GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION

Appendix A

Technical Memorandum No. 1

Technical Rating Criteria and Initial Ranking of Potential Recharge Sites

FLOOD CONTROL DISTRICT of MARICOPA COUNTY 1959

Submitted by

CH2M HILL

in association with

ERROL L. MONTGOMERY & ASSOCIATES

and

L. G. WILSON, RECHARGE SPECIALIST

MARCH 1988

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GROUNDWATER RECHARGE FEASIBILITY INVESTIGATION APPENDIX A

TECHNICAL MEMORANDUM NO. 1

TECHNICAL RATING CRITERIA AND INITIAL RANKING OF POTENTIAL RECHARGE SITES

Prepared for

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PLANNING & PROJECTS
MANAGEMENT DIVISION

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by
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In Association With

Errol L. Montogmery & Associates, Inc.
and
L. G. Wilson, Recharge Specialist

March 1988

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N22984.A0

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1 TECHNICAL RATING SHEET FOR RECHARGE POTENTIAL OF MARICOPA COUNTY FLOOD CONTROL DISTRICT SITES

2 SUMMARY OF WATERSHED CHARACTERISTICS AND EXCESS FLOOD FLOWS

P005/038

TECHNICAL MEMORANDUM

TO: Lionel Lewis/Flood Control District of Maricopa County

SUBJECT: Maricopa Recharge Feasibility Investigation
Flood Control District of Maricopa County
TECHNICAL MEMORANDUM NO. 1
TECHNICAL RATING CRITERIA AND INITIAL RANKING OF POTENTIAL SITES

PREPARED BY: Richard Randall/CH2M HILL
Shirley Heckman/Montgomery & Associates

DATE: July 28, 1987 (Revised March 30, 1988)

PROJECT: N22984.AO

INTRODUCTION

This technical memorandum identifies locations of potential recharge sites for Maricopa County Flood Control District (FCD) facilities, presents a technical rating sheet for the initial evaluation of the potential sites, and defines the technical rating criteria. The technical rating criteria which will be used to determine suitability of potential sites for recharge operations are defined and available data sources for evaluation of the technical rating criteria are identified.

FCD has 15 flood control facilities where floodwaters are diverted or detained. Another flood control structure near Queen Creek that is not a FCD facility was also identified. From the 16 facilities, 34 potential recharge sites near or downstream from these facilities were identified during the initial evaluations. A map of the FCD projects with corresponding map identification numbers is attached.

This initial evaluation identifies fatal technical flaws for potential recharge sites. Table 1 is a technical rating sheet for recharge potential of the 34 identified FCD sites. Inspection of Table 1 indicates that 19 of the 34 potential sites have been eliminated from further consideration. Table 2 is a summary of watershed characteristics and excess flood flows for selected FCD sites. The technical rating criteria which are identified herein will be applied to the remaining sites to select the most feasible sites for additional consideration.

