Flood Control District of Maricopa County

Volume I - Report

Dambreak Study

Dambreak Analyses for Powerline, Vineyard, and Rittenhouse Flood Retarding Structures (FCD 88-37)

October 1989

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Arizona, U.S.A.

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of
Maricopa County

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LETTER OF TRANSMITTAL

Date: 04-04-90
File No. SQ.1

Maricopa County Department of Civil Defense ATTENTION: C. Goodwin
2035 North 52nd Street
Phoenix, Arizona 85008

SUBJECT: Dambreak analysis report: Powerline, Vineyard, and Rittenhouse Flood Retarding Structures.

We are sending you [X] Attached [ ] Under separate cover via Interoffice mail

the following items: [ ] Shop drawings [ ] Plans [ ] Samples [ ] Specifications

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Copies	Date	No.	Description
1	Oct. '89		Volume I - Report; Dambreak study

These are transmitted as checked: [ ] For approval [ ] Approved as submitted

[X] For your use [ ] Approved as noted [ ] As requested [ ] For review and comment

REMARKS: This report is presented for your use in preparing the Peacetime Disaster Plan warning and evacuation documents.

Copy to: File

Signed: *Ellery A. Biathrow, Jr.*
Ellery A. Biathrow, Jr., P.E.
Deputy Chief, Construction and Operations Division

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JMM James M Montgomery
Consulting Engineers Inc.

October 4, 1989

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

ATTN: Mr. J.M. Rumann
Hydrologist

SUBJECT: Submittal of Final Dambreak Study Report - Dambreak Analyses for Powerline, Vineyard, and Rittenhouse Flood Retarding Structures (FCD 88-37)

Gentlemen:

In accordance with the contract for the subject project, we are herewith submitting final dambreak inundation information for the area downstream of the Powerline, Vineyard, and Rittenhouse Flood Retarding Structures (FRS).

The essential material in this submittal consists of inundation maps showing predicted areas of inundation and arrival times of flood waves. Also submitted is a brief report describing the methodologies and assumptions used to develop the inundation maps.

The final maps and report have been prepared based on comments received from the District.

We would like to thank the District staff for its assistance in providing data and performing review. It has been a pleasure working with the District on this study.

Very truly yours,

Fred K. Duren, Jr.

Fred K. Duren, Jr., P.E., P.G.
Project Manager

/jw

cc: 1213.0020.3.1.2

FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY

DAMBREAK STUDY

DAMBREAK ANALYSES FOR POWERLINE, VINEYARD, AND RITTENHOUSE FLOOD RETARDING STRUCTURES

Prepared by

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October 1989

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ABBREVIATIONS

Abbreviation	Definition
ADWR	Arizona Department of Water Resources
AFB	Air Force Base
CAP	Central Arizona Project
cfs	cubic feet per second
csm	cubic feet per second per square mile
District, FCD	Flood Control District of Maricopa County
FRS	Flood Retarding Structure
ft.	feet
$ft.^2$	square feet
hrs	hours
JMM	James M. Montgomery, Consulting Engineers, Inc.
NWS	National Weather Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
SCS	Soil Conservation Service
USGS	U.S. Geological Survey

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CHAPTER 1

INTRODUCTION

The contract for this project includes two separate elements: hydrologic studies for three drainage basins and dambreak analyses for the three flood retarding structures (FRS) located below these basins. The three FRS's are earthfill construction and are operated by the Flood Control District of Maricopa County (District). The hydrologic studies were the subject of an earlier report (JMM, 1989). The dambreak analyses are the subject of this report.

An introduction of the dambreak study is provided in this chapter of the report. Later chapters describe the technical analyses and results in detail.

PROJECT AUTHORIZATION

The project was authorized by a contract between the District and James M. Montgomery, Consulting Engineers, Inc., (JMM) dated February 22, 1989, and is designated FCD Project No. 88-37.

