rainfall runoff response in the Wittmann ADMS study area. Peak discharges were computed for the 2, 5, 10, 50 and 100 year floods along with the standard project flood and the probable maximum flood. The model represents the basin watershed as an interconnected system of hydrologic and hydraulic components. The watershed was divided into over 200 subbasins in order to derive flood hydrographs for a series of locations throughout the study area.

There were two methods used in the HEC-1 computer program to compute flood hydrographs. The kinematic wave method was used in the flatter desert and alluvial fan regions and the unit hydrograph method was used in the mountainous areas.

The kinematic wave method was used in the desert and alluvial fan areas because it uses the physical processes involved in the movement of water over the drainage basin which make modification of the model due to land use changes easier. The rainfall runoff process is modeled using overland flow, collector channel, and main channel characteristics. Parameters, such as roughness,

slope, drainage lengths, drainage areas, and channel dimensions are used to define the runoff process. These parameters can be easily modified to represent future urbanization. A more complete discussion of the basic concepts of the kinematic wave method can be found in the Hydrologic Engineering Center's, "Introduction and Application of Kinematic Wave Routing Techniques Using HEC-1", May 1979.

The Phoenix Mountain S-Graph was used to derive unit hydrographs in the mountainous areas of the watershed. The S-Graph was developed by the U.S. Army Corps of Engineers for the Phoenix area. A computer program, supplied by the Flood Control District, was used to compute unit hydrographs from the Phoenix Mountain S-Graph. The required input is basin area, lag time, and the computation time interval. The resulting unit hydrographs were input into the HEC-1 computer model.

The Phoenix Mountain S-Graph unit hydrograph was used because it is based on observed data in the vicinity of the study area. These same S-Graphs have been used to compute design flood hydrographs for numerous flood control projects in Maricopa County. The kinematic wave model was not used in the mountainous regions because there will be very little urbanization in the mountains and therefore the advantage of the kinematic wave model in representing land use changes is not necessary. Furthermore, the kinematic wave model is not as applicable to the larger mountainous subbasins.

The Phoenix Mountain S-Graph was developed by the U.S. Army Corps of Engineers for use in their study, "Gila River Basin, New River, and Phoenix City Streams, Arizona", Design Memorandum Number 2, Hydrology, Part 2, 1982. It was derived from reconstitutions of observed floods on New River at Rock Springs and New River at New River. The S-graph is a summation graph of discharge in percent of ultimate discharge versus time in percent of lag time. The input hydrographs can be seen in the HEC-1 program and are labeled with the record identification symbol UI.

3.2 *Subbasin Areas*

The watershed was divided into over 200 subbasins using the 7-1/2 minute USGS quadrangle maps; the aerial mapping prepared for the Wittmann ADMS; plans for Grand Avenue, the Atchison Topeka, and Santa Fe Railroad, Morristown Highway, Granite Reef Aqueduct, Chrysler Proving Grounds, 163rd Avenue Paving, Patton Road Paving and the proposed Deer Valley Road paving; various drainage reports in the area; 1986 aerial photographs; and field investigations. The subbasin divisions were based on obtaining flood hydrographs at points of interest along the AT&SF Railroad, the CAP Canal, the Beardsley Canal, and McMicken Dam and Outlet Channel. Further, the watershed was divided into subbasins that have the same hydrologic and hydraulic characteristics.

R 4 W — R 3 W — R 2 W — R 1 W

T 8 N — T 7 N — T 6 N — T 5 N — T 4 N — T 3 N

WICKENBURG MOUNTAINS

YAVAPAI COUNTY
MARICOPA COUNTY

BITTER CREEK

HIEROGLYPHIC MOUNTAINS

GRAND AVE.
A. T. & S.F. R.R.

MORRISTOWN

MORRISTOWN HIGHWAY (S.R. 74)

CIRCLE CITY

CHRYSLER PROVING GROUNDS

WITTMANN

CROZER RD.

203rd AVE.

PATTON RD.

JOMAX RD

LUKE A.F.B. AUXILIARY FIELD #1

PINNACLE PEAK ROAD

TRILBY WASH

C.A.P. CANAL

HAPPY VALLEY ROAD

LUKE A.F.B. AUXILIARY FIELD #2

163rd AVE.

BEARDSLEY CHANNEL

DAM OUTLET

McMICKEN DAM OUTLET WASH

DEER VALLEY ROAD

NORTHWEST LANDFILL

AREA RETAINED BASIN

SUN VALLEY PARKWAY

WHITE TANK MOUNTAINS

BEARDSLEY

BEARDSLEY RD.

SARIVAL AVE.

REEMS RD.

BULLARD AVE.

LITCHFIELD RD.

DYSART RD.

EL MIRAGE RD.

AGUA FRIA RIVER

SUN CITY WEST

ATCHISON, TOPEKA & SANTA FE RAILROAD
GRAND AVENUE (U.S. 60 & U.S. 89)

UNION HILLS DR.

BELL RD.

GREENWAY RD.

WADDELL RD.

CACTUS RD.

PERRYVILLE RD.

PEORIA AVE.

OLIVE AVE.

JACKRABBIT RD.

McMICKEN DAM

COTTON LN.

CITRUS RD.

PADELFORD

C.A.P. CANAL

BUNKER PEAK

LAKE BONITA

JOMAX RD.

WASH

DRAINAGE AREA MAP

WITTMANN ADMS

LEGEND

- DRAINAGE AREA BOUNDARY
- SUBAREA BOUNDARY
- SUBAREA NUMBER (00)
- CONCENTRATION POINT
- C.A.P. CANAL
- CONCRETE PIPE OVERCHUTE
- CONCRETE OVERCHUTE
- BRIDGE

0' 1000' 2000' 4000' 6000'

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3.3 Precipitation Parameters

The precipitation values for the Wittmann ADMS were computed using the "NOAA Atlas No. 2, Precipitation - Frequency Atlas of the Western United States, Vol. VIII - Arizona", dated 1973. Point rainfall values were aerially reduced by the use of the depth area curve in the NOAA Atlas. The following table shows the precipitation values used in this study.

PRECIPITATION VALUES

Return Interval (Years)	Duration (Hours)	Point Rainfall (Inches)
2	24	1.63
5	24	2.29
10	24	2.70
50	24	3.72
100	24	4.21

POINT RAINFALL AREAL REDUCTION

(24-HOUR DURATION)

Area (sq.mi.)	% Point Rainfall	RAINFALL (inches)				
		2-year	5-year	10-year	50-year	100-year
1	100	1.63	2.29	2.70	3.72	4.21
10	99	1.61	2.27	2.67	3.68	4.17
50	95	1.55	2.18	2.57	3.53	4.00
100	93.3	1.52	2.14	2.52	3.47	3.93
200	91.7	1.49	2.10	2.48	3.41	3.86
350	90.7	1.48	2.08	2.45	3.37	3.82

The precipitation depth-area relation was incorporated into the model to maintain consistency between successive downstream hydrographs by generating each from precipitation quantities that correspond to that particular basin size.

The SCS Type II rainfall distribution was used to distribute the above rainfall amounts over the 24-hour period. This distribution is generally accepted as being applicable for storms in the southwestern desert regions. The time increment used in the distribution was 15 minutes.

3.4 Standard Project Storm and Probable Maximum Precipitation

The precipitation amounts for the Probable Maximum Precipitation (PMP) and the Standard Project Storm (SPS) were generated to determine the effect each would have on McMicken Dam and Outlet Channel. The SPS was taken from "Design Memorandum No. 1 - Hydrology and Hydraulic Design for Trilby Wash Detention Basin and Outlet Channel", dated November 1953 by the Corps of Engineers. This storm was used to design McMicken Dam. The basin average SPS

corresponding to the 247 square mile basin that drains to McMicken Dam is 8.6 inches. For the 320 square mile drainage basin that contributes to McMicken Dam and the Outlet Channel, the average rainfall is 7.4 inches.

The rainfall distribution for the SPS was also taken from Design Memorandum No. 1. The rainfall was distributed over a 72-hour duration in one hour increments. This storm follows the pattern of the August 1951 storm for Phoenix and Poland Junction.

The Probable Maximum Precipitation was calculated using the procedure outlined in the U.S. Department of Commerce's 'Hydrometeorological Report No. 49 - Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages", dated September 1977. With this procedure an accumulated rainfall depth, incremental rainfall depth, and a rainfall distribution pattern was developed for 6-hour time increments over a 72-hour period. The total 72-hour PMP is 15.3 inches. The following table shows the values computed using HMR No. 49.

Probable Maximum Precipitation Data

Time Increment (Hrs.)	6	12	18	24	30	36	42	48	54	60	66	72
Accumulated Rainfall Depth (In.)	7.1	9.3	10.6	11.7	12.4	13.2	13.8	14.3	14.6	14.9	15.1	15.3
Incremental Rainfall Depth (In.)	7.1	2.2	1.3	1.1	0.7	0.6	0.6	0.5	0.3	0.3	0.2	0.2
Rainfall Distribution (In.)	0.2	0.3	0.5	0.6	1.1	2.2	7.1	1.3	0.7	0.6	0.3	0.2

3.5 Lag Time

Basin lag time is required input for the unit hydrograph method. As described earlier the Phoenix Mountain S-Graphs were used to develop unit hydrographs for the mountainous subbasins. The following equation was used to compute lag time.

$$T = Ct\left(\frac{L\ Lca}{S^{1/2}}\right)^{.38}$$

where,

T = Lag time in hours, hrs.

L = Length of longest watercourse, ft.

Ct = $.0003489\ \frac{n}{0.05}$, where n = channel roughness.

Lca= Length along largest watercourse measured upstream to a point opposite center of area, ft..

S = Overall slope of longest watercourse, ft/ft.

This equation was taken from Plate 24 of the U.S. Army Corps of Engineers "Gila River Basin, New River and Phoenix City Streams, Arizona", Design Memorandum No. 2, Hydrology Part 2. The equation constant, .0003489, was converted for use with feet instead of miles.

3.6 Channel Routing

Although the Kinematic Wave method was used to compute most of the subbasin outflow hydrographs, it was not used for channel routing because it does not provide for attenuation of the flood wave. The washes in the study area are natural with no lining or improvements and therefore significant storage and attenuation of the flood hydrographs would be expected. To account for attenuation, the Muskingum routing method was used.

The Muskingum x coefficient (wedge storage factor) was set equal to 0.2 which is commonly used in absence of observed data. This coefficient can range in value from 0.0 to 0.5. Using an x of 0.5 results in translation of the routed hydrograph with no attenuation and an x of 0.0 would be used for a reservoir.

The Muskingum K coefficient (HEC-1 variable AMSKK) was set equal to the travel time in the routing reach. An iterative procedure was used to calculate the travel time. In an initial model, an assumed velocity of 4 fps was used to determine a travel time for each reach. Then, using the resulting 100-year peak discharges, more representative velocities were obtained with normal depth calculations. These velocities were used to compute travel times in the final model.

The number of routing steps (HEC-1 variable NSTPS) was set equal to 1 for each reach. As is the case with the x coefficient, the number of routing steps is a calibration parameter and is typically chosen so that the K coefficient is between 0.65 and 2.5

times the computation time interval. Based on this criteria, as many as 70 routing steps would be required in some reaches because the time interval is only 3 minutes. (The small time interval was required to adequately define the hydrographs from the smaller subbasins). The result of having a large number of routing steps is very little attenuation of the routed hydrograph. It was decided that one routing step for each reach would be adequate if the resulting hydrographs were checked to make sure they do not oscillate.