EVALUATIONS CRITERIA OUTLINE

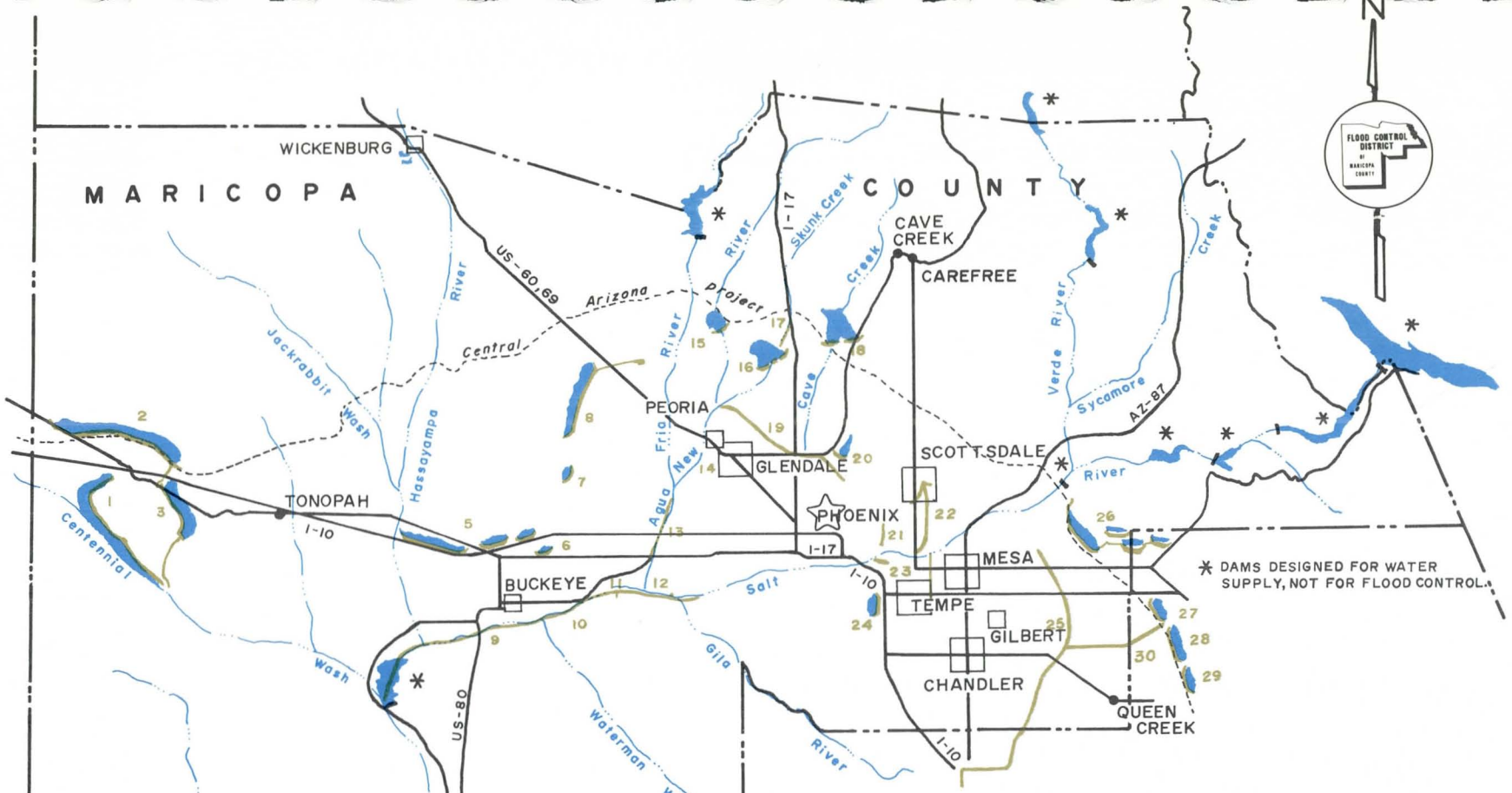
Following is an outline of the proposed criteria for evaluating the potential recharge sites.

RECHARGE WATER AVAILABILITY

- o Excess Floodwaters
- o Potential for a Joint Project using:
  - CAP Water
  - Sewage Effluent
  - SRP Water
  - Beardsley Canal (Maricopa Water District)

FLOOD CONTROL CONSIDERATIONS

- o Flood Control Benefits



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY PROJECTS (June 30, 1986)