PROJECT DESCRIPTION

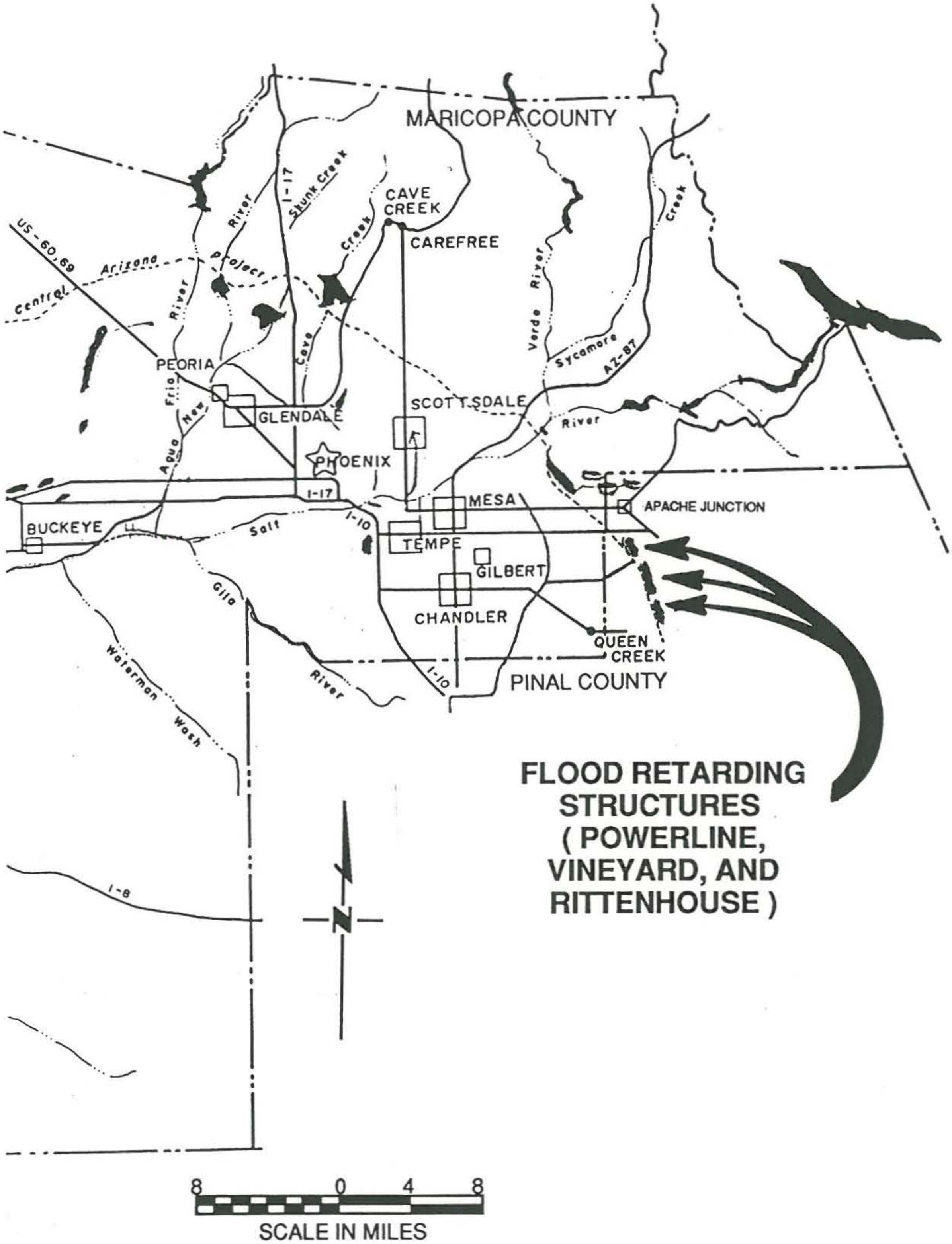
The following paragraphs describe the basic project features.

Location

As shown in Figures 1-1 and 1-2, the three FRS's are located in northwestern Pinal County, south of Apache Junction. The combined watershed above the three FRS's covers 146.9 square miles and extends from the desert floor at a minimum elevation of 1,560 feet northeastward to the peaks of the Superstition Mountains at a maximum elevation of 5,057 feet. The three FRS's provide flood protection to southeastern Maricopa County.