3.7 Curve Numbers

The Soil Conservation Service curve number method was used to calculate precipitation losses. Curve numbers were interpolated from SCS Technical Release No. 55. This document relates curve number to the hydrologic soil group, soil cover, land use type, and antecedent moisture conditions. The following table shows curve numbers that were used in the Wittmann ADMS.

Curve Numbers

LAND USE TYPE	HYDROLOGIC SOIL GROUP		
	B	C	D
RESIDENTIAL LAND			
R-3	86	93	94
R-4	86	91	93
R-5	85	90	92
R1-6	83	88	91
R1-7	81	86	90
R1-8	79	85	89
R1-9	77	84	88
R1-10	75	83	87
DESERT SHRUB			
Poor Condition	77	85	88
Fair Condition	72	81	86
Good Condition	68	79	84
Hydrologic Conditions	Poor: 30% Ground Cover Fair: 30% - 70% Ground Cover Good: 70% Ground Cover		

3.8 Storage Routing

Reservoir routing was used in the HEC-1 model to account for the effects of storage behind the Central Arizona Project Canal, Beardsley Canal, AT&SF Railroad, Chrysler Proving Grounds, and McMicken Dam. Bureau of Public Roads culvert charts, the aerial topographic mapping, and construction plans were used to create stage-storage-discharge tables. Reservoir routing was also performed at Lake Bonita with an assumed starting water surface elevation set at the top of the spillway.

3.9 Diversions

Diversions were used in the HEC-1 hydrology model for two main reasons:

1. To model the flows that exceed the railroad culverts and continue along the railroad to the next culvert downstream.
2. To model the outflow of the storage area north of the CAP Canal east of Grand Avenue.

In many cases the railroad culverts do not have sufficient capacity to pass the 100-year flood. Since the railroad is high enough to preclude overtopping, the excess flow is diverted downstream along the railroad to the next culvert. The diversion routine in the HEC-1 computer program was used to model these situations.

The diversion routine was also used to model the outflow from the ponding area behind the CAP Canal east of Grand Avenue. This storage area acts as two large interrelated reservoirs with 17 total outlet culverts. 163rd Avenue divides the storage area between the CAP9EAST and CAP10EST culverts. For infrequent events, larger than the 100-year flood, stormwater will flow from the western reservoir, over 163rd Avenue, into the eastern reservoir.

This area was modeled by totaling the contributing subbasin hydrographs to each reservoir and then storage routing the combined hydrograph using stage-storage-discharge data based on the combined outflow of all the associated CAP Canal culverts.

The outflow hydrograph was then diverted into each of the outflow culverts to obtain peak discharges at each location. These culverts included CAP1EAST through CAP9EAST for west of 163rd Avenue and CAP10EST through CAP14EST east of 163rd Avenue. In addition, a diversion was included to model the flow from the western reservoir to the eastern reservoir during the more infrequent flooding events.

3.10 Results

A summary of the cumulative peak discharges is in Appendix A. The summary includes the 2, 5, 10, 50, and 100-year floods. The drainage area map depicts the location of each subbasin along with its identification number and concentration point.

The HEC-1 computer printouts for the 2, 5, 10, 50 and 100-year storms plus the standard project storm and the probable maximum precipitation are in Appendix C (under separate cover).

The following is a brief discussion of the results at major concentration points within the study area.

Grand Avenue and AT&SF Railroad

As described earlier, reservoir routing was performed at the culvert locations along the AT&SF Railroad. The resulting inflow and outflow peak discharges are in the summary (Appendix A). The peak stage can be found in the HEC-1 output (Appendix C).

At every culvert the 100-year runoff is contained upstream of the Railroad. The discharges are either outlet through the culvert or are diverted along the railroad to the next downstream culvert.

The culverts along Grand Avenue were not included in the HEC-1 model because the effective storage between the roadway and the railroad is insignificant. However, the culverts were checked to determine if they have the capacity to convey the 100-year outflow peak discharges from the Railroad. There was only one culvert location where the 100-year flood might flow over the roadway and it occurs near Circle City. Refer to discussion in Section 3.3 in Part B.

CAP Canal

The following is a summary of the 100-year peak discharges and peak stages along the CAP Canal.

Location	100-Year Peak discharge (CFS)		Culvert Capacity	100-year Peak Stage	CAP Dike Elevation
	Inflow	Outflow	(CFS)	(FT)	(FT)
CAP1WEST	6548	6455	4725*	1551.94	1551.7
CAP2WEST	3172	2268	3920	1548.43	1550.9
Trilby (CAP3WEST)	3851	3845	9506	1548.87	1553.4
Iona (CAP4WEST)	5309	5001	2460*	1552.35	1552.0
CAP5WEST	4953	3724	5695	1541.91	1545.1
CAP1EAST - CAP9EAST Combined	11128	3043	6035	1549.88	1554.0
CAP10EAST - CAP14EAST Combined	5389	2200	4085	1545.90	1554.0

* Insufficient Capacity

The results indicate that the overchutes are undersized at CAP1WEST and at Iona Wash. Refer to Section 3.4 in Part B for further discussion.

Beardsley Canal

The Beardsley Canal has 3 major wash crossings in the study area. They are located at washes CAP5EAST, Padelford Wash, and CAP16EST. The following is a summary of these crossings.

Location	100-Year Peak discharge (CFS)		Culvert Capacity	100-year Peak Stage	Canal Dike Elevation
	Inflow	Outflow	(CFS)	(FT)	(FT)
CAP5EAST	2227	2227	4410	1337.36	1340
Padelford Wash	2718	2718	1392*	1342.13	1342
CAP16EAST	4535	4197	4950	1340.26	1342

* Insufficient Capacity

McMicken Dam and Outlet Channel

The standard project flood and the probable maximum flood were routed through McMicken Dam. The following is a summary of the results.

Description	Wittmann ADMS Results	U.S. Army Corps of Engineers Design
McMicken Dam		
100-Year Peak Inflow	20,431 CFS	Not Calculated
100-Year Peak Outflow	2,998 CFS	Not Calculated
100-Year Peak Stage	1349.92 FT	Not Calculated
100-Year Peak Volume	13,374 AC-FT	Not Calculated
SPF Peak Inflow	37,503 CFS	35,000 CFS
SPF Peak Outflow	15,518 CFS	4,450 CFS
SPF Peak Stage	1354.98 FT	1356.0 FT
SPF Peak Volume	24,013 AC-FT	32,800 AC-FT
PMF Peak Inflow	110,374 CFS	120,000 CFS
PMF Peak Outflow	95,042 CFS	Not Calculated
PMF Peak Stage	1360.46 FT	Not Calculated
PMF Peak Volume	39,098 AC-FT	Not Calculated
Outlet Channel		
SPF Upstream of confluence with Agua Fria River	16,443 CFS	14,000 CFS

Note: Top of Dam Elevation = 1360.7 FT
Top of Spillway Elevation = 1353.65 FT

Wittmann Wash Split Flow

A split flow analysis was performed on Wittmann Wash approximately 1/2 mile upstream of the CAP Canal and it was determined that 542 cfs splits to the west and continues to the Patton Road Bridge area where it flows across Patton Road and continues to flow south to the CAP2WEST Wash. The remaining 1722 cfs continues in the main channel to the east and flows to the CAP1WEST Overchute on the CAP Canal.

4.0 FLOODPLAIN/FLOODWAY DELINEATIONS

The Wittmann Area Drainage Master Study included the delineations of approximately 90 stream miles of floodplain and the computations of 21 miles of floodway. This section of the report describes the methodology and assumptions in computing the water surface profiles.

The HEC-2 computer printouts for each wash are located in Appendix D (under separate cover). A composite of the delineations is shown on the floodplain map included in this report. Detailed floodplain and floodway delineations are also shown on the topographic mapping prepared in conjunction with this study.

4.1 Methodology and Basic Assumptions

The Hydrologic Engineering Center's "HEC-2 Water Surface Profiles", computer program was used to compute water surface profiles. The computation procedure used in the program is the standard step method. The program can evaluate the effects of such obstructions as bridges, culverts, and weirs.

The starting water surface elevation for each wash was set equal to critical depth. Critical depth was assumed in reaches where the water surface fell below critical depth.

100 YEAR FLOODPLAIN DELINEATION MAP

WITTMANN ADMS

LEGEND

- 100 YEAR FLOODPLAIN
- THALWEG
- STANDARD PROJECT FLOOD BOUNDARY
- McMICKEN DAM STRUCTURE AND FLOWAGE EASEMENT
- 100-YEAR FLOOD ZONE DETERMINED BY APPROXIMATE METHODS.

R 4 W — R 3 W — R 2 W — R 1 W

T 8 N — T 7 N — T 6 N — T 5 N — T 4 N — T 3 N

WICKENBURG MOUNTAINS

YAVAPAI COUNTY
MARICOPA COUNTY

BITTER CREEK

HIEROGLYPHIC MOUNTAINS

DRAINAGE AREA BOUNDARY

GRAND AVE.
A. T. & S.F. RR.
MORRISTOWN

MORRISTOWN HIGHWAY (S.R. 74)

CIRCLE CITY

CHRYSLER PROVING GROUNDS

DOVE VALLEY RD.

WITTMANN

CROZIER RD.

WITTMAN WASH

203rd AVE.

PATTON RD.

JOMAX RD.

LUKE A.F.B. AUXILIARY FIELD #1

LUKE A.F.B. AUXILIARY FIELD #2

HAPPY VALLEY ROAD

PINNACLE PEAK ROAD

195th AVE

163rd AVE

C.A.P. CANAL

BUNKER PEAK

LAKE BONITA

PARADISE WASH

CANAL

BEARDSLEY

McMICKEN DAM OUTLET CHANNEL

NORTHWEST LANDFILL

DEER VALLEY

SUN VALLEY PARKWAY

BEARDSLEY RD.

SARIVAL AVE.

REEMS RD.

BULLARD AVE.

LITCHFIELD RD.

DYSART RD.

COTTON LN.

UNION HILLS DR.

CITRUS RD.

BELL RD.

GREENWAY RD.

WADDELL RD.

CACTUS RD.

PEORIA AVE.

OLIVE AVE.

McMICKEN DAM RD.

JACKRABBIT RD.

PERRYVILLE RD.

EL MIRAGE RD.

AGUA FRIA RIVER

ATCHISON, TOPEKA & SANTA FE RAILROAD
GRAND AVENUE (U.S. 60 & U.S. 89)

SUN CITY WEST

WHITE TANK MOUNTAINS

DRAINAGE AREA BOUNDARY

0' 1000' 2000' 4000' 6000'

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Manning's roughness coefficients (Mannings "n") were chosen with the help of aerial photographs, field inspections, Chow's Handbook of Hydraulics, U.S.G.S. Water Supply Paper 1849, and an unpublished report by the U.S.G.S. entitled "Roughness Coefficients for Stream Channels in Arizona". Channel "n" values for he study ranged from 0.025 to 0.05 and overbank "n" values ranged from 0.035 to 0.10.

The numbering system for the floodplain cross-sections is based on river miles. The length between successive cross sections was kept between 400 and 1000 feet. This value was dependent upon channel geometry and the sinuosity of the channel. Cross section data was taken from the topographic mapping prepared for this study. Mapping scales are at 1"=200' and 1"=400'. Major structures were included in the hydraulic analysis and the dimensions for each were taken from either the as-built plans or field measurements.

The floodplain analyses were prepared based on unobstructed flow. The water surface profiles are only valid if hydraulic structures remain unobstructed, operate properly, and do not fail.

An option was used in the HEC-2 program to insert interpolated cross sections when the change in velocity head between cross sections was too great to accurately determine the energy gradient. A maximum allowable change in velocity head between cross sections was specified to be 0.5 feet.

There were three washes that required a split flow analysis. They were IONAWEST, CAP7EAST, and WITTWASH.