1. Centennial Levee (Partly complete)
2. Harquahala Dam and Floodway (1982)
3. Saddleback Dam and Diversion (1981)
4. Sunset and Sunnycove Dams (1976)
5. Buckeye Dams 1, 2 and 3 (1975)
6. White Tanks Dam 4 (1954)
7. White Tanks Dam 3 (1954)
8. McMicken Dam (1956)
9. SR 85 Bridge Channel (1982)
10. Salt-Gila Clearing (1985)
11. Perryville Bank Stabilization (1984)
12. Holly Acres Levee and Bank Stabilization (1985)
13. Agua Fria Channel Projects (Partly complete)
14. Flowage Easements (Partly complete)
15. New River Dam (1985)
16. Adobe Dam (1984)
17. Skunk Creek Channels and Levee (1983)
18. Cave Buttes Dam (1980)
19. Arizona Canal Diversion Channel (Partly complete)
20. Dreamy Draw Dam (1973)
21. Old Cross Cut Canal (1975) (Restudy)
22. Indian Bend Wash (1985)
23. 48th Street Drain (1981)
24. Guadalupe Dam (1975)
25. RWCD Floodway (Partly complete)
26. Buckhorn-Mesa Projects (including Spook Hill Dam, Signal Butte Floodway and Dam, Pass Mountain Diversion, Bull Dog Floodway, and Apache Junction Dam) (Partly complete)
27. Powerline Dam (1967)
28. Vineyard Road Dam (1968)
29. Rittenhouse Dam (1969)
30. Powerline Floodway (1968)

- Adaptation of Existing Structures
- Operational Changes

WATER QUALITY IMPACTS

- Chemical Quality of Groundwater
- Known Groundwater Contamination
- Presence of Landfills and Waste Disposal Sites

HYDROGEOLOGIC CONDITIONS

- Depth to Groundwater Level
- Thickness of Upper Alluvial Unit
- Depth to Middle Alluvial Unit
- Depth to Bedrock Complex
- Aquifer Transmissivity
- Occurrence of Perched Groundwater Conditions
- Recoverability of Recharged Water
  - Ratio of Invested to Recoverable Water
  - Existing Groundwater Users

SOILS AND INFILTRATION RATES

- Suitability of Soils for Recharge
- Estimated Infiltration Rates
- Potential Geochemical Reactions

LAND OWNERSHIP AND USE

- Land Ownership
- Availability of Undeveloped Lands
- Compatibility of Recharge Operations with Present and Future Land Use

DISCUSSION OF TECHNICAL RATING CRITERIA

A discussion of each criterion and how it applies to the site evaluation process follows. A description of the

available data sources for these criteria is also included in each discussion.

Recharge Water Availability

Initial estimates of excess floodwaters will rely heavily on the Stormwater Augmentation Study prepared for the Department of Water Resources by Dames & Moore. This report estimated the excess floodwaters available at most of the FCD facilities for a 2-, 10-, and 25-year storm. Table 2 summarizes the reported estimates of floodwater availability for selected watersheds.

For facility planning purposes, USGS stream gauge records and runoff models may be needed. Runoff models that are available include the SCS handbook method, Corps of Engineers HEC 1 model, and modified linear regression models developed on experimental watersheds.

Availability of other water sources will be determined by visiting with the water resource planners for the municipalities and other water purveyors. To consider another water source it is essential to identify a municipality or other entity that could potentially be involved in a joint project. Where needed, the capacity of the existing facilities to deliver recharge water will be determined (i.e. Beardsley or SRP canals).

Flood Control Considerations

Flood control benefits due to recharge will be identified where applicable. Consequently, the potential for flood control benefits will be included in the final evaluations.

Changes to structures and operations will be considered during the final ranking of sites. Adaptation of existing structures could include use of the sediment pool for recharge storage, raising the discharge outlet elevation, increasing the storage capacity of the facility, or adding outlet controls. Changes in operations could include modifications to existing procedures or new operations associated with structural changes. Data sources include design drawings for existing or planned structures and data from similar projects involving floodwater detention and recharge. Potential modifications will be discussed with Soil Conservation Service (SCS) or Corps of Engineers (COE) designers as needed.

WATER QUALITY IMPACTS

Chemical Quality of Groundwater

Recharge operations are not acceptable and should not be conducted where the aquifer presently contains groundwater which does not meet drinking water standards due to poor chemical quality. Maps of specific electrical conductance, fluoride, nitrate, chromium, arsenic, and sulfate content for groundwater have been prepared for Maricopa Association of Governments, Arizona Department of Water Resources, and the U.S. Geological Survey (Reeter and Remick, 1986; Long, 1983; Schmidt, 1981; Graf, 1980; Schmidt, 1978). These maps have been used to identify chemical quality of groundwater for potential recharge sites.