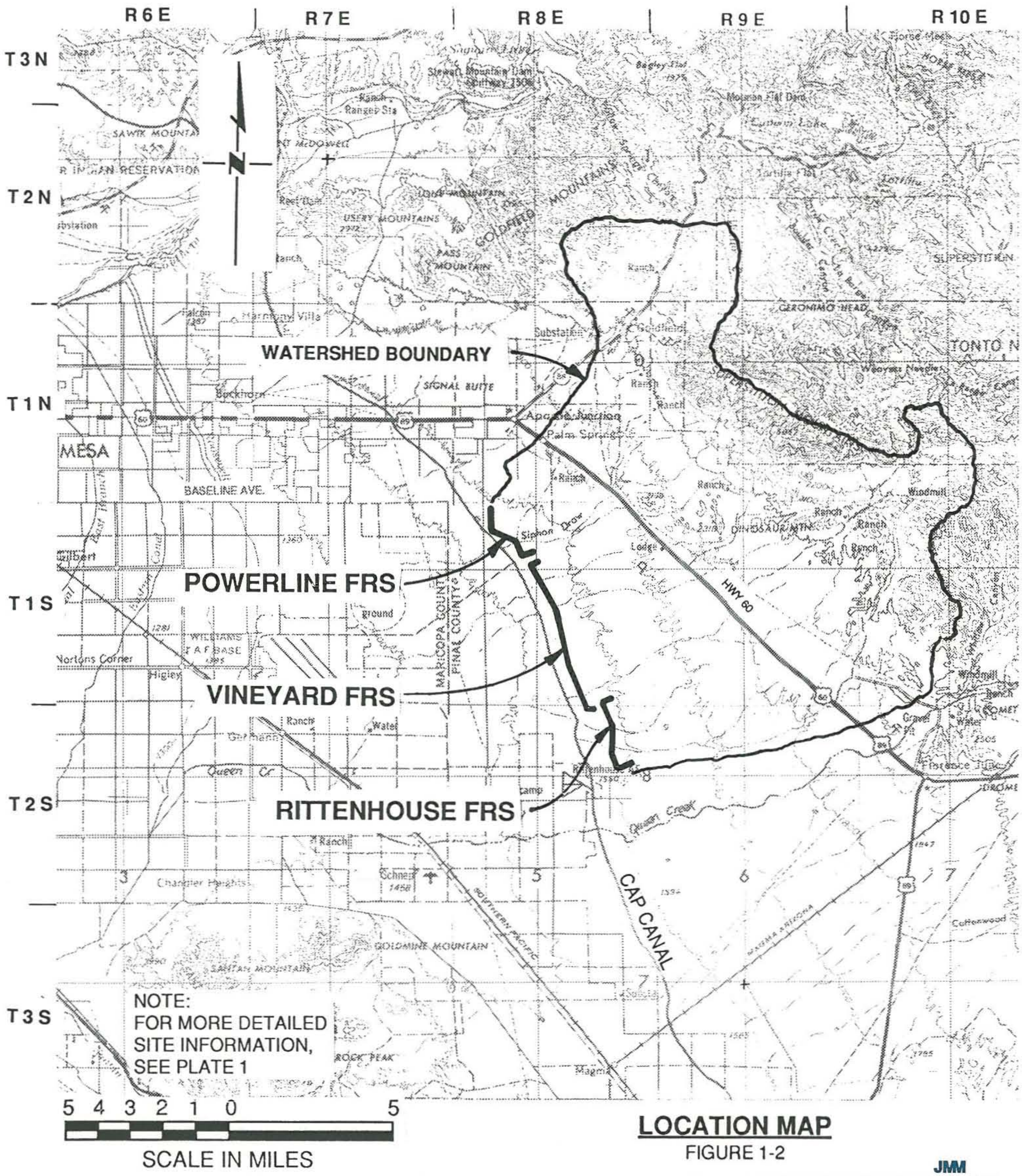
Purposes

There are two purposes for the project. The first is to develop hydrologic models for the basins above Vineyard and Rittenhouse FRS's and to modify the existing hydrologic model above the



VICINITY MAP

FIGURE 1-1



LOCATION MAP

FIGURE 1-2

JMM

Powerline FRS. These models are to be delivered to the District on flexible diskette for its use in performing subsequent hydrologic evaluations of the Vineyard and Rittenhouse drainage basins for later periods when more development has occurred. The models are also to be used to assess the capabilities of each FRS under selected flooding conditions. Discussions of the preparation of the hydrologic models for the three basins and the evaluation of FRS performance are included in the prior report on the hydrologic study.

The second purpose of the project is to develop inundation information for assumed failures of the FRS's. This information is to be submitted by the District to the Arizona Department of Water Resources (ADWR) Dam Safety Division as part of the dam certification requirements for the three FRS's. A discussion of this inundation information is provided in this report.

Scope of Work

The scope of work for the dambreak portion of the project includes the necessary analyses to develop estimated inundation information below the three FRS's, based on assumed dam failures. Due to the elongated nature of the three adjacent structures, it was determined to develop detailed inundation information for the northern portion of the Powerline FRS and for the southern portion of the Rittenhouse FRS. Inundation information for the area between the limits of the detailed inundated areas developed for these two assumed failure sites would be interpolated from the results of the detailed analyses.

The analyses conducted as part of the study included the following:

1. Select the probable maximum flood (PMF) inflow hydrograph for the Powerline and Rittenhouse FRS's having the most critical characteristics for downstream routing.

2. Utilizing the most critical PMF inflow hydrograph, develop failure hydrographs for the two assumed failure sites utilizing the BREACH model developed by the National Weather Services (NWS; NWS, 1988). Analyze both overtopping and piping failures at each site.

3. Select the most critical failure hydrograph at each FRS for input into the NWS DAMBRK model (NWS, 1988) and route the failure hydrograph from each FRS downstream. Terminate the routing at the point where the average depth of flow reached two feet or at pre-determined flow barriers.

The products of the dambreak study includes inundation maps and a report describing the analyses and the economic and social impacts of potential inundation by the assumed dam failures.

COMPLETION SCHEDULE

The original contract requires completion of both phases of the project (i.e., the hydrology and dambreak phases) within 150 calendar days of issuance of Notice to Proceed, exclusive of District review time, which was set at a maximum of 90 days in the contract. Notice to Proceed was received at JMM on March 3, 1989. Thus, project completion is to be achieved by August 5, 1989, exclusive of District review time. The final Hydrology Study report, with related documents, was submitted to the District on August 7, 1989. A contract amendment to include additional work on the project set the time to submit the draft Dambreak Study report at August 31, 1989.

PRIOR STUDIES

As described in the hydrology report for this project, there are several prior hydrologic studies that have been completed for the watershed area. However, relative to the development of inundation information below the three FRS's, there were no prior reports found.

The list of references contained in the Appendix at the back of this report includes technical reports and the computer models utilized in the study.

CHAPTER 2

FAILURE HYDROGRAPHS

INTRODUCTION

This chapter describes the development of failure hydrographs for the assumed failure sites at the north end of the Powerline FRS and at the south end of the Rittenhouse FRS. Discussions of the procedures used to select the critical PMF reservoir inflow hydrographs for input into the BREACH model and the critical failure hydrographs (output from the BREACH model) for input into the DAMBRK model are included.

RESERVOIR INFLOW FLOOD HYDROGRAPHS

Table 2-1 presents the reservoir inflow floods developed in the hydrology study for this project.