4.2 Approximate Floodplain Delineations

Floodplain delineations were carried out by approximate methods on Padelford Wash, Trilby Wash, and Iona Wash between Morristown Highway and the CAP Canal. Cross section data was taken from USGS 7-1/2 minute quadrangle maps and normal depth calculations were made at approximately five locations on each wash. These calculations were supplemented with inspection of aerial photographs to prepare approximate floodplain delineations.

The 100-year floodplain for McMicken Dam Outlet Channel was also delineated using approximate methods. Normal depth calculations were prepared for several locations along the channel using channel cross sections taken from the 4' contour interval mapping prepared with this study.

5.0 REFERENCES

"Atchison, Topeka and Santa Fe Railroad Plan and Profile", As-Built 1941.

Adam, Hamlyn, Anderson, "McMicken Dam Restoration Construction Plans", March 1983.

Arizona Department of Transportation, "Hydrologic Design for Highway Drainage in Arizona", Revised April 1975.

Arizona Department of Transportation, "Morristown, New River Highway Plans", As-Built 1966 & 1971.

Arizona Department of Transportation, "Phoenix, Wickenburg Plans (State Highway 60 and 89)", As-Built 1943 and 1966.

Arizona State Land Department, State Trust Lands and Bureau of Land Management Map, Yavapai County, April 1984.

Arizona State Land Department, State Trust Lands and Bureau of Land Management Map, Maricopa County, September 1986.

Brater, Ernest F. and King, Horace Williams, "Handbook of Hydraulics for the Solution of Hydraulic Engineering Problems", Sixth Edition, 1982.

Chow, Ven Te, "Handbook of Applied Hydrology", 1964.

Chow, Ven Te, "Open-Channel Hydraulics", 1959.

Collar, Williams & White Engineering, "Drainage Report Sun Valley Parkway Phase I", March 1987.

Collar, Williams & White Engineering, "Sun Valley Parkway Grading, Drainage and Paving Plans, Phase I-A and Phase I-B", April 1987.

Collar, Williams & White Engineering, "Hydrologic/Hydraulic Design Analysis", Bell Road Crossing of McMicken Dam and Reservoir, October 1986.

Cooper Aerial Survey Company, Aerial Photographs, June 1986.

Dames and Moore, "Surface Water Design Considerations for the Maricopa County Northwest Regional Landfill", Technical Memorandum, November 21, 1986.

Dames & Moore, "Northwest Regional Landfill Plans", April 1987.

Dibble & Associates, "Hydrologic Study", 163rd Avenue from Grand Avenue to Jomax Road Maricopa County, Arizona, August 1985.

Dibble & Associates, "Plans for the Construction of 163rd Avenue, Grand Avenue to Jomax Road", As-Built June 27, 1986.

Federal Emergency Management Agency, Federal Insurance Administration, "Flood Insurance Study Guidelines and Specifications for Study Contractors", September 1985.

Flood Control District of Maricopa County, "Uniform Drainage Policys and Standards for Maricopa County, Arizona", February 25, 1987.

Flood Control District of Maricopa County, "Floodplain Regulation for Maricopa County", Amended March 23, 1987.

HDR, Inc., "Paving and Grading Plans, Sun City West Unit 12", 1979.

HDR, Inc., "El Mirage Channel HEC-2 Computer Runs", March 1979.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Routing of Floods Through River Channels", EM 1110-2-1408, March 1960.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "HEC-1 Flood Hydrograph Package", Users Manual, Revised January 1985.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "HEC-2 Water Surface Profiles", Users Manual", September 1982.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Application of the HEC-2 Split Flow Option", Training Document No. 18, Smith, April 1982.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Storm Drainage and Urban Region Flood Control Planning", Technical Paper No. 40, by Darryl Davis, October 1974.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Hydrologic Engineering in Planning", Training Document No. 14, April 1981.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Introduction and Application of Kinematic Wave Routing Techniques Used in HEC-1", Training Document No. 10, May 1979.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "The New HEC-1 Flood Hydrograph Package", Technical Paper No. 82, by David Goldman, May 1981.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Testing of Several Runoff Models on an Urban Watershed", Technical Paper No. 59, by Jess Abbot, October 1978.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Comparative Analysis of Flood Routing Methods", Research Document No. 24, September 1980.

Hydrologic Engineering Center, U.S. Army Corps of Engineers, "Hydrologic Analysis of Ungaged Watersheds Using HEC-1", Training Document No. 15, April 1982.

Johannessen & Girand, "Drainage Report for Chrysler Arizona Proving Grounds", September 1979.

Johannessen & Girand, "Drainage Report for Northerly Extension of 203rd Avenue", October 1978.

Johannessen & Girand, "Plan and Profile for Chrysler Proving Grounds and 203rd Avenue Access Road", 1979.

Maricopa County, Arizona "Zoning Maps", 1985.

Maricopa County Highway Department, "Patton Road and 203rd Avenue Plan and Profile", As-Built January 1986.

Maricopa County Highway Department, "Plan and Profile for Proposed Deer Valley Road", 1987.

National Oceanic and Atmospheric Administration, "NOAA Atlas 2", Precipitation Frequency Atlas of the Western Unied States, Volume VIII - Arizona, 1973.

National Oceanic and Atmospheric Administration and U.S. Department of the Army Corps of Engineers, "Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages", Hydrometeorological Report No. 49, September 1977.

Sergent, Hauskins and Beckwith, "Surface Water Hydrology Report", McMicken Dam Restoration Study Maricopa County, Arizona, February 1983.

Soil Conservation Service, "Soil Survey, Aguila - Carefree Area", Parts of Maricopa and Pinal Counties, Arizona, Advance Copy, 1985.

Soil Conservation Service, "Urban Hydrology for Small Watersheds", Technical Release No. 55, June 1986.

Soil Conservation Service, "Design of Open Channels", Technical Release No. 25, October 1977.

Soil Conservation Service, "National Engineering Handbook" Section 5, Hydraulics, August 1956.

Soil Conservation Service, "National Engineering Handbook" Section 4, Hydrology", March 1985.

Soil Conservation Service, "General Soil Map Maricopa County Arizona", March 1973.

Soil Conservation Service and Forest Service, "Soil Survey of Yavapai County, Arizona, Western Part", March 1976.

Soil Conservation Service, "Soil Survey of Maricopa County, Arizona - Central Part", September 1977.

U.S. Army Corps of Engineers, "Design Memorandum No. 1", Hydrology and Hydraulic Design for Trilby Wash Detention Basin and Outlet Channel, November 1953.

U.S. Army Corps of Engineers, "Design Memorandum No. 2 - Hydrology - Part 2," Gila River Basin, New River and Phoenix City Streams, Arizona, 1982.

U.S. Army Corps of Engineers, "Trilby Wash Detention Basin Dam and Appurtenances", Land to be Acquired Plans, April 1955.

U.S. Bureau of Reclamation, "Central Arizona Project, Plan and Profile Reach 8 and Reach 9 Granite Reef Aqueduct", As-built June 16, 1982 and As-built June 17, 1980.

U.S. Bureau of Reclamation, "Specifications Design Data for Reach 8 and Reach 9, Granite Reef Aqueduct, Central Arizona Project, Arizona", Memorandum, June 9, 1978.

U.S. Department of Commerce, Bureau of Public Roads, "Hydraulic Charts for the Selection of Highway Culverts", Hydraulic Engineering Circular No. 5, September 1961.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, "Approximate Studies - Unincorporated Areas of Maricopa County, Arizona", Flood Insurance Study, January 1979.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, "Unincorporated Areas of Maricopa County", Flood Insurance Study, January 1979.

U.S. Bureau of Reclamation, "Patton Road Bridge Approaches Plan and Profile", Granite Reef Aqueduct, Reach 8, Central Arizona Project, As-built 1982.

U.S. Bureau of Reclamation, "Central Arizona Project, R-O-W Boundary Map - Granite Reef Aqueduct Reach 9", December 1978.

U.S. Geological Survey, "Roughness Coefficients for Stream Channels in Arizona", (Unofficial), 1973.

U.S. Geological Survey, Roughness Characteristics of Natural Channels, Geological Survey Water - Supply Paper 1849, 1977.

U.S. Geological Survey Quadrangle Maps - Wickenburg (1964) Red Picacho (1964) Garfias MTN (1964) Governor's Peak (1964) Wickenburg SW (1965) Wittmann (1965) Hieroglyphic MTNS SW (1965) Baldy MTN (1964) White Tank MTNS (1957) White Tank MTNS NE (1971) White Tank MTNS SE (1971) McMicken Dam (1974) Waddell (1975) Calderwood Butte (1974) El Mirage (1974).