Existing Groundwater Contamination

Recharge operations are not acceptable and should not be conducted where the recharge water may induce movement of

contaminants which originate from activities of man. Areas where contaminated groundwater occurs have been identified from maps prepared by Salt River Project and Arizona Department of Health Services (Graf, 1986; Salt River Project, 1985).

Presence of Landfills

Recharge operations are not acceptable and should not be conducted where the recharge water may saturate an active or abandoned landfill and cause formation and movement of leachate from the landfill to the aquifer. Locations of landfills have been identified from maps prepared by Maricopa County Landfill Department.

HYDROGEOLOGIC CONDITIONS

Depth to Groundwater Level

Because available volume for groundwater storage is small where depth to groundwater is small, areas where average depth to groundwater level is less than 50 feet are generally unfavorable for recharge operations. Because the amount of infiltrated water which may be required or "invested" in the vadose zone prior to reaching a water content equal to the specific retention may be large, areas where average depth to groundwater level is large may be unfavorable for recharge operations by surface methods. Large average depth to groundwater has not been defined for the purposes of this investigation. In areas where recharge is currently occurring, moisture content for the underlying unsaturated zone is estimated to be equal to the wetting requirements or specific retention. For these areas, a large average depth to groundwater level would not result in a large amount of invested water which would not be recovered. Large average

depth to groundwater level may also be favorable where the present-day groundwater level is below the top of the Middle Alluvial unit, and where the Middle Alluvial unit functions as a perching layer. Large average depth to groundwater may be acceptable where the Middle Alluvial unit is areally extensive and where from 100 to 200 feet of unsaturated Upper Alluvial unit is present. Depth to groundwater level has been compiled from maps prepared by Arizona Department of Water Resources, and U.S. Geological Survey (Reeter and Remick, 1986; Long, 1983; Graf, 1980).

Thickness of Upper Alluvial Unit

The Upper Alluvial unit consists of sand, gravel, cobbles, and boulders, with thin interbeds of silt and clay, and comprises floodplain and alluvial fan deposits. The Upper Alluvial unit constitutes the medium for receiving recharge from most recharge operations by surface methods. The coarse-grained fabric of the unit accommodates the percolation of water into the underlying saturated zone, and permits easy lateral groundwater movement. Because more groundwater can be held in storage in the vadose zone where thickness of the Upper Alluvial unit is large, reaches where average thickness of the Upper Alluvial unit is large are generally more favorable for recharge operations by surface methods. In areas where natural recharge is not occurring and depth to groundwater level is large, a maximum thickness of Upper Alluvial unit favorable for recharge operations by surface methods may be defined. In these locations the ratio of invested water to recoverable water may be large and may result in unfavorable conditions for recharge by surface methods. Thickness of the Upper Alluvial unit has been compiled from maps prepared by the U.S. Bureau of Reclamation and U.S. Geological Survey (Laney and Hahn, 1986; U.S. Bureau of Reclamation, 1977).

Depth to Middle Alluvial Unit

The Middle Alluvial unit consists of interbedded clay, silt, silty sand, sand, and gravel strata which are weakly cemented. The percentage of sand and gravel for the unit ranges from about 10 to 80 percent. Depth to the Middle Alluvial unit is included as an indication of the potential for perching of infiltrating water from land surface where the Middle Alluvial unit is fine-grained. Structure contour maps for the top of the Middle Alluvial unit have been prepared by the U.S. Geological Survey and the U.S. Bureau of Reclamation (Laney and Hahn, 1986; U.S. Bureau of Reclamation, 1977).

Depth to Basement Complex

Because more groundwater can be held in storage in the vadose zone where thickness of alluvial deposits is large, areas where average depth to basement complex is large are generally more favorable for recharge operations. Depth to basement complex has been compiled from maps prepared by Arizona State Land Department and the U.S. Geological Survey (Laney and Hahn, 1986; Cooley, 1973; Denis, 1971).