TABLE 2-1

**PEAK FLOWS
INFLOW FLOOD HYDROGRAPHS
POWERLINE, VINEYARD, AND RITTENHOUSE FRS'S**

	Flood Retarding Structure					
Flooding Event	Powerline Peak Flow		Vineyard Peak Flow		Rittenhouse Peak Flow	
	(cfs)	(csm)	(cfs)	(csm)	(cfs)	(csm)
25-year	9,101	193	8,895	171	6,669	140
50-year	11,534	245	11,057	212	8,438	177
100-year	12,073	256	12,843	247	9,925	208
PMF						
6-hour	62,044	1,317	59,484	1,142	46,895	983
72-hour	53,807	1,142	57,349	1,101	47,190	989

For the purposes of developing failure hydrographs with the BREACH model at the Powerline and Rittenhouse FRS's, the 6-hour probable maximum floods (PMF) were used. Development of the PMF's are described in the hydrology report for the project. The 6-hour PMF is that flood resulting from the occurrence of the local storm, 6-hour, probable maximum precipitation (PMP) falling on the drainage area.

As Table 2-1 indicates, the 6-hour PMF for the Powerline drainage basin has a larger peak flow than the 72-hour PMF; thus, its use in developing a failure hydrograph for the Powerline FRS is evident. However, the 72-hour PMF for Rittenhouse has a slightly higher peak flow (i.e., 295 cfs, or 0.6 percent, greater) than the 6-hour PMF. The 6-hour PMF was selected for use at Rittenhouse because the time to peak flow is less for the 6-hour event and because the slightly larger peak flow for the 72-hour PMF will be insignificant in the routing analysis for the downstream area.

A discussion regarding the relative peak flows for the three drainage areas is provided in the hydrology report. To summarize that discussion, the difference in relative peak flows (e.g., the larger peak for the 6-hour PMF at Powerline vs. the larger peak flow for the 72-hour PMF at Rittenhouse) is due to the difference in orientation of the tributary basins and the varying degree of development within the basins.

INPUT TO THE BREACH MODEL

Using record drawing information for the Powerline and Rittenhouse FRS's, much of the required input describing the physical arrangement of the FRS's was developed. Additionally, a contact was made with the Soil Conservation Service (SCS) to discuss input regarding soil properties for the structures. Estimates of soil unit weights and cohesive strengths for the FRS embankment material were obtained from the SCS contact.

As described above, the inflow hydrograph used as input in the BREACH model was the 6-hour PMF at both structures. At the beginning time of the BREACH run (i.e., at t = 0), it was assumed that the water surface elevation within each reservoir was at the level of the emergency spillway. Thus, the most severe combination of conditions was used in the BREACH model runs for the two FRS's.

Four separate failure mechanisms were investigated at both the Powerline and the Rittenhouse FRS's. Overtopping and piping failures were assumed at the principal dam structure; and overtopping and piping failures were also assumed at the earthern emergency spillway. The results of the failure analysis at the emergency spillway showed that this failure site was much less critical than at the principal dam structure. In the piping failure analyses, the location of the piping failure was assumed to occur at a point one-third of the height of the structure.

A detailed discussion of all input parameters in the BREACH models is not included in this report. However, Appendix B contains the input and output from the BREACH runs at the principal dam structures; and all input parameters are listed therein should a more detailed investigation be desired.

OUTPUT FROM THE BREACH MODEL

Table 2-2 contains the summary results of the BREACH output in the form of peak flows and times of peak flow occurrence for the Powerline and Rittenhouse FRS's.

TABLE 2-2
BREACH OUTPUT SUMMARY
POWERLINE AND RITTENHOUSE FRS'S

Failure Mechanism	Flood Retarding Structure: Powerline		Flood Retarding Structure: Rittenhouse	
	Peak Flow (cfs)	Time to Peak (hr)	Peak Flow (cfs)	Time to Peak (hr)
Overtopping	71,351	6.72	71,420	9.11
Piping	82,570	5.74	60,605	7.58

Based on the above BREACH results, the piping failure hydrograph was used for routing below the Powerline FRS and the overtopping failure hydrograph was used below Rittenhouse.

The change in relative magnitude between the overtopping and piping failure peak flows from Powerline to Rittenhouse, as indicated in the table, was initially viewed as a discrepancy. However, a detailed review of this result showed that there is a basis for the difference in relative peak flows. The explanation for Powerline having a larger piping failure peak flow is principally due to the shorter time to peak of the 6-hour PMF inflow hydrograph (i.e., 5.1 hours for Powerline vs. 7.25 hours for Rittenhouse). In the piping failure procedure programmed into the BREACH model, initiation of failure occurs at t = 0. At Powerline the peak inflow of the 6-hour PMF occurs at a time shortly after the breach formed from the piping mechanism is expanded to near its largest size. Thus, a large outflow is shown to occur at Powerline for the piping failure mechanism because the outlet capacity of the breach is great at the time of the peak inflow and because the reservoir storage is also great.

However, at the Rittenhouse FRS, the peak inflow occurs at a later time, which is after the piping breach has reached near its maximum size. Thus, substantial drainage of the reservoir has occurred when the peak inflow occurs such that less outflow is coming from storage, in contrast to Powerline, where a large outflow is coming from water in storage in addition to the large outflow generated from the peak inflow.

Detailed output for the BREACH runs at the two FRS's is found in Appendix B, as indicated above.

CHAPTER 3

ROUTING ANALYSES

INTRODUCTION

The DAMBRK model (NWS, 1988) was utilized to predict inundated areas and arrival times for the assumed failures at Powerline and Rittenhouse FRS's. This chapter describes the procedures and results of those analyses.