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Appendix

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APPENDIX A

SUMMARY OF PEAK CUMMULATIVE DISCHARGES

SUMMARY OF PEAK CUMMULATIVE DISCHARGES
FLOW IN CUBIC FEET PRE SECOND
TIME IN HOURS, AREA IN SQUARE MILES

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
1	Inflow	10.	32.	52.	110.	134.	0.09	AT&SF Railroad
	Outflow	7.	20.	30.	53.	83.	0.09	
2	Inflow	20.	66.	106.	248.	332.	0.50	AT&SF Railroad
	Outflow	20.	64.	105.	243.	325.	0.50	
3	Inflow	24.	71.	110.	230.	303.	0.35	AT&SF Railroad
	Outflow	22.	69.	109.	230.	301.	0.35	
4	Inflow	29.	84.	130.	281.	374.	0.65	AT&SF Railroad
	Diversion to 5	0.	9.	55.	196.	283.	0.65	
	Outflow	29.	74.	75.	85.	91.	0.65	
5	Inflow	17.	63.	107.	268.	375.	0.35	AT&SF Railroad
	Diversion to 6	0.	0.	0.	53.	169.	0.35	
	Outflow	17.	59.	94.	185.	195.	0.35	
6	Inflow	6.	16.	25.	55.	168.	0.03	AT&SF Railroad
	Diversion to 7	0.	0.	0.	34.	136.	0.03	
	Outflow	4.	7.	10.	19.	31.	0.03	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
7	Inflow	4.	13.	21.	50.	141.	0.04	AT&SF Railroad
	Diversion to 8	0.	0.	0.	0.	0.	0.04	
	Outflow	3.	9.	14.	28.	77.	0.04	
8	Inflow	2.	5.	8.	15.	19.	0.01	AT&SF Railroad
	Diversion to 9	0.	0.	0.	0.	0.	0.01	
	Outflow	1.	4.	6.	11.	12.	0.01	
9	Inflow	7.	20.	32.	66.	87.	0.08	AT&SF Railroad
	Diversion to 10	0.	6.	16.	43.	59.	0.08	
	Outflow	6.	13.	15.	21.	25.	0.08	
10A		293.	631.	860.	1477.	1788.	4.94	AT&SF Railroad
10	Inflow	171.	529.	827.	1789.	2371.	8.87	AT&SF Railroad
	Outflow	171.	529.	827.	1789.	2371.	8.87	Iona Wash Crossing
11	Inflow	15.	44.	69.	154.	204.	0.20	AT&SF Railroad
	Outflow	14.	36.	44.	72.	79.	0.20	
12		0.	1.	1.	3.	4.	0.01	AT&SF Railroad
13	Inflow	8.	26.	40.	90.	108.	0.10	AT&SF Railroad
	Outflow	8.	24.	35.	73.	87.	0.10	
14		2.	5.	8.	15.	20.	0.01	AT&SF Railroad
15	Inflow	31.	92.	146.	325.	435.	0.57	AT&SF Railroad
	Diversion to 16	0.	0.	0.	4.	29.	0.57	
	Outflow	28.	78.	109.	192.	215.	0.57	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
16	Inflow	35.	103.	167.	361.	479.	0.62	AT&SF Railroad
	Diversion to 17	0.	0.	0.	166.	295.	0.62	
	Outflow	34.	76.	87.	111.	114.	0.62	
17	Inflow	6.	21.	33.	176.	309.	0.05	AT&SF Railroad
	Diversion to 18	0.	0.	0.	34.	184.	0.05	
	Outflow	6.	18.	30.	93.	101.	0.05	
18	Inflow	6.	18.	28.	54.	179.	0.04	AT&SF Railroad
	Diversion to 19	0.	0.	0.	4.	58.	0.04	
	Outflow	3.	7.	10.	20.	47.	0.04	
19	Inflow	10.	28.	45.	94.	132.	0.14	AT&SF Railroad
	Diversion to 20	0.	0.	0.	0.	0.	0.14	
	Outflow	9.	26.	41.	65.	78.	0.14	
20	Inflow	29.	88.	139.	320.	422.	0.70	AT&SF Railroad
	Diversion to 21	0.	0.	0.	118.	215.	0.70	
	Outflow	29.	87.	136.	201.	205.	0.70	
21	Inflow	0.	3.	6.	122.	220.	0.02	AT&SF Railroad
	Diversion to 22	0.	0.	0.	105.	200.	0.02	
	Outflow	0.	3.	5.	17.	19.	0.02	
22	Inflow	4.	19.	37.	158.	276.	0.26	AT&SF Railroad
	Diversion to 23	0.	0.	0.	79.	193.	0.26	
	Outflow	4.	18.	33.	76.	80.	0.26	
23	Inflow	0.	1.	2.	83.	198.	0.01	AT&SF Railroad
	Diversion to 24	0.	0.	0.	0.	0.	0.01	
	Outflow	0.	1.	2.	83.	198.	0.01	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
24	Inflow	0.	1.	3.	6.	8.	0.01	AT&SF Railroad
	Diversion to 25	0.	0.	0.	0.	0.	0.01	
	Outflow	0.	1.	1.	2.	3.	0.01	
25	Inflow	1.	6.	12.	33.	51.	0.05	AT&SF Railroad
	Diversion to 26	0.	0.	0.	1.	9.	0.05	
	Outflow	1.	5.	9.	24.	32.	0.05	
26B		926.	1802.	2381.	3919.	4685.	12.72	
26A		663.	1331.	1774.	2956.	3550.	14.98	
26	Inflow	487.	1009.	1380.	2428.	2970.	16.10	AT&SF Railroad
	Outflow	487.	1009.	1380.	2428.	2970.	16.10	Trilby Wash Crossing
27	Inflow	1.	7.	13.	40.	53.	0.06	AT&SF Railroad
	Diversion to 28	0.	0.	0.	9.	23.	0.06	
	Outflow	1.	6.	11.	26.	28.	0.06	
28	Inflow	7.	28.	49.	133.	188.	0.24	AT&SF Railroad
	Diversion to 29	0.	0.	0.	52.	99.	0.24	
	Outflow	7.	26.	44.	65.	70.	0.24	
29	Inflow	2.	6.	8.	55.	102.	0.01	AT&SF Railroad
	Diversion to 30	0.	0.	0.	16.	67.	0.01	
	Outflow	1.	3.	4.	26.	31.	0.01	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
30	Inflow	2.	6.	9.	17.	69.	0.01	AT&SF Railroad
	Diversion to 31	0.	0.	0.	0.	0.	0.01	
	Outflow	2.	5.	7.	12.	50.	0.01	
31	Inflow	16.	54.	88.	208.	288.	0.63	AT&SF Railroad
	Diversion to 32	0.	0.	0.	0.	16.	0.63	
	Outflow	16.	53.	86.	174.	224.	0.63	
32	Inflow	5.	16.	24.	51.	66.	0.05	AT&SF Railroad
	Diversion to 33	0.	0.	0.	0.	4.	0.05	
	Outflow	4.	13.	19.	34.	42.	0.05	
33	Inflow	4.	11.	17.	32.	41.	0.02	AT&SF Railroad
	Diversion to 34	0.	0.	0.	0.	0.	0.02	
	Outflow	1.	4.	6.	11.	14.	0.02	
34	Inflow	20.	56.	88.	193.	242.	0.34	AT&SF Railroad
	Diversion to 35	0.	0.	0.	10.	35.	0.34	
	Outflow	19.	46.	59.	83.	89.	0.34	
35	Inflow	19.	54.	84.	183.	236.	0.34	AT&SF Railroad
	Diversion to 36	0.	0.	0.	1.	49.	0.34	
	Outflow	18.	48.	66.	100.	112.	0.34	
36	Inflow	91.	251.	385.	824.	1115.	3.64	AT&SF Railroad
	Outflow	91.	251.	385.	824.	1115.	3.64	
37	Inflow	68.	188.	288.	622.	810.	2.71	AT&SF Railroad
	Outflow	68.	188.	288.	622.	810.	2.71	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
38	Inflow	161.	477.	749.	1660.	2202.	8.65	AT&SF Railroad
Diversion to 39		0.	0.	0.	0.	0.	8.65	Wittmann Wash
	Outflow	161.	477.	749.	1660.	2202.	8.65	Crossing
38A		11.	34.	55.	128.	172.	0.28	
38B		86.	257.	404.	902.	1195.	4.47	
39	Inflow	9.	40.	71.	192.	270.	0.76	AT&SF Railroad
	Outflow	9.	40.	71.	192.	270.	0.76	
40	Inflow	326.	1116.	1788.	3627.	4442.	20.73	AT&SF Railroad
	Outflow	326.	1113.	1783.	3620.	4439.	20.73	
40A		90.	318.	538.	1333.	1824.	7.11	Chrysler Proving Grounds
40B	Inflow	320.	960.	1383.	2497.	2953.	12.17	Chrysler Proving
	Outflow	320.	958.	1375.	2452.	2883.	12.17	Grounds
40C	Inflow	103.	323.	501.	1087.	1373.	3.86	Chrysler Proving
	Outflow	103.	320.	492.	998.	1188.	3.86	Grounds
40D	Inflow	253.	686.	1017.	1841.	2204.	7.80	Chrysler Proving
	Outflow	245.	652.	907.	1510.	1759.	7.80	Grounds
40E	Inflow	3.	14.	26.	80.	108.	0.14	Chrysler Proving
	Outflow	3.	14.	25.	62.	69.	0.14	Grounds

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
40F	Inflow	98.	310.	498.	1153.	1541.	3.51	Chrysler Proving
	Outflow	98.	310.	482.	1044.	1314.	3.51	Grounds
40G	Inflow	251.	715.	1089.	2188.	2774.	7.61	Chrysler Proving
	Outflow	250.	682.	1015.	1844.	2192.	7.61	Grounds
40H		221.	538.	776.	1426.	1764.	3.91	
40I		115.	245.	333.	568.	686.	1.65	
40J		326.	640.	846.	1389.	1658.	3.24	
41	Inflow	338.	1130.	1800.	3644.	4475.	21.41	AT&SF Railroad
	Outflow	338.	1130.	1800.	3643.	4475.	21.41	
42	Inflow	65.	209.	328.	701.	902.	3.73	CAP1EAST First Overchute
	Outflow	46.	116.	172.	272.	311.	47.77	east of Grand Avenue. *
42A	Inflow	7.	34.	61.	172.	230.	0.47	Chrysler Proving
	Outflow	7.	30.	45.	78.	86.	0.47	Grounds

* 47.77 miles is the combined area contributing to the reservoir behind the CAP Canal east of Grand Avenue and west of 163rd Avenue.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
42B	Inflow	14.	49.	75.	109.	151.	0.75	Chrysler Proving
	Outflow	14.	48.	75.	99.	108.	0.75	Grounds
42C	Inflow	7.	35.	65.	199.	279.	0.63	Chrysler Proving
	Outflow	7.	31.	56.	120.	137.	0.63	Grounds
42D	Inflow	2.	12.	24.	69.	101.	0.14	Chrysler Proving
	Outflow	2.	11.	19.	37.	42.	0.14	Grounds
42D1	Inflow	1.	5.	9.	26.	38.	0.04	Chrysler Proving
	Outflow	1.	4.	7.	14.	16.	0.04	Grounds
42E	Inflow	13.	48.	80.	143.	158.	0.58	Chrysler Proving
	Outflow	13.	47.	70.	100.	112.	0.58	Grounds
42E1	Inflow	12.	48.	83.	221.	292.	0.48	Chrysler Proving
	Outflow	12.	47.	79.	134.	146.	0.48	Grounds
42F	Inflow	4.	19.	32.	76.	109.	0.33	Chrysler Proving
	Outflow	4.	18.	32.	71.	90.	0.33	Grounds
42F1	Inflow	3.	16.	29.	82.	116.	0.22	Chrysler Proving
	Outflow	3.	15.	28.	63.	79.	0.22	Grounds
43	Inflow	168.	549.	874.	1875.	2448.	8.48	CAP2EAST Second Overchute
	Outflow	59.	131.	187.	285.	323.	47.77	east of Grand Avenue on CAP Canal. *

* 47.77 miles is the combined area contributing to the reservoir behind the CAP Canal east of Grand Avenue and west of 163rd Avenue.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
43A	Inflow	109.	328.	503.	1068.	1382.	2.98	Chrysler Proving
	Outflow	109.	326.	498.	1049.	1351.	2.98	Grounds
43B		133.	262.	347.	578.	692.	1.52	
43C	Inflow	23.	66.	104.	221.	284.	0.31	Chrysler Proving
	Outflow	20.	52.	76.	117.	126.	0.31	Grounds
43D	Inflow	26.	77.	120.	251.	330.	0.35	Chrysler Proving
	Outflow	25.	74.	94.	127.	138.	0.35	Grounds
43E	Inflow	25.	74.	118.	245.	321.	0.32	Chrysler Proving
	Outflow	23.	61.	94.	143.	158.	0.32	Grounds
44	Inflow	168.	549.	874.	1875.	2448.	8.38	CAP3EAST Third Overchute
	Outflow	69.	137.	190.	288.	330.	47.77	east of Grand Avenue on CAP Canal. *
45	Inflow	25.	104.	185.	487.	690.	2.29	CAP4EAST Forth Overchute
	Outflow	78.	151.	207.	303.	340.	47.77	east of Grand Avenue on CAP Canal. *

* 47.77 miles is the combined area contributing to the reservoir behind the CAP Canal east of Grand Avenue and west of 163rd Avenue.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
								CAP5EAST
46	Inflow	14.	65.	118.	328.	458.	1.22	Fifth Overchute
	Outflow	83.	151.	202.	302.	346.	47.77	east of Grand Avenue on CAP Canal. *
47C		1061.	2078.	2749.	4535.	5428.	16.43	Picacho Wash
47B		584.	1269.	1769.	3205.	3939.	18.73	Me Wash
47A		559.	1291.	1835.	3350.	4122.	20.63	
								CAP6EAST
47	Inflow	556.	1285.	1823.	3318.	4080.	20.87	Sixth Overchute
	Outflow	88.	162.	217.	313.	350.	47.77	east of Grand Avenue on CAP Canal. *
								CAP7EAST
48	Inflow	247.	721.	1131.	2487.	3286.	9.63	Seventh Overchute
	Outflow	82.	158.	215.	313.	350.	47.77	east of Grand Avenue on CAP Canal. *

* 47.77 miles is the combined area contributing to the reservoir behind the CAP Canal east of Grand Avenue and west of 163rd Avenue.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
								CAP8EAST
49	Inflow	8.	34.	61.	166.	234.	0.57	Eight Overchute
	Outflow	86.	164.	224.	321.	357.	47.77	east of Grand Avenue on CAP Canal. *
								CAP9EAST
50	Inflow	5.	24.	46.	128.	191.	0.32	Ninth Overchute
	Outflow	72.	148.	205.	301.	337.	47.77	east of Grand Avenue on CAP Canal. *
								CAP10EAST
51	Inflow	7.	30.	55.	151.	218.	0.48	Tenth Overchute
	Outflow	14.	43.	65.	145.	191.	23.06	east of Grand Avenue on CAP Canal. **

* 47.77 miles is the combined area contributing to the reservoir behind the CAP Canal east of Grand Avenue and west of 163rd Avenue.