Aquifer Transmissivity

Aquifer transmissivity is included in the hydrogeologic conditions criteria as an indication of the ability of the aquifer to transmit the recharged water from the recharge site and as an indication of the lithology of the aquifer. Areas of high aquifer transmissivity are more favorable for recharge operations. Saturation of the Upper Alluvial unit from recharge operations would be expected to result in high transmissivities. Aquifer transmissivity data are available from a modeling report prepared by Arizona Department of

Water Resources and from estimates for the Middle Alluvial unit based on percent sand and gravel and saturated thickness prepared by the U.S. Geological Survey (Long and others, 1982; Laney and Hahn, 1986). Additional data may be collected for selected areas to estimate the magnitude of aquifer transmissivity.

Occurrence of Perched Groundwater

Presence of shallow groundwater conditions beneath a potential surface recharge operation is considered to be unfavorable. For purposes of this report, shallow perched groundwater conditions are identified where depth to perched groundwater is less than 100 feet below land surface. Shallow perched groundwater conditions separate infiltrating water from the regional aquifer system and the infiltrated water may not be available for recovery. Potential for perched groundwater conditions has been identified from areas where perched groundwater conditions have been reported and from areas where extensive clay deposits have been described in the upper 100 feet below land surface. Data for the presence of, or potential for, perched groundwater conditions have been identified from maps prepared by Maricopa Association of Governments, Arizona Department of Water Resources, and U.S. Geological Survey (Laney and Hahn, 1986; Long, 1983; Schmidt, 1981; Graf, 1980).

Recoverability of Recharged Water

An estimate of the ratio of invested water to recoverable water will be prepared from existing data for depth to groundwater level, presence of the Middle Alluvial unit, and amount of water available for recharge operations. The location of groundwater users in the area of a potential

recharge project has been identified from maps prepared by U.S. Bureau of Reclamation.

Soils and Infiltration Rates

Recharge operations by surface spreading methods require soil conditions that will sustain reasonable long-term infiltration rates. The suitability of soils is related to soil structure, clay content, depth, and presence of restricting layers created by caliche or clays. Soils suitability, infiltration rate estimates and potential for geochemical reactions will be assessed during facilities planning. Data sources will include SCS soils maps and USGS reports.

Land Ownership and Use

The availability of undeveloped land impacts the feasibility of recharge by spreading methods. The present ownership and value of the land also affects its availability for recharge purposes. Other considerations include the compatibility of a recharge project with long range land use planning for the vicinity. Data sources will include State Land Department ownership maps, county assessors maps, USGS maps, and municipal land use planning maps.