INPUT TO THE DAMBRK MODEL

The primary input to the DAMBRK model runs for the Powerline and Rittenhouse FRS's consisted of the failure hydrographs generated from the BREACH model, cross sections, and roughness values. The selection of the input (i.e., failure) hydrographs is described above. Cross sections were selected from U.S.G.S. topographic quadrangles. Due to the flat topography below the FRS's, the uppermost sections below each FRS were articulated near their ends to more properly model the flow behavior. A general guideline of 4 to 1 for defining cross section widths was used in the upper sections. Roughness values were set at values of 0.05 and 0.04, as suggested by a nomograph in a U.S.G.S. report (U.S.G.S., 1984) based on average slope of the flow path.

In routing the failure hydrograph downstream of the two FRS's, the effect of the CAP canal and downstream dikes was ignored. This decision, reached in conjunction with District staff, reduced the complexity of the routing analysis to a level that could be performed with the DAMBRK model, while at the same time provided conservatism to the routing results.

Option 7 of the DAMBRK model was used for both FRS's since the inflow hydrograph was generated outside the program and since subcritical flow was assumed for all downstream areas.

As stated in the discussion of the BREACH input, a detailed explanation of all input parameters in the DAMBRK models is not appropriate in this report. However, Appendix C contains the input and output from the DAMBRK runs; and all input parameters are listed therein should a more detailed investigation be desired.

OUTPUT FROM THE DAMBRK MODEL

Table 3-1 and 3-2 provide summary results from the DAMBRK model runs for the Powerline and Rittenhouse FRS's, respectively.

TABLE 3-1

POWERLINE DAMBRK SUMMARY RESULTS
PEAK FLOW CONDITIONS

TT	Cross Section		Q	Flow	Crest	Flow[1]	Avg.[2]
Time (hrs)	No.	Distance (XS (I)) (miles)	(max) (cfs)	Area (ft^2)	Elev. (ft)	Width (ft)	Depth (ft)
5.70	1	0.01	82,570	7,233.0	1,572.10	1,040.1	6.95
5.85	2	0.96	82,100	14,090.0	1,524.42	4,226.0	3.33
6.30	3	3.04	81,352	14,953.0	1,452.14	6,082.0	2.46
6.70	4	4.71	80,934	16,786.0	1,400.25	8,987.5	1.87
6.90	5	5.68	80,710	20,012.0	1,374.86	10,619.0	1.88
7.25	6	6.81	80,409	16,540.0	1,347.55	10,925.0	1.51
7.40	7	7.42	80,264	18,170.0	1,329.69	9,459.0	1.92

[1] Computed from DAMBRK cross section cards, using crest water surface elevations.

[2] Computed as: Average Depth = Area/Width.

TABLE 3-2

RITTENHOUSE DAMBRK SUMMARY RESULTS
PEAK FLOW CONDITIONS

TT	Cross Section		Q	Flow	Crest	Flow[1]	Avg.[2]
Time (hrs)	No.	Distance (XS (I)) (miles)	(max) (cfs)	Area (ft^2)	Elev. (ft)	Width (ft)	Depth (ft)
9.10	1	0.01	71,479	8,606.0	1,588.87	1,300.0	6.62
9.40	2	1.64	71,110	17,718.0	1,539.32	7,206.7	2.46
10.28	3	4.73	70,592	19,043.0	1,468.29	11,258.0	1.69
10.48	4	5.46	70,480	18,508.0	1,454.80	10,860.0	1.70
11.00	5	7.45	70,231	20,468.0	1,409.36	11,104.0	1.84
11.38	6	8.48	69,900	18,021.0	1,392.47	11,911.0	1.51
11.96	7	10.29	69,485	19,392.0	1,358.99	10,873.0	1.78

[1] Computed from DAMBRK cross section cards, using crest water surface elevations.

[2] Computed as: Average Depth = Area/Width.

CHAPTER 4

INUNDATION INFORMATION

INTRODUCTION

The information developed in Chapter 3 was used to prepare inundation information for areas downstream of the Powerline, Vineyard, and Rittenhouse FRS's. This chapter describes the transferral of the DAMBRK output into inundation information and contains a discussion on the social and economic impacts that could result from a failure of any of the three FRS's.

INUNDATION LIMITS AND ARRIVAL TIMES

Using the output from the DAMBRK model runs for the Powerline and Rittenhouse FRS's, as summarized in Tables 3-1 and 3-2, inundation information was placed on U.S.G.S. topographic quadrangle maps. These maps, which accompany this report, indicate the detailed inundation limits and flood wave arrival times for assumed failures below the Powerline and Rittenhouse FRS's. The maps also present interpolated inundation information for the area between the two detailed areas. Delineation of the inundation limits was performed on the basis of the model-generated water surface elevations, not the generated flood widths. (This basis for delineation was selected due to the need to modify the actual cross sections into a format acceptable to the DAMBRK model. Interpretation of the results of the DAMBRK analyses was then transferred back to the actual cross sections, using model-generated water surface elevations.)