** 23.06 miles is the combined area contributing to the reservoir behind the CAP Canal east of 163rd Avenue and west of the end plug.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
52	Inflow	525.	1155.	1658.	3302.	4261.	20.94	
								CAP11EAST & CAP12EAST
	Diversion to 52P1	129.	324.	475.	817.	988.	23.06	Eleventh and Twelth Overchutes east of Grand Avenue on CAP Canal.
								CAP13EAST
	Diversion to 52P2	35.	85.	123.	209.	252.	23.06	Thirteenth Overchute east of Grand Avneue on the CAP Canal. **
52A		405.	778.	1021.	1661.	1982.	4.32	
52B		437.	874.	1162.	1927.	2308.	4.92	
52C		804.	1615.	2150.	3571.	4281.	10.69	
								CAP14EAST
53	Inflow	180.	405.	560.	983.	1200.	1.64	Fourteenth
	Outflow	105.	268.	395.	648.	768.	23.06	Overchute east of Grand Avenue on CAP Canal. **
								CAP15EAST
54	Inflow	135.	317.	443.	787.	963.	0.85	Fifteenth
	Outflow	68.	162.	229.	323.	372.	0.85	Overchute east of Grand Avenue on CAP Caanl.

** 23.06 miles is the combined area contributing to the reservoir behind the CAP Canal east of 163rd Avenue and west of the end plug.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
								CAP16EAST
55	Inflow	285.	594.	804.	1368.	1652.	3.27	Sixteenth
	Outflow	285.	595.	802.	1366.	1650.	3.27	Overchute east of Grand Avenue on CAP Canal.
								CAP17EAST
56	Inflow	164.	315.	414.	673.	801.	0.48	Seventeenth
	Outflow	108.	211.	266.	336.	375.	0.48	Overchute east of Grand Avenue on CAP Canal.
59		57.	170.	270.	602.	811.	2.29	
								CAP5WEST
60	Inflow	540.	1359.	1990.	3904.	4953.	16.23	Fifth Overchute
	Outflow	530.	1322.	1886.	3053.	3724.	16.23	west of Grand Avenue on CAP Canal.
60A		358.	874.	1263.	2447.	3063.	9.38	
60B		241.	599.	874.	1743.	2183.	5.31	
60C		59.	171.	268.	591.	786.	1.19	
60D		139.	349.	513.	1029.	1292.	1.78	
61		70.	187.	281.	588.	757.	1.27	
62	Inflow	560.	1517.	2234.	4249.	5309.	31.33	IONA WASH
	Outflow	427.	1084.	1577.	3718.	5001.	31.33	Forth Overchute west of Grand Avenue on CAP Canal.

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
62A		60.	167.	259.	562.	744.	1.58	
62B		527.	1458.	2175.	4253.	5350.	24.66	
62C		519.	1448.	2166.	4257.	5360.	23.77	
62E		468.	1321.	1981.	3904.	4915.	22.11	
62G		218.	625.	948.	1932.	2470.	7.93	
62H		91.	264.	406.	869.	1122.	2.42	
62I		48.	139.	215.	467.	591.	0.99	
62K		169.	498.	766.	1604.	2064.	5.98	
62L		26.	81.	131.	295.	372.	0.45	
62M		22.	73.	119.	267.	353.	0.74	
63	Inflow	531.	1263.	1773.	3135.	3851.	26.03	TRILBY WASH Third Overchute west of Grand Avenue on CAP Canal.
	Outflow	531.	1262.	1773.	3129.	3845.	26.03	
63A		68.	216.	349.	803.	1088.	2.67	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
63B		496.	1037.	1410.	2460.	3035.	17.92	
63C		559.	1156.	1567.	2705.	3322.	20.58	
64	Inflow	314.	827.	1228.	2471.	3172.	14.47	CAP2WEST Second Overchute
	Outflow	240.	628.	924.	1795.	2268.	14.47	west of Grand Avenue on CAP Canal.
C64A 64A		81.	222.	332.	709.	926.	2.67	
C64B 64B		182.	479.	715.	1461.	1897.	8.28	
65	Inflow	435.	1476.	2423.	5171.	6548.	33.08	CAP1WEST First Overchute
	Outflow	435.	1429.	2280.	4611.	6455.	33.08	west of Grand Avenue on CAP Canal.
65A		177.	519.	808.	1749.	2291.	10.98	
65B		172.	507.	792.	1729.	2275.	10.10	
66		10.	47.	86.	242.	345.	0.54	
67		402.	853.	1178.	2113.	2594.	6.74	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
68		452.	974.	1345.	2416.	2977.	8.41	
69		365.	836.	1162.	2062.	2528.	9.12	
70		638.	1446.	2013.	3520.	4286.	16.02	
70A		503.	1014.	1355.	2265.	2720.	5.87	
71		510.	1150.	1595.	2806.	3428.	16.85	
72		515.	1159.	1608.	2832.	3459.	18.95	
73		422.	938.	1304.	2309.	2830.	23.27	
74		402.	886.	1230.	2177.	2669.	26.04	
75		128.	278.	380.	658.	798.	1.51	
76T	Trilby Wash	1244.	3268.	4773.	8999.	11688.	113.00	Flow from Trilby Wash along at 76T.
	Total at Trilby	1527.	4010.	5837.	10853.	14002.	139.04	Combined flow from Trilby Wash and flow along McMicken Dam from the south.
77T		101.	294.	436.	842.	1054.	2.15	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
78T		1225.	3185.	4646.	8769.	11499.	103.94	
79T		26.	104.	181.	476.	663.	2.80	
81T		696.	1847.	2751.	4844.	6036.	42.38	Flow from CAP5WEST and White Tanks Mountains at 83T.
83T		666.	1726.	2517.	5211.	6965.	60.46	Flow from Iona and Trilby Wash at 83T.
83T		1362.	3573.	5268.	10055.	13001.	102.84	Approximate combined flow at 83T.
86AT		232.	520.	720.	1266.	1543.	2.77	
87T		666.	1758.	2612.	4497.	5548.	37.56	
89T		605.	1565.	2292.	3725.	4554.	25.17	
89AT		127.	310.	442.	814.	1006.	2.69	
90T		36.	137.	235.	600.	824.	2.23	
91		1663.	4487.	6573.	12423.	15990.	161.48	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
93		261.	676.	988.	1888.	2377.	21.32	
95		254.	660.	966.	1856.	2340.	18.61	
96		23.	105.	191.	526.	755.	1.89	
97	Inflow	2095.	5585.	8297.	16882.	20431.	258.85	Flow at Outlet
Diversion	to 103	0.	0.	0.	0.	0.	258.85	Works of McMicken
	Outflow	673.	760.	944.	2298.	2998.	258.85	Dam.
97A		8.	34.	60.	160.	223.	0.81	
98A		15.	63.	112.	302.	426.	1.33	
100		39.	108.	164.	351.	449.	0.74	
101		199.	391.	543.	1312.	1773.	6.07	
102		521.	1578.	2460.	4873.	6219.	87.49	
102A		503.	1532.	2412.	4803.	6228.	84.43	
103		16.	53.	87.	199.	276.	0.37	
104	Inflow	1.	4.	8.	26.	38.	0.04	AT&SF Railroad
Diversion	to 105	0.	0.	0.	0.	0.	0.04	
	Outflow	1.	4.	8.	26.	38.	0.04	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
105	Inflow	1.	3.	7.	21.	30.	0.03	AT&SF Railroad
Diversion to 105		0.	0.	0.	0.	0.	0.03	
	Outflow	0.	2.	4.	10.	15.	0.03	
106	Inflow	52.	130.	190.	287.	330.	0.06	AT&SF Railroad
Diversion to 107		0.	0.	0.	0.	0.	0.06	
	Outflow	52.	130.	190.	287.	330.	0.06	
107	Inflow	70.	149.	211.	311.	354.	0.32	AT&SF Railroad
Diversion to 108		0.	0.	0.	0.	0.	0.32	
	Outflow	70.	149.	211.	311.	354.	0.32	
108	Inflow	9.	44.	80.	231.	321.	0.67	AT&SF Railroad
Diversion to 109		0.	0.	0.	0.	0.	0.67	
	Outflow	9.	44.	80.	230.	319.	0.67	
109	Inflow	2.	11.	21.	64.	93.	0.12	AT&SF Railroad
Diversion to 110		0.	0.	0.	3.	8.	0.12	
	Outflow	2.	11.	21.	58.	79.	0.12	
110	Inflow	169.	328.	446.	669.	786.	2.06	AT&SF Railroad
Diversion to 111		0.	0.	0.	0.	0.	2.06	
	Outflow	169.	328.	446.	669.	785.	2.06	
111	Inflow	5.	23.	43.	121.	168.	0.35	AT&SF Railroad
Diversion to 112		3.	19.	36.	102.	144.	0.35	
	Outflow	2.	4.	7.	18.	23.	0.35	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
112	Inflow	20.	91.	164.	440.	614.	1.34	AT&SF Railroad
Diversion	to 113	0.	0.	0.	0.	0.	1.34	
	Outflow	20.	91.	164.	439.	613.	1.34	
113	Inflow	6.	25.	44.	116.	162.	0.59	AT&SF Railroad
Diversion	to 114	0.	0.	0.	0.	0.	0.59	
	Outflow	6.	25.	44.	116.	162.	0.59	
114	Inflow	1.	7.	14.	43.	59.	0.08	AT&SF Railroad
Diversion	to 115	0.	0.	0.	20.	32.	0.08	
	Outflow	1.	7.	14.	18.	20.	0.08	
115	Inflow	3.	10.	18.	41.	59.	0.05	AT&SF Railroad
Diversion	to 116	0.	0.	3.	22.	35.	0.05	
	Outflow	2.	9.	12.	15.	17.	0.05	
116	Inflow	43.	137.	226.	536.	703.	1.00	AT&SF Railroad
	Outflow	36.	136.	225.	532.	697.	1.00	
117		493.	921.	1232.	1805.	2044.	6.08	Flow at end of dike along Happy Valley Road.
117A		487.	907.	1214.	1772.	2006.	5.14	
117D		99.	177.	236.	339.	382.	0.55	
117E		194.	362.	489.	696.	779.	1.03	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
117F		192.	357.	483.	681.	762.	0.63	
118		38.	130.	215.	511.	683.	1.39	
119		731.	1349.	1717.	2856.	3823.	293.93	
120	Inflow	492.	948.	1276.	1945.	2227.	31.36	Flow through
	Outflow	488.	948.	1275.	1945.	2227.	31.36	first siphon east of Grand Avenue on Beardsley Canal.
121		843.	1918.	2613.	4266.	5064.	303.82	
122		844.	1921.	2613.	4279.	5087.	304.92	Flow at end of McMicken Dam Outlet Channel.
123	Inflow	357.	864.	1259.	2201.	2718.	9.34	Flow through
	Outflow	349.	811.	1164.	2201.	2718.	9.34	second siphon east of Grand Avenue on Beardsley Canal.
123A		161.	379.	540.	940.	1122.	2.29	Flow through breach in dike northeast of Lake Bonita.
123B		148.	353.	509.	909.	1079.	1.35	

CONCENTRATION POINT NOS.	STATION	2-YR (CFS)	5-YR (CFS)	10-YR (CFS)	50-YR (CFS)	100-YR (CFS)	BASIN AREA	LOCATION REMARKS
124	Inflow	207.	496.	711.	1205.	1448.	3.07	Flow over spillway section of Lake Bonita.
	Outflow	173.	441.	646.	1138.	1409.	3.07	
124A		152.	371.	535.	909.	1094.	1.31	
124B		44.	104.	147.	288.	397.	0.90	
125	Inflow	577.	1444.	2062.	3747.	4535.	10.19	Flow through third siphon east of Grand Avenue on Beardsley Canal.
	Outflow	576.	1418.	1998.	3582.	4197.	10.19	
127		504.	1262.	1797.	3222.	3898.	8.72	
127A		347.	775.	1064.	1755.	2078.	4.61	
128		31.	115.	194.	469.	662.	0.82	
129		70.	237.	389.	905.	1233.	2.48	
130		109.	338.	529.	1135.	1495.	4.09	
131		16.	54.	89.	217.	294.	0.59	
132		904.	2074.	2835.	4747.	6023.	318.13	
134		937.	2131.	2917.	5085.	6522.	322.99	Flow from McMicken Dam Wash into Agua Fria River.

