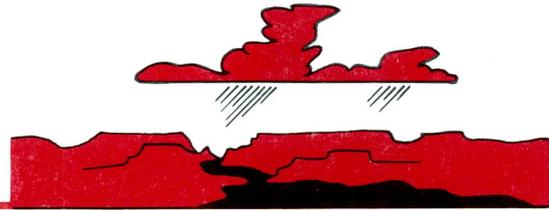


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FLOOD CONTROL
DISTRICT OF
MARICOPA COUNTY

FLOOD REPORT

OCTOBER 14, 1988 STORM



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FLOOD REPORT

OCTOBER 14, 1988 STORM

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OCTOBER 14, 1988 STORM

Flood Control District of Maricopa County
3335 West Durango
Phoenix, Arizona 85009
(602) 262-1501

prepared by
Glen L. Vortherms, Hydrologist

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PRELIMINARY FLOOD REPORT FROM THE STORM OF OCTOBER 14, 1988

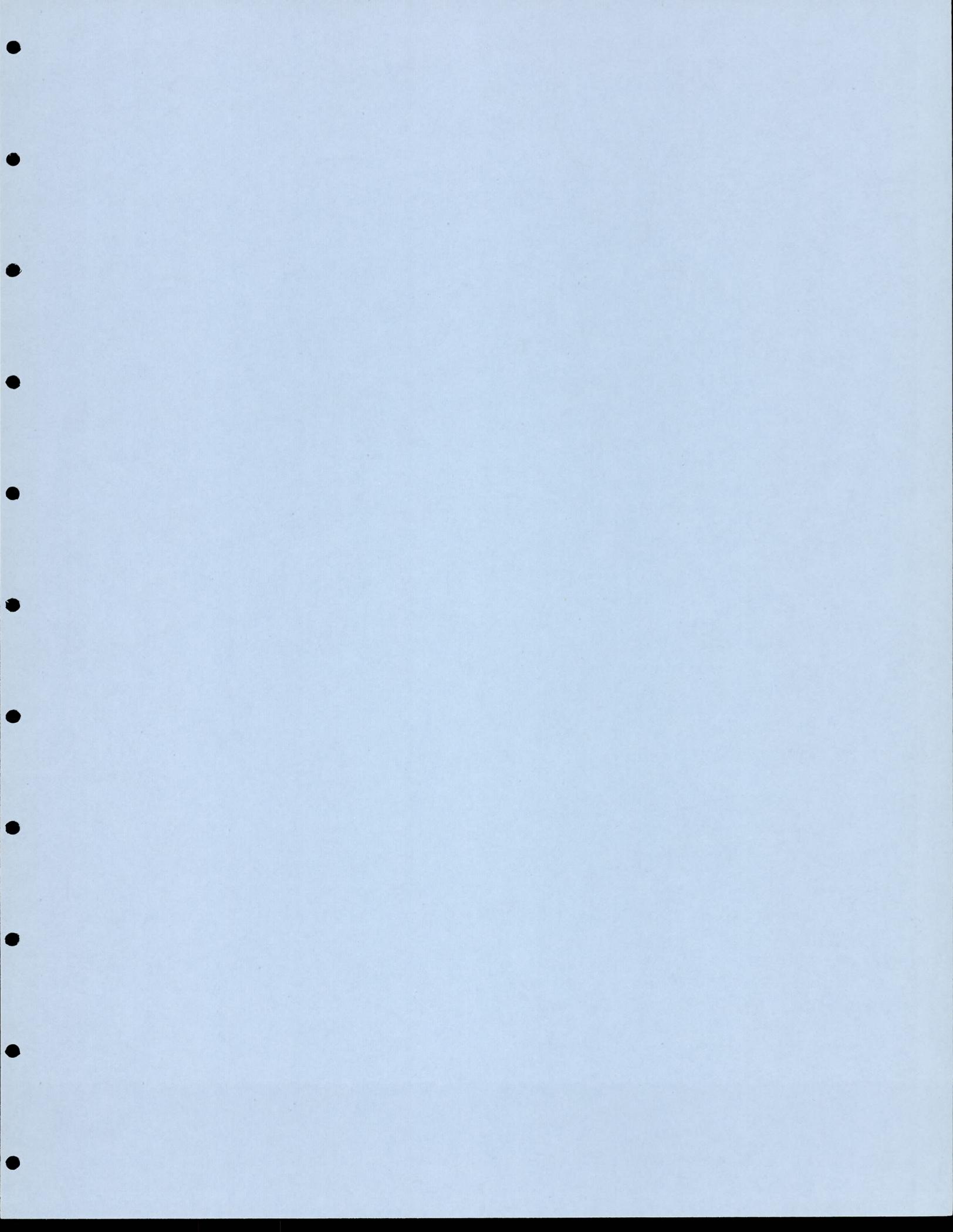
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Introduction

The purpose of the report is to present the information gathered from various sources on what occurred and to present the results of an evaluation of the flood alert system during the rain storm of October 14th 1988. Included in this report are the rainfall data from the telemetered gauges, and any stream flow records and field observations.

On the morning of October 14th, 1988, the National Weather Service forecasted partly cloudy skies, and warm temperatures, with slight possibility of rain. However as conditions developed during the day an upper level low pressure system formed over Baja California and pumped moisture into the state. Flash flood watches and warnings were subsequently posted for eastern Maricopa, Gila, and Pinal Counties.

Precipitation began to fall in the valley at approximately 8:00 AM. There were also areas throughout the valley that received hail. The most intense portion of the storm occurred from about 11:00 AM to 3:00 PM. The total duration was approximately 8 hours.