Taking into consideration the numerous assumptions involved in preparation of inundation maps for dam failures, it is reported that the accuracy of the flow depth estimates is two feet (Fread, 1989). Consequently, the downstream limits of routing with the model were selected on that basis and also on the location of two flow barriers: the Southern Pacific Railroad embankment and the East Maricopa Floodway. Routing was to be continued to these two barriers. Should the average depth of flow at the barriers be greater than two feet, further downstream routing would be performed. If the flow was found to average less than two feet deep at the barriers, no further detailed routing would be undertaken. Consequently, detailed routing using the DAMBRK model was terminated at the two barriers because the average flow depths for both the Powerline and Rittenhouse routings are less than two feet at these points.

In plotting flood wave arrival times for the Powerline failure analysis, the model-generated times were used because the Powerline failure hydrograph was based on a piping failure, which starts to occur at t = 0 in the model. However, for the Rittenhouse failure, which was based on overtopping, the time at which the overtopping failure begins was shown to be at t = 5.92 hours in the BREACH model analysis. Because of the need to achieve a consistency in arrival times between the routing analyses at Powerline and Rittenhouse and in light of the fact that the purpose of the arrival time estimates is to provide authorities with lead time criteria for notifying downstream residents, an adjustment was made in the model-generated arrival times for Rittenhouse. It was assumed that the point at which authorities would be alerted to an impending dam failure would be when the reservoir water surface elevation reached to within three feet of the crest of the FRS. In the Rittenhouse BREACH analysis, this time was shown to be at t = 4.4 hours. Consequently, the arrival times presented on the inundation maps for Rittenhouse are equivalent to the DAMBRK-generated values reduced by 4.4 hours.

The arrival times shown on the inundation maps for each cross section are for a discharge of 5,000 cfs. It was decided not to use the peak discharge for denoting arrival times because significant impact from flooding would have occurred before the peak arrives. Upon arrival of the peak flow at any particular location, slightly increased water depth (e.g., averaging about 3 feet greater than at the 5,000-cfs flow) is predicted to occur. This greater depth will likely cause more damage at the particular locations. However, for the purposes of emergency notification, the 5,000-cfs flow arrival time was selected as more appropriate than the peak flow.

SOCIAL AND ECONOMIC IMPACTS

As indicated on the inundation maps, there is little development within the predicted inundated limits of the three FRS's. The major downstream development within the inundated area is the Williams Field Air Force Base (AFB). A lesser concentration of population and development occurs at the General Motors Testing Ground. Since these developed areas are far enough downstream from the FRS's such that the predicted average depth of flow is less than two feet, the social and economic impacts as a result of a failure at the three FRS's will not be catastrophic.

Due to the shallow nature of the flooding at these points, it is expected that loss of life would not be a significant concern at these developments. The principal adverse impacts in these developed areas would be caused by the short term disruption of travel and the possible, minor damage to critical facilities located in the inundated area. (Locations of critical facilities obtained from the Maricopa County Department of Civil Defense and Emergency Services are shown on the inundation maps, which are included as plates at the back of this report.)

The locations of several critical facilities at the Williams Field AFB are shown on the plates. These include three schools and a hospital. The depth of flow at these facilities, as well as other sites of interest (e.g., runways), cannot be determined since the precision of the DAMBRK model and the availability of precise topographic information do not permit calculation below a two-foot depth. However, based on the results of this study, it can be concluded that the average depth of flow across the base would be less than 2 feet.

Table 4-1 presents summary information regarding anticipated affects and travel times to specific roads and developments.

TABLE 4-1

SUMMARY INUNDATION INFORMATION

	Arrival of 5,000-cfs Flow	
Location	Time(1) (hrs)	Depth(2) (ft)
General Motors Proving Grounds		
- Track	1.8	1.7
- Occupied Buildings	2.4	0.9
Williams Field AFB		
- Runways	3.0	1.1
- Occupied Buildings	3.2	0.4
Southern Pacific RR Tracks		
- at Queen Creek	2.9	0.9
Ellsworth Road		
- at Elliot Rd.	2.3	0.9
Sossaman Road		
- at Elliot Rd.	3.2	0.4

(1) Arrival times obtained directly or through interpolation from Plates at back of report.
(2) Flow depths taken to be wave heights (WAVHT) as indicated in DAMRK print-out contained in Appendix C (Volume II).

As can be seen from Table 4-1, depths at a 5,000-cfs flow are not large. Consequently, the flooding affects of this flow at the specified locations would not be great. With passage of the peak flows at the locations listed in the table, flow depth is estimated to be between 2 and 3 feet greater than at the 5,000 cfs flow. Thus, more significant affects would be expected at the peak flow. However, due to the shallow nature of flooding, even at the peak flow, and due to limited development, widespread serious affects from flooding at these locations would not be expected.