APPENDIX B

ELEVATION REFERENCE MARKS

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 1	Brass Cap in Concrete on Top of McMicken Dam, Stamped 40.	MC-15	Pub 1360.94
R.M. 2	Brass Cap in Concrete on Top of McMicken Dam, Stamped 65.	MC-15	Pub 1361.36
R.M. 3	Brass Cap in Concrete on Top of McMicken Dam, Stamped 90.	MC-15	Pub 1361.27
R.M. 4	Brass Cap in Concrete on Top of McMicken Dam, Stamped 115.	MC-15	Pub 1361.38
R.M. 5	Brass Cap in Concrete on Top of McMicken Dam, Stamped 140.	MC-15	Pub 1361.34
R.M. 6	Brass Cap in Concrete, Beardsley Road and Cactus Road, Stamped M265.	MC-15	Pub 1326.20
R.M. 7	Brass Cap in Concrete on Top of McMicken Dam, Stamped 165.	MC-14	Pub 1361.27
R.M. 8	Brass Cap in Concrete on Top of McMicken Dam, Stamped 190.	MC-14	Pub 1360.98
R.M. 9	Brass Cap in Concrete on Top of McMicken Dam, Stamped 215.	MC-14	Pub 1361.05

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 10	Brass Cap in Concrete on Top of McMicken Dam, Stamped 240.	MC-14	Pub 1360.89
R.M. 11	Brass Cap in Concrete on Top of McMicken Dam, Stamped 265.	MC-14	Pub 1361.25
R.M. 12	Brass Cap in Headwall, Beardsley Canal & Waddell Road, Stamped K475.	MC-14	1327.60
R.M. 13	Brass Cap in Top of Concrete Post. Beardsley Canal & Bell Road, Stamped Q265.	MC-13	1327.53
R.M. 14	Brass Cap in Concrete on Top of McMicken Dam, Stamped 290.	MC-13	1361.02
R.M. 15	Brass Cap in Concrete on Top of McMicken Dam, Stamped 315.	MC-13	1360.88
R.M. 16	Brass Cap in Concrete on Top of McMicken Dam, Stamped 340.	MC-13, T-12	1360.98
R.M. 17	Brass Cap in Concrete Headwall, Beardsley Canal & Union Hills Drive, Stamped R265.	MC-13, T-12	1332.86
R.M. 18	Brass Cap in Concrete on Top of McMicken Dam, Stamped 365.	MC-13, T-12	1361.09

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 19	Brass Cap in Concrete on Top of McMicken Dam, Stamped 390.	MC-13	Pub. 1360.83
R.M. 20	Brass Cap in Concrete on Top of McMicken Dam, Stamped 415.	MC-13	Pub. 1361.16
R.M. 21	Brass Cap in Concrete on Top of McMicken Dam, Stamped 440.	MC-19	Pub. 1361.57
R.M. 22	5/8-Inch Copper Coated Rod Encased in a 5-Inch Iron Pipe, Beardsley Canal at Cotton Lane, Stamped L366.	MC-19	1334.41
R.M. 23	Brass Cap in Concrete on Top of McMicken Dam, Stamped 465.	MC-19	Pub. 1361.25
R.M. 24	Brass Cap in Concrete on Top of McMicken Dam, Stamped 490.	MC-19	Pub. 1361.21
R.M. 25	Brass Cap in Concrete on Top of McMicken Dam, Stamped 500.	MC-19	Pub. 1361.45
R.M. 26	Brass Cap Set in the Top of the East End of the South Wall of the Concrete Spillway at the McMicken Dam Outlet Structure, Stamped H366.	MC-19	Pub. 1339.78

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 27	Brass Cap on Top of Pipe, Section Corner 30 | 24 / 31 | 32.	MC-9, T-10	1440.03
R.M. 28	Find Set Rebar with Yellow Cap, Section Corner 13 | 18 / 24 | 19.	MC-8, T-5	1459.30
R.M. 29	Find Set Rebar with Yellow Cap, 1/4 Corner 13 | 18.	MC-8, T-5	1469.01
R.M. 30	Find Set Rebar with Yellow Cap, Section Corner 12 | 7 / 13 | 18	MC-7 T-3	1481.41
R.M. 31	Brass Cap on Top of Pipe, 1/4 Corner 12 | 7	MC-7	1494.40
R.M. 32	Brass Cap on Top of Pipe, Section Corner 36 | 31.	MC-6	1522.18
R.M. 33	Brass Disk at CAP Station 801+77.63, 125' South of Centerline on R.O.W.	PC-1	Pub. 1547.809
R.M. 34	Brass Disk at CAP Station 790+99.52, 125' South of Centerline on R.O.W.	PC-1	Pub. 1545.236

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 35	Brass Disk at CAP Station 766+42.02, 196' South of Centerline on R.O.W.	PC-1	Pub. 1544.545
R.M. 36	Brass Disk at CAP Station 725+99.33, 125' South of Centerline on R.O.W.	PC-1	Pub 1546.197
R.M. 37	Brass Disk at CAP Station 699+99.94, 125' South of Centerline on R.O.W.	PC-1	Pub 1540.743
R.M. 38	1574 (U.S.G.S.).-- 10.4 miles southwest along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, Maricopa County, 3.0 miles southeast of the siding at Wittmann, between the highway and the railroad, and 60 feet southwest of the centerline of the track. A United States Geological Survey standard cap, stamped "1574 PHNX" and rivited on the top of a 3-1/2-inch iron pipe.	PC-1	Pub. 1573.146
R.M. 39	Brass Cap on Top of Pipe, 1/4 Corner 14 | 13	MC-5, T-5	1485.90
R.M. 40	Brass Cap in Concrete, Near Section 14 | 13 / 23 | 24.	MC-5, T-5	1473.77

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 41	Find Rebar, 1/4 Corner 23|24	MC-5 T-7	1466.60
R.M. 42	Brass Cap on Top of Pipe, 1/4 Corner 15|14	MC-5	1513.53
R.M. 43	Brass Cap on Top of Pipe, 1/4 Corner 22|23	MC-5	1509.51
R.M. 44	Rebar on Section Corner 2|1 / 11|12	MC-4	1526.29
R.M. 45	Brass Cap on Top of Pipe, 1/4 Corner 11|12	MC-4, T-3	1511.84
R.M. 46	Brass Cap on Top of Pipe, Section Corner 11|12 / 14|13	MC-4, T-3	1500.81
R.M. 47	Brass Disk at Cap Station 598+99.65 175' South of Centerline on ROW REACH 8	MC-4, T-1	Pub. 1551.363
R.M. 48	Brass Disk at Cap Station 559+99.95 125' South of Centerline on ROW. REACH 8	MC-4, T-2	Pub. 1542.344

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 49	Brass Disk at Cap Station 679+99.93 125' South of Centerline on ROW. REACH 8	MC-3	Pub. 1541.191
R.M. 50	Brass Disk at Cap Station 659+47.64 125' South of Centerline on ROW. REACH 8	MC-3	Pub. 1546.767
R.M. 51	Brass Disk at Cap Station 630+98.76 114.35' South of Centerline on ROW. REACH 8	MC-3	Pub. 1555.547
R.M. 52	Brass Disk at Cap Station 529+99.88 125' South of Centerline on ROW. REACH 8	MC-1	Pub. 1541.884
R.M. 53	Brass Disk at Cap Station 499+68.77 125' South of Centerline on ROW. REACH 8	MC-1	Pub. 1533.554
R.M. 54	Brass Disk at CAP Station 474+00.24 125' South of Centerline on ROW. REACH 8	MC-2	Pub 1537.096

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 55	Brass Disk at CAP Station 451+98.91 125' South of Centerline on ROW. REACH 8	MC-2	Pub 1539.544
R.M. 56	Brass Disk at CAP Station 422+99.50 125' South of Centerline on ROW. REACH 8	MC-2	Pub 1545.923
R.M. 57	Brass Disk at CAP Station 28+93.07 125' South of Centerline on ROW. REACH 9	MC-10, G-3	Pub 1544.095
R.M. 58	Brass Disk at CAP Station 44+99.97 125' South of Centerline on ROW. REACH 9	MC-10, G-3	Pub 1540.343
R.M. 59	Brass Disk at CAP Station 69+00.92 125' South of Centerline on ROW. REACH 9	MC-10	Pub 1538.874
R.M. 60	Brass Disk at CAP Station 95+00.14 125' South of Centerline on ROW. REACH 9	MC-10	Pub 1540.570

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 61	Brass Disk at CAP Station 119+00 125' South of Centerline on ROW. REACH 9	MC-10	Pub 1542.939
R.M. 62	RV 99 (A.T.&S.F.Ry.).-- 7.9 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, northwest of milepost 162, northeast of the track, at culvert 162, and in the top of the concrete head wall. A standard Monel-metal rivet.	MC-10, G-3	Pub 1544.541
R.M. 63	RV 98 (A.T.&S.F.Ry.).-- 6.6 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, northwest of milepost 163, at the southwest end of trestle A 163, on top of the shelf of the concrete wing wall, and 12 feet southwest of the center line of the track. A standard Monel-metal rivet.	MC-10, G-3	Pub 1491.595

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 64	A 24.-- 5.5 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, 2.0 miles northwest of Mountain View, 250 feet west of milepost 164, between the highway and the railroad, 180 feet east of a highway culvert, and 60 feet southwest of the centerline of the track. A standard disk, stamped "A 24 1933" and set in the top of a concrete post. NOTE.--This bench mark was used as reference mark No. 2 for triangulation station Beardsley. Recorded as described - Date 1956.	MC-11, G-4	1446.56 (Pub 1447.028)
R.M. 65	Brass Disk at CAP Station 138+08.80 125' South of Centerline on ROW. REACH 9	MC-16	1541.70 (Pub 1541.696)
R.M. 66	Brass Disk at CAP Station 169+06.33 125' South of Centerline on ROW REACH 9	MC-16	Pub. 1539.37
R.M. 67	Brass Disk at CAP Station 190+00 125' South of Centerline on ROW REACH 9	MC-16	Pub. 1539.85