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P005/021

Table 1
TECHNICAL RATING SHEET FOR RECHARGE POTENTIAL OF MARICOPA COUNTY FLOOD CONTROL DISTRICT SITES

Name		Map I.D. Number	Floodwater Availability	Depth to Groundwater Level (feet)	Occurrence of Perched Water	Thickness of Upper Alluvium[b] (feet)	Depth to Basement Complex (feet)	Proximity to Landfills or Contaminated Groundwater[c]	Chemical Quality: Fluoride[d] mg/l	Chemical Quality: Specific Electrical Conductance[e] umhos/cm	Comments
Harquahala Valley	Centennnial Levee	29	good	304 - 510	present	400 - 1300	700->1200		2.6-6.5	1090-3900	reject: shallow clay layers (up to 1000 ft thick)
	Harquahala Dam	25	fair	ND[a]		400 - 1300	700->1200		ND	ND	
	Saddleback Dam	27	fair	450		400 - 600	700->1200		ND	ND	
Centennial Wash from Levee to Narrows			good	146 - 322		200 - 400	<300-700		ND	ND	
Centennial Wash from Narrows to Railroad			good	194 - 219	present ?[f]	<100	<400-1200		7 - 15	1950-5000	reject: shallow clay layers, high fluoride concentration in groundwater
Buckeye Dams	Dam #1	6	poor	147 - 234		300 - 400	<400	A	ND	ND	reject: lack of floodwater
	Dam #2	7	poor	ND		SB[b]	<400		ND	ND	reject: shallow depth to basement complex, lack of floodwater
	Dam #3	8	poor	ND		SB	<400		ND	ND	reject: shallow depth to basement complex, lack of floodwater
White Tanks	Dam #4	5	poor	348		300	>1200		3	795-1020	reject: lack of floodwater
	Dam #3	4	poor	198 - 245		<400 ?	>1200		0.3-1.8	360-715	reject: lack of floodwater
McMicken Dam		3	fair	474 - 504		500 - 700	>1200		1 - 1.5	295-440	
Outlet Channel			fair	484		<550	>1200	A	ND	ND	
Tributary to Agua Fria			fair	345		<550 - 700	>1200		ND	ND	
New River Dam		34	good	ND		ND	<400		ND	ND	
Dam to Skunk Creek			good	343 - 475		<500 - 800	>1200		0.3-0.6	445-615	
Adobe Dam		31	poor	505 - 550		ND	<400->1200		0.9	390	reject: lack of floodwater
Skunk Creek from Dam to New River			poor	389 - 550		<500 - 800	>1200		0.3-0.9	390-1750	reject: lack of floodwater
Cave Buttes Dam		33	good	379		ND	<400		ND	ND	
Cave Creek from Dam to ACDC			good	272 - 533		<500	800	C	0.3-0.5	335-720	
ACDC from I-17 to Skunk Creek		32	fair	293 - 365		500 - 700	>1200		0.5-0.6	500-1150	
New River from Skunk Creek to Agua Fria			good	158 - 278		700 - 800	>1200		0.2-0.5	405-960	
Lower Agua Fria from New River to I-10			good	95 - 153		600 - 750	>1200	D, C, V	0.3-1.4	405-1500	
Dreamy Draw		30	poor	ND		SB	<400		ND	ND	reject: shallow depth to basement complex, lack of floodwater

Table 1 (continued)

TECHNICAL RATING SHEET FOR RECHARGE POTENTIAL OF MARICOPA COUNTY FLOOD CONTROL DISTRICT SITES

Name		Map I.D. Number	Floodwater Availability	Depth to Groundwater Level (feet)	Occurrence of Perched Water	Thickness of Upper Alluvium[b] (feet)	Depth to Basement Complex (feet)	Proximity to Landfills or Contaminated Groundwater[c]	Chemical Quality .....of Groundwater.... Fluoride[d] mg/l	Specific Electrical Conductance[e] umhos/cm	Comments
Indian Bend Wash		17 - 20	good	191 - 409		100 - 200	500-600	V	0.0-1.2	385-1400	reject: groundwater contamination by volatile organic compounds
Buckhorn Mesa Projects	Spookhill Dam	35	poor	ND (500 ?)		SB ?	<400	V	ND	ND	reject: shallow depth to basement complex, lack of floodwater
	Floodway		poor			SB	0				reject: shallow depth to basement complex, lack of floodwater
Powerline Projects	Powerline Dam	21	poor	ND (500 ?)		100 - 200	800-1200		ND	ND	reject: lack of floodwater
	Vineyard Road Dam	23	poor	410		100 - 200	>1200		ND	ND	reject: lack of floodwater
	Rittenhouse Dam	24	poor	ND (500 ?)		100 - 200	800-1200		ND	ND	reject: lack of floodwater
	Powerline Floodway	22	poor	287 - 326		100 - 200	>1200		ND	ND	reject: lack of floodwater
East Maricopa Floodway (RWCD)		41	poor	132 - 291	present	200 - 1100?	>1200		0.9	800	reject: lack of floodwater
Guadalupe Dam		14	poor	60 - 195		SB	<400		0.5	2540	reject: shallow depth to basement complex
Queen Creek	CAP to Rittenhouse Road		excellent	438 - 500		200 - 300	>1200	A	0.5-0.6	680-840	
	Rittenhouse Road to RWCD		excellent	291 - 444		200 - 300	>1200		0.4-1.0	840-2150	