R6E | R7E

1	2	3
	4	

KEY PLAN

LEGEND

- P3 (2.6) — CROSS SECTION FLOOD WAVE ARRIVAL TIME (HOURS)
- INUNDATED AREA LIMIT (DAMBRK GENERATED)
- 1.0 — REPRESENTATIVE FLOOD WAVE ARRIVAL TIME CONTOUR (HOURS)
- SITE OF FLOW THROUGH SPRR EMBANKMENT

2000 0 2000 4000
SCALE IN FEET

PLATE 1 of 4

INUNDATION INFORMATION

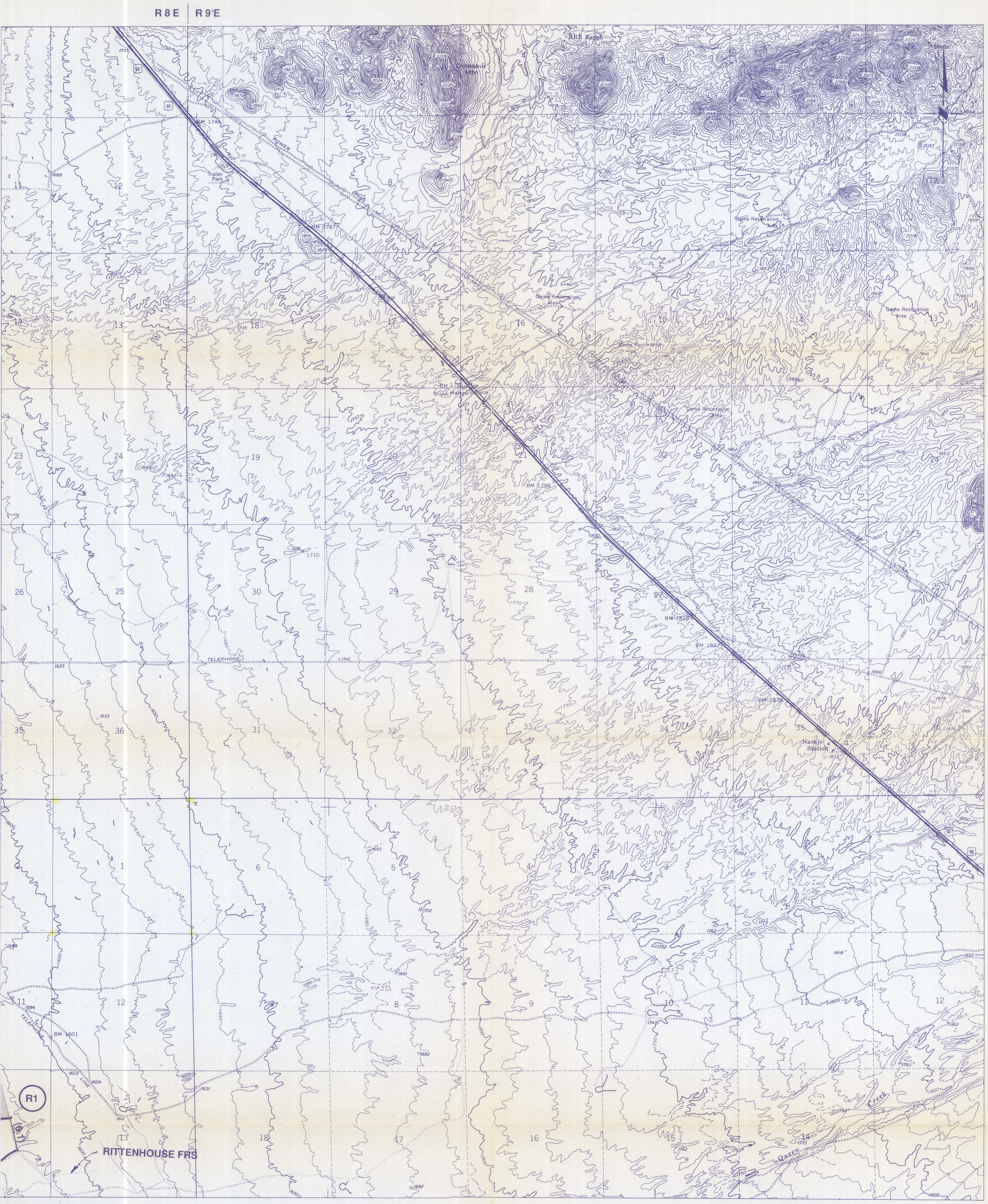
DAMBREAK FAILURES AT
POWERLINE, VINEYARD, AND RITTENHOUSE FRS'S

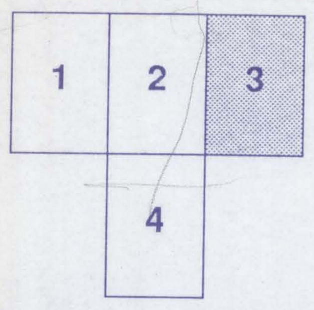
BASE MAP: U.S.G.S. QUADRANGLE "HIGLEY"

JMM James M. Montgomery
Consulting Engineers Inc.

Phoenix, Arizona


R7E | R8E
P1
P2
P3
R2
R3
R4
R5
R6
POWERLINE FRS
VINEYARD FRS
RITTENHOUSE FRS
INTERPOLATED
INUNDATION
INFORMATION
CAP CANAL
Hawk Rock
Desert Well
Anderson Ranch
DESERT PROVING GROUNDS
MARICOPA CO
PINAL CO
Water Tank
Swimming Pool
Landing Field
RITTENHOUSE AIR FORCE
AUXILIARY FIELD
Siphon Draw
Beekes Wash
TELEPHONE LINE
(0.8)
(1.2)
1.0
(1.8)
2.0
3.0
(3.9)
(2.9)
(2.6)
(0.9)





KEY PLAN

LEGEND

P3 (2.6) — CROSS SECTION FLOOD WAVE ARRIVAL TIME (HOURS)