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 68	Brass Disk at CAP Station 209+98.01 125' South of Centerline on ROW REACH 9	MC-16	Pub. 1544.052
R.M. 69	Brass Disk at CAP Station 228+92.10 125' South of Centerline on ROW REACH 9	MC-16	Pub. 1542.723
R.M. 70	Brass Disk at CAP Station 260+87.31 125' South of Centerline on ROW REACH 9	MC-20	Pub. 1533.70
R.M. 71	Brass Disk at CAP Station 289+07.38 125' South of Centerline on ROW REACH 9	MC-20	Pub. 1537.14
R.M. 72	Brass Disk at CAP Station 321+72.80 125' South of Centerline on ROW REACH 9	MC-20	Pub. 1536.93
R.M. 73	Brass Disk at CAP Station 348+50.00 125' South of Centerline on ROW REACH 9	MC-20	Pub. 1528.60

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 74	Rebar at Base of Bent Brass Cap Section 19 | 20 30 | 29	MC-20	1499.30
R.M. 75	Brass Disk at CAP Station 375+50.00 125' South of Centerline on ROW REACH 9	MC-24	Pub. 1528.60
R.M. 76	Brass Disk at CAP Station 407+07.79 125' South of Centerline on ROW REACH 9	MC-24	Pub. 1539.49
R.M. 77	Brass Disk at CAP Station 433+00.00 125' South of Centerline on ROW REACH 9	MC-24	Pub. 1527.62
R.M. 78	Brass Disk - Section Corner 28 | 27 33 | 34	MC-25	1446.38

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 79	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office at El Mirage, thence 6.05 miles northeast along Canal Road which parallels the southeast side of the Beardsely Canal, in Section 36, T5N, R1W, on the west bank of a wash crossed by a large metal pipe aqueduct, 36 feet southwest of the junction of the aqueduct and the west concrete funnel in the canal, 150 feet north of the centerline of the road, set in the top of the west end of a short wing wall on the southeast side of the funnel, and at the junction of the concrete and rock canal lining and formed concrete funnel. Stamped J266 1948.	MC-25	Pub. 1346.17
R.M. 80	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office at El Mirage, thence 5.05 miles northeast along Canal Road, in Section 2, T4N, R1W, 115 feet north of the centerline of the road, set in the top of the south end of the west concrete headwall of a concrete siphon, and about 12 feet above the level of the wash. Stamped B266 1948.	MC-26	Pub. 1344.17

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 81	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office at El Mirage, thence 4.32 miles northeast along Canal Road which parallels the southeast side of the Beardsley Canal, in Section 3, T4N, R1W, 31 feet southeast of the centerline of the road, 3 feet northeast of a telephone pole, in line with a row of poles, 2.6 feet southwest of a 4x4 inch wooden witness post, about 3 feet below the level of the road, and set in the top of a concrete post. Stamped A266 1948.	MC-26	Pub. 1340.15
R.M. 82	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office at El Mirage, thence 3.3 miles northeast along Canal Road which parallels the southeast side of the centerline of a wash, 30 feet southeast of the centerline of the road, 10 feet southwest of a telephone pole, in line with a row of poles, 1.4 feet northeast of a metal witness post, and on the top of a 5/8-inch copper coated rod that is driven to a depth of 8 feet and is encased in a 5-inch iron pipe which projects 12 inches. Stamped Q366 1967.	MC-26	Pub. 1339.73

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 83	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office at El Mirage, thence 2.45 miles northeast along Canal Road which parallels the southeast side of the Beardsley Canal, in Section 9, T4N, R1W, 120 feet north of the centerline of the road, set in the top of a 45 degree angle in the old concrete retaining wall at the west end of a concrete siphon, and 8 feet southwest of the south end of the headwall of the siphon. Stamped W265 1948.	MC-26	Pub. 1340.76
R.M. 84	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office in El Mirage, thence 1.2 miles northeast along Canal Road which parallels the southeast side of the Beardsley Canal, in Section 18, T4N, R1W, 40 feet southeast of the centerline of the road, 28 feet southeast of a fence which parallels the road. 1-1/2 feet west of a fence which leads south, 2.4 feet north of a metal witness post about 3 feet below the level of the road, and set in the top of a concrete post projecting 6 inches. Stamped Y265 1948.	MC-22	Pub. 1336.55

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 85	About 7.0 miles northwest along U.S. Highways 60, 70 and 89 and State Highway 93 from the post office at El Mirage, thence 0.7 mile northeast along Canal Road which parallels the southwest side of the Beardsley Canal, in Section 18, T4N, R1W, 0.15 mile southwest of a farmhouse, 25 feet southeast of the centerline of Canal Road, 27-1/2 feet northwest of a power pole which is braced by a guy wire, 19 feet northeast of the more northeasterly of two poles which bears a platform supporting a transformer, set in the top of the east corner of a concrete platform which is poured around an abandoned and capped well casing, and about 2-1/2 feet below the level of the road. Stamped N366 1967.	MC-23, G-4	Pub. 1337.95

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 86	About 7.0 miles northwest along U.S. Highways 60, 70, and 89 and State Highway 93 from the post office at El Mirage, in Section 13, T4N, R2W, 67 yards west of the center of the intersection of U.S. Highways 60, 70 and 89, State Highway 93 and Canal Road, 95-1/2 feet southwest of the center-line of the highways, 130 feet west of the northwest end of the southwest concrete head wall of a culvert under the highways, 18-1/2 feet southeast of a power pole which is braced by a guy wire, 1.7 feet northeast of a metal witness post, about 1-1/2 feet below the level of the highways, and on the top of a 5/8-inch copper coated rod that is driven to a depth of 18 feet and is encased in a 5-inch iron pipe which projects 8 inches.	MC-23, G-4	Pub. 1338.96

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 87	1351 (U.S.G.S.) -- 2.3 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, 0.2 mile northwest of milepost 167, between the highway and the railroad, and 100 feet southwest of the centerline of the track. A United States Geological Survey standard cap, Stamped #1351 PHNX" and riveted on the top of a 3-1/2-inch iron pipe.	MC-19, G-4	1350.17 (Pub. 1350.699)
R.M. 88	RV 94 (A.T.& S.F.Ry.).-- 2.9 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, northwest of milepost 167, northeast of the track, at culvert C 167, and in the top of the concrete head wall. A standard Monel-metal rivet.	MC-19, G-4	1367.92 (Pub. 1368.426)
R.M. 89	Z 23.-- 3.2 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, at Mountain View, 450 feet southeast of milepost 166, between the highway and the railroad, and 45 feet southwest of the centerline of the track. A standard disk, stamped #Z 23 and set in the top of a concrete post.	MC-18 G-4	1372.29 (Reset)

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 90	RV 96 (A.T.&S.F.Ry.).-- 4.4 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, northeast of the track, at culvert C 165, and in the top of the concrete head wall. A standard Monel-metal rivet.	G-4	1411.73 (Pub. 1412.359)
R.M. 91	1451 (U.S.G.S.).-- 5.4 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, 1/4 mile northwest of milepost 164, between the highway and railroad, and 75 feet southwest of the centerline of the track. A United States Geological Survey standard cap, stamped "1451 PHNX" and riveted on the top of a 3-1/2 inch iron pipe.	MC-11 G-6	1450.75 (Pub. 1450.827)
R.M. 92	RV 97 (A.T.&S.F.Ry.).-- 5.8 miles northwest along the Atchison, Topeka & Santa Fe Railway from Beardsley, Maricopa County, northwest of milepost 164, northeast of the track, at culvert B 164, and in the top of the concrete headwall. A standard Monel-metal rivet.	MC-10 G-4	1464.21 (Pub. 1464.584)

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 93	9.6 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, Maricopa County, 2.2 miles northeast of the siding at Wittmann, 96 feet southwest of milepost 160, between the highway and the railroad, and 60 feet southwest of the centerline of the track. A standard disk stamped "C 24 1933" and set in the top of a concrete post.	G-3	1606.36 (Pub. 1606.496)
R.M. 94	9.0 miles southeast along the Atchison Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 160, northeast of the track, at culvert A 160, and in the top of the concrete headwall. A standard Monel-metal rivet.	G-3	1635.51 (Pub. 1635.630)
R.M. 95	7.9 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 159, opposite bridge A 159, at a highway bridge and in the top of the east concrete wind wall. A standard Monel-metal rivet.	G-2, W-2	Pub. 1678.540

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 96	7.8 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, at Wittmann, 600 feet southeast of milepost 158, 450 feet southeast of the southeast switch block, at bridge A159, in the top of the northwest concrete abutment, and 10 feet southwest of the centerline of the track. A standard disk, stamped "D 24 1933."	G-2 W-2	1679.05 (Pub. 1679.094)
R.M. 97	7.4 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, at the siding at Wittmann, 450 feet northwest of the station booth, 200 feet northwest of culvert E 158, and 75 feet northeast of the centerline of the track. A United States Geological Survey standard cap, stamped "1697 PHNX" and riveted on the top of a 3-1/2" iron pipe.	G-2, W-2	1695.85 (Pub. 1695.922)
R.M. 98	5.7 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 157, at the southeast end of bridge Aa 157, southwest of the track, and in the top of the concrete parapet wall. A standard Monel-metal rivet.	G-2	1767.66 (Pub. 1767.674)

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 99	5.4 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, 600 feet northwest of milepost 156, at culvert G 156, and in the top of the southwest concrete headwall. A standard disk, stamped "E 24 1933."	G-2	Pub. 1781.529
R.M. 100	4.6 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 156, at culvert A 156, and in the top of the northeast concrete headwall. A standard Monel-metal rivet.	G-2	1823.13 (Pub. 1823.074)
R.M. 101	3.7 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, 0.2 mile southeast of milepost 154, near Big Chief store, at culvert B 155, and in the top of the southwest concrete headwall. A standard disk, stamped F 24 1933."	G-2, C-2	Pub. 1865.544

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 102	3.6 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 155, at culvert A 155, and in the top of the northeast concrete headwall. A standard Monel-metal rivet.	G-2, C-2	1873.20 (Pub. 1873.188)
R.M. 103	3.4 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, 0.2 mile northwest of milepost 154, 0.2 mile northwest of Big Chief store, between the highway and the railroad, and 50 feet southwest of the centerline of the track. A United States Geological Survey standard cap, stamped "1883 PHNX" and riveted on the top of a 3-1/2-inch iron pipe.	G-1, C-1	Pub. 1882.860
R.M. 104	2.7 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 154, at culvert A 154, and in the top of the northeast concrete headwall. A standard Monel-metal rivet.	G-1, C-1	Pub. 1903.986

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 105	1.7 miles southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, northwest of milepost 153, at culvert A 153, and in the top of the northeast concrete headwall. A standard Monel-metal rivet.	G-1	1942.41 (Pub. 1942.427)
R.M. 106	0.8 mile southeast along the Atchison, Topeka & Santa Fe Railway from Hot Springs Junction, at a concrete highway overpass, in the top ofthe west wing of the north abutment, and 3 feet higher than the track. A standard disk, stamped "G 24 1933."	G-1	Pub. 1961.381

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 107	At Hot Springs Junction (Morristown), Maricopa County, 250 feet northwest of the Atchison, Topeka & Santa Fe Railway station, at a road crossing, 60 feet northeast of the centerline of the track, and 30 feet north of the centerline of the road. A United States Geological Survey standard cap, stamped "1971 PHNX" and riveted on the top of a 3-1/2 inch iron pipe.	G-1	Pub. 1970.682
R.M. 108	Brass Cap in the west 1/4 Corner of Section 26 or the east 1/4 Corner of Section 25. T5N, R2W.	MC-17	Pub. 1506.25
R.M. 109	B.M. 5/8" I.P. in concrete 100 feet Rt. Sta. 48+14	MH-1	2029.11 (Pub. 2030.82)
R.M. 110	Brass Cap 100 Rt. on east edge at Cattle Guard Sta. 65+73	MH-1	Pub. 2023.35
R.M. 111	Brass Cap 100 feet Rt. Sta. 96+22	MH-1	Pub. 2034.59