a ND - no data

b SB - shallow depth to basement complex estimated from geologic maps from the Bureau of Reclamation and the Arizona Bureau of mines

c A - active
C - construction debris
D - disposal site
V - volatile organic compounds

d mg/l - milligrams per liter

e umhos/cm - micromhos per centimeter

f ? - queried where uncertain

Table 2
SUMMARY OF WATERSHED CHARACTERISTICS & EXCESS FLOOD FLOWS

Watershed/Structures	CN No.	Drainage Area (sq. mi.)	Structure Detention Capacity (ac-ft)	2 YEAR STORM Est. Yield (ac-ft)	2 YEAR STORM Total Excess Runoff (ac-ft)	2 YEAR STORM Unit Excess Runoff (ac-ft/ac)	2 YEAR STORM Structure Infiltration (ac-ft)	10 YEAR STORM Est. Yield (ac-ft)	10 YEAR STORM Total Excess Runoff (ac-ft)	10 YEAR STORM Unit Excess Runoff ac-ft/ac)	10 YEAR STORM Structure Infiltration (ac-ft)	25 YEAR STORM Est. Yield (ac-ft)	25 YEAR STORM Total Excess Runoff (ac-ft)	25 YEAR STORM Unit Excess Runoff (ac-ft/ac)	25 YEAR STORM Structure Infiltration (ac-ft)
CENTENNIAL WASH	68	1,950		6,200	0	0.0		40,600	32,500	16.7		70,700	62,600	32.1	
Saddleback FRS			7,600				690				1,030				1,030
Harquahala FRS			8,000				750				1,130				1,130
LOWER AGUA FRIA RIVER	67	380		400	0	0.0		4,900	650	1.7		8,900	4,570	12.0	
White Tanks #3			2,660				170				250				330
MCMICKEN DAM	67	300		800	0	0.0		5,800	2,470	8.2		9,400	6,070	20.2	
McMicken			19,300				1,750				2,630				2,630
NEW RIVER	73	190		2,400	0	0.0		7,500	2,720	14.3		10,600	4,640	24.4	
New River			43,540				2,440				3,250				4,060
SKUNK CREEK	72	120		1,200	0	0.0		3,700	0	0.0		6,000	0	0.0	
Adobe			18,350				3,750				7,500				9,380
ACDC	68	40		100	0	0.0		700	370	9.3		1,100	770	19.3	
Dreamy Draw Dam			317				10				30				30
CAVE CREEK WASH @ ACDC	72	250		2,400	0	0.0		9,200	2,530	10.1		13,200	6,270	25.1	
Cave Buttes			46,600				2,810				5,630				5,630
INDIAN BEND WASH	70	80		200	0	0.0		1,300	910	11.4		2,300	1,910	23.9	
APACHE JUNCTION - EAST MESA FRS SYSTEM	63	30		30	0	0.0		300	0	0.0		800	0	0.0	
Spook Butte FRS			992				280				410				550
Signal Butte FRS			1,365				130				190				250
RWCD FLOODWAY @ AZ 87	65	270		100	0	0.0		2,300	380	1.4		4,900	2,980	11.0	
POWERLINE, VINEYARD ROAD, & RITTENHOUSE FRS SYSTEM	67	130		300	0	0.0		1,900	0	0.0		4,100	1,370	10.5	
Powerline			4,194				470				700				700
Vineyard Road			4,310				850				1,280				1,280
Rittenhouse			4,060				280				410				410
LOWER QUEEN CREEK FRS	74	260		3,600	1,940	7.5		10,000	7,790	30.0		14,400	12,190	46.9	
Lower Queen Creek			11,720				1,250				1,670				1,670
Whitlow Dam			35,593				130				170				170

Data Source: Stormwater Augmentation Study, February 1987
Prepared for ADWR by Dames & Moore