INUNDATED AREA LIMIT (DAMBRK GENERATED)

1.0 — REPRESENTATIVE FLOOD WAVE ARRIVAL TIME CONTOUR (HOURS)

2000 0 2000 4000

SCALE IN FEET

PLATE 3 of 4

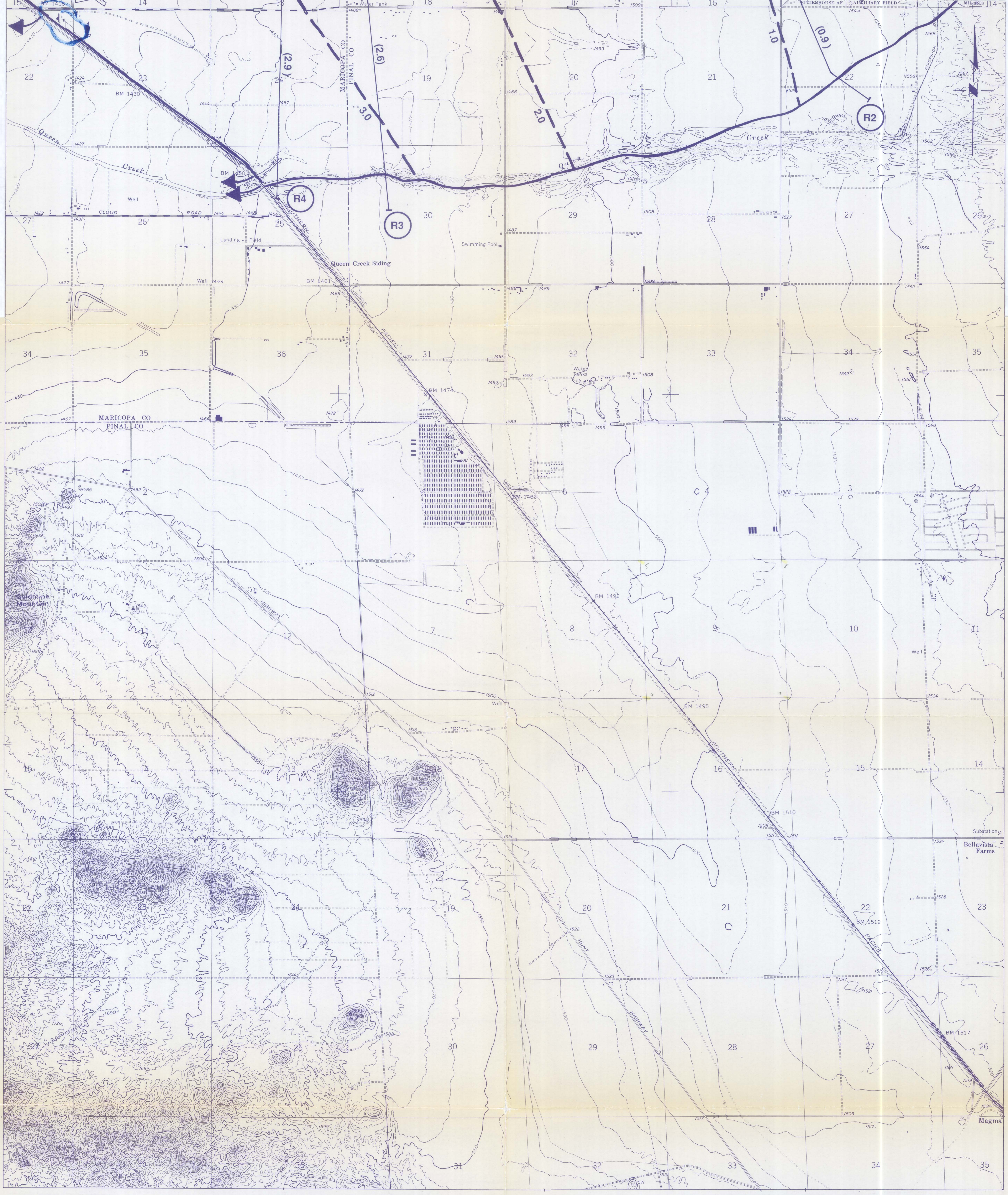
INUNDATION INFORMATION

DAMBREAK FAILURES AT POWERLINE, VINEYARD, AND RITTENHOUSE FRS'S

BASE MAP: U.S.G.S. QUADRANGLE "SUPERSTITION MTS SW"

JMM James M. Montgomery
Consulting Engineers Inc.

Phoenix, Arizona



1	2	3
	4	

KEY PLAN

JMM James M. Montgomery
Consulting Engineers Inc.

Phoenix, Arizona

LEGEND

P3 (2.6)
CROSS SECTION
FLOOD WAVE ARRIVAL TIME (HOURS)

INUNDATED AREA LIMIT
(DAMBRK GENERATED)

1.0
REPRESENTATIVE FLOOD WAVE ARRIVAL TIME CONTOUR (HOURS)

SITE OF FLOW THROUGH SPRR EMBANKMENT

2000 0 2000 4000
SCALE IN FEET

PLATE 4 of 4

INUNDATION INFORMATION

DAMBREAK FAILURES AT POWERLINE, VINEYARD, AND RITTENHOUSE FRS'S

BASE MAP: U.S.G.S. QUADRANGLE "SACATON NE"