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 112	Brass Cap Top of Headwall Rt. Sta. 107+60	MH-1	2036.78 (Pub. 2036.73)
R.M. 113	Brass Cap Top of Headwall Rt. Sta. 126+76	MH-1	2041.65 (Pub. 2041.49)
R.M. 114	Brass Cap Top of Headwall Rt. Sta. 144+50	MH-1	2060.56 (Pub. 2060.31)
R.M. 115	Brass Cap Top of Headwall Rt. Sta. 201+30	MH-1	2071.13 (Pub. 2070.91)
R.M. 116	Brass Cap Top of Headwall Rt. Sta. 219+50	MH-1	Pub. 2059.07
R.M. 117	Brass Cap Top of Headwall Rt. Sta. 231+80	MH-1	2056.08 (Pub. 2056.00)
R.M. 118	Brass Cap Top of Headwall Rt. Sta. 247+70	MH-1	Pub. 2039.13

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 119	Brass Cap Top of Headwall Rt. Sta. 290+10	MH-1	2048.42 (Pub. 2048.27)
R.M. 120	Brass Cap Top of Headwall Rt. Sta. 297+80	MH-1	Pub. 2043.84
R.M. 121	Brass Cap Top of Headwall Rt. Sta. 322+43	MH-1	2022.70 (Pub. 2022.63)
R.M. 122	Brass Cap Top of Headwall Rt. Sta. 333+13	MH-2	Pub. 2019.71
R.M. 123	Brass Cap Top of Headwall Rt. Sta. 360+23	MH-2	2004.11 (Pub. 2004.06)
R.M. 124	Brass Cap Top of Headwall Rt. Sta. 383+85	MH-2	1996.11 (Pub. 1996.04)
R.M. 125	Brass Cap Top of Headwall Rt. Sta. 392+40	MH-2	1993.46 (Pub. 1993.40)

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 126	Brass Cap Top of Headwall Rt. Sta. 414+50	MH-2	1982.14 (Pub. 1982.14)
R.M. 127	Brass Cap Top of Headwall Rt. Sta. 439+50	MH-2	Pub. 1963.87
R.M. 128	Brass Cap Top of Headwall Rt. Sta. 460+59	MH-2	1978.63 (Pub. 1978.54)
R.M. 129	Brass Cap Top of Headwall Rt. Sta. 476+59	MH-2	Pub. 1978.00
R.M. 130	Brass Cap Top of Headwall Rt. Sta. 484+30	MH-2	1987.91 (Pub. 1987.85)
R.M. 131	Brass Cap Top of Headwall Rt. Sta. 500+00	MH-2	Pub. 1982.45
R.M. 132	Brass Cap Top of Headwall Rt. Sta. 538+70	MH-2	Pub. 1967.42
R.M. 133	Brass Cap 100 feet Rt. in ROW Sta. 555+43	MH-2	Pub. 1969.03

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 134	Brass Cap Top of Headwall Lt. Sta. 572+46	MH-2	Pub. 1951.57
R.M. 135	Brass Cap Top of Headwall Lt. Sta. 592+98	MH-2	Pub. 1921.97
R.M. 136	Brass Cap Top of Headwall Lt. Sta. 607+30	MH-2	Pub. 1916.14
R.M. 137	Brass Cap Top of Headwall Lt. Sta. 620+35	MH-3	1906.16 (Pub. 1907.40)
R.M. 138	Brass Cap Top of Headwall Lt. Sta. 654+50	MH-3	1866.70 (Pub. 1867.94)
R.M. 139	Brass Cap 100 feet Rt. in ROW Sta. 675+00	MH-3	Pub. 1858.53
R.M. 140	Brass Cap Top of Headwall Lt. Sta. 709+40	MH-3	Pub. 1839.83
R.M. 141	Brass Cap Top of Headwall Lt. Sta. 734+07	MH-3	Pub. 1860.14

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 142	Brass Cap Top of Headwall Lt. Sta. 748+74	MH-3	Pub. 1897.50
R.M. 143	Brass Cap Top of Headwall Lt. Sta. 773+10	MH-3	Pub. 1930.22
R.M. 144	Brass Cap 100 feet Rt. in ROW Sta. 798+97	MH-3	Pub. 1953.91
R.M. 145	Brass Cap 100 feet Rt. in ROW Sta. 823+68	MH-3	Pub. 1917.46
R.M. 146	Rebar at PP-1015 Near Section Corner 2 | 1 / 11 | 12	M-1 & MC-26	1323.74
R.M. 147	Rebar at PP-1024 Near 1/4 Corner 11 | 12	M-1 & MC-26	1306.48
R.M. 148	Rebar at PP-1016 Near 1/4 Corner 12 / 13	M-1	1289.97
R.M. 149	Rebar at PP-1017 Near 1/4 Corner 11 / 14	M-1 & MC-26	1288.17
R.M. 150	Rebar at PP-1003	M-1 & MC-26	1311.92

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 151	Rebar at PP-1004 Near 1/4 Corner 2/11	M-1 & MC-26	1314.21
R.M. 152	Rebar at PP-1025	M-2	1280.29
R.M. 153	Rebar at PP-1018	M-2	1270.45
R.M. 154	Rebar at PP-1028	M-2	1256.92
R.M. 155	Rebar at PP-1027	M-2	1242.91
R.M. 156	Rebar at PP-1019 Near Section Corner 23 | 14 / 24 | 13	M-2	1258.61
R.M. 157	Rebar at PP-1019A Near 1/4 Corner 23/14	M-2	1259.69
R.M. 158	Rebar at PP-1026 Near Center of Section 14	M-2	1271.98
R.M. 159	Rebar at PP-1023 Near Section Corner 26 | 25 / 35 | 36	M-3	1202.43
R.M. 160	Rebar at PP-1030 Near 1/4 Corner 26 | 25	M-3	1221.72
R.M. 161	Rebar at PP-1021	M-3	1231.31

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 162	Rebar at PP-1020	M-3	1240.79
R.M. 163	Rebar at PP-1010	MC-20	1552.43
R.M. 164	Rebar at PP-1011	MC-20	1538.91
R.M. 165	Rebar at PP-1507 Near Section Corner 30 | 29 / 31 | 32	MC-21	1451.83
R.M. 166	Rebar at PP-1007 Near Section Corner 32 | 33 / 5 | 4	MC-21	1391.17
R.M. 167	Rebar at PP-1008	MC-21	1425.08
R.M. 168	Rebar at PP-1001 Near Section Corner 8 | 9 / 17 | 16	MC-22	1318.47
R.M. 169	Rebar at PP-1500	MC-22	1365.09
R.M. 170	Rebar at PP-1013 Near 1/4 Corner 22 | 23	MC-24	1517.30
R.M. 171	Rebar at PP-1503	MC-24 & MC-25	1433.75
R.M. 172	Brass Cap on Steel Post at PP-1505 Section 21 | 22 / 28 | 27	MC-24 & MC-25	BC 1454.56 Gr 1453.41

WITTMANN REFERENCE MARKS

Reference Mark Number	Description	Map Location	Elevation
R.M. 173	Rebar at PP-1504 Near 1/4 Corner 26/35	MC-25	1384.10
R.M. 174	Rebar at PP-1005	MC-25	1347.02
R.M. 175	Rebar at PP-1006	MC-25	1437.60
R.M. 176	Rebar at PP-1002	MC-26	1292.84
R.M. 177	Brass Cap on Section Corner 23 | 24 / 25 | 26	MC-16	1529.72
R.M. 178	Rebar at PP-1009 Near Section Corner 22 | 23 / 27 | 26	MC-16	1558.86
R.M. 179	Rebar at PP-1501 Near Section Corner 26 | 25 / 35 | 36	MC-17	1486.06
R.M. 180	Rebar at PP-1008 Near Section Corner 36 | 31 / 1 | 6	MC-17	1425.08

APPENDIX E

CAPACITY TABLE FOR RAILROAD CULVERTS

APPENDIX E

Capacity Table For Railroad Culverts

Concentration Point	Culvert Size & Type*	Culvert Capacity (cfs)**	100-Year Inflow***(cfs)
C1	4 - 30" CMP 1 - 24" CMP	373	134
C2	6'x 4' BC	468	332
C3	50"x 30" CMPA	335	301
C4	48" CMP	74	374
C5	48" CMP 4'x 4' BC	168	375
C6	36" CMP	12	168
C7	48' Oval RCP	90	141
C8	36" RCP	20	19
C9	2'x 4' BC	12	87
C10 (Iona Wash)	168' Bridge 7' Opening	14784	2371
C11 &	2'x 1.5' BC		
C12	34"x 36" Oval RCPA	115	204
C13	2 - 42" RCP	280	108
C15	4'x 4' CPA 2'x 1.5' BC	188	435
C16	24" RCP 36"x 42" Oval RCPA	90	479
C17	42" Oval RCP	85	309
C18	2'x 1.5' BC 24" RCP 36" RCP	19	179
C19	36" RCP	100	132

Concentration Point	Culvert Size & Type*	Culvert Capacity (cfs)**	100-Year Inflow***(cfs)
C20	2 - 3'x 3' BC	156	422
C21	2'x 1.5' BC	6	220
C22	2'x 1' BC 36"x 42" Oval RCPA	70	276
C23	2 - 10'x 4' BC	460	198
C24	24" Oval RCP	17	8
C25	48" Oval RCP	23	51
C26 (Trilby Wash)	237' Bridge 4' Opening	7200	2970
C27	3'x 2.5' BC 36" Oval RCP	24	53
C28	36"x 42" Oval RCPA	60	188
C29	36" Oval RCP	24	102
C30	48" Oval RCP	100	69
C31	2 - 3'x 4' BC	222	288
C32	42" Oval RCP	40	66
C33	24" Oval RCP 24" Oval RCP	16	41
C34	36" Oval RCP	80	242
C35	36"x 42" Oval RCPA	100	236
C36	24" Oval RCP 84' Bridge 5' Opening	2960	1115
C37	70' Bridge 5' Opening	1680	810
C38	170' Bridge 3' Opening	2550	2202
C39	56' Bridge 7' Opening	3024	270

Concentration Point	Culvert Size & Type*	Culvert Capacity (cfs)**	100-Year Inflow***(cfs)
C40	2 - 30" RCP 3 - 10'x 10' BC	6000	4442
C41	126' Bridge 4.5' Opening	4662	4475
C104	3 - 10'x 5' BC	990	38
C105	42" Oval RCP	15	30
C106	3 - 10'x 3.5' BC	660	330
C107	10 - 10'x 3' BC	1900	354
C108	4 - 11'x 4.5' BC	528	321
C109	2 - 48 CIP	46	93
C110	3'x 2' BC 8 - 7'x 5' BC	1120	786
C111	2 - 36" RCP	2	168
C112	84' Bridge 4' Opening	1120	614
C113	69' Bridge 4' Opening	1470	162
C114	36" Oval RCP	15	59
C115	36" Oval RCP	12	59
C116	2 - 36" CMP	70	703

* Abbreviations: CMP - Corrugated Metal Pipe
BC - Box Culvert
CMPA - Corrugated Metal Pipe Arch
Oval RCP - Oval Reinforced Concrete Pipe
RCP - Reinforced Concrete Pipe
Oval RCPA - Oval Reinforced Concrete Pipe Arch
CIP - Concrete Incased Steel Pipe

** The culvert capacity is based on the highest discharge possible, without any diversion along or flow over the railroad. In most cases, if the culvert capacity is exceeded, the excess flows will continue southeasterly along the railroad.

*** Does not include any attenuation due to storage behind culverts.