System Performance

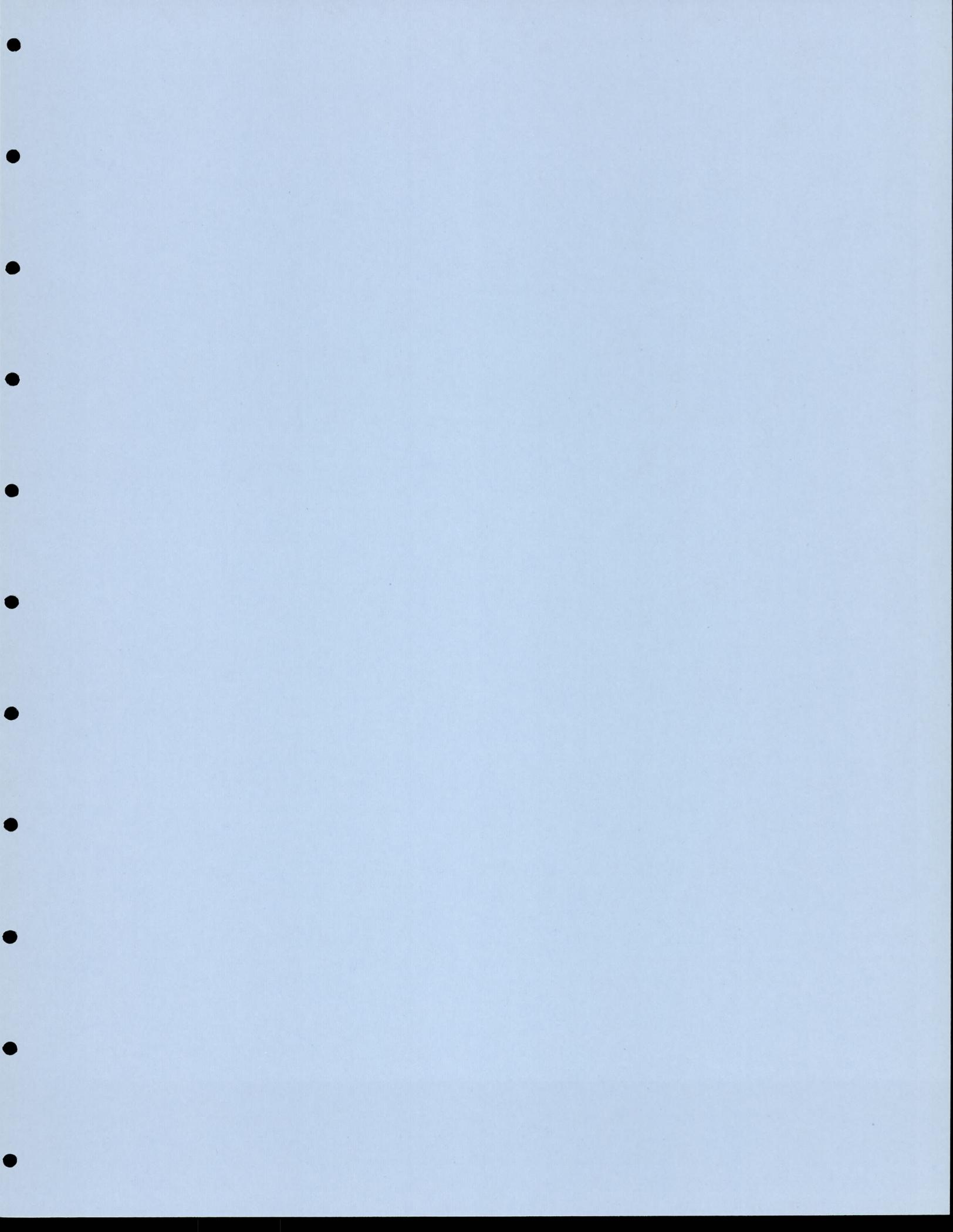
During the storm the flood warning system did not perform up to previous capabilities. Throughout the day various rain gauges either failed to report or if they did report the data was of poor quality. The cause of this problem was attributed to lost or low transmission signals. This can occasionally occur when the number of transmission is so great they are blocked out, or that the microwave towers receiving the transmissions were not operational. Of the 45 rain gauges that reported any rainfall, 28 of these rain gauges had transmission problems. These rain gauges with transmission problems were sending transmission signals through either the White Tanks Peak (19 gauges) or Thompson Peak (9 gauges) microwave towers.

The flood warning system is enhanced by a color weather radar via a direct telephone line with the National Weather Service. The intent of the radar is to give location and direction of storms and to "see" rainfall in areas that do not have telemetered rain gauges. However, during the early part of the storm a power surge, caused by a lightning strike, came in over the telephone line and shorted out a chip on the demodulator board. As a result, the weather radar was lost for the remainder of the storm as the demodulator board had to be sent to the manufacturer to be repaired. Since this incident, the manufacturer has provided the necessary chips so that if a similar problem occurs in the future the weather radar can be repaired on site by FCD staff.

Because of the above mentioned transmission problems rainfall intensities and durations were not recorded for those gauges. However, most rain gauges did

perform correctly during the storm. Every time it rains 0.04 of an inch the rain gauge bucket tips. The rain gauge keeps track of the total number of times a rain bucket has tipped and this is the number that is transmitted. Even though the flood warning system was not receiving all of these transmissions the rain gauges were keeping track of how much it had rained. As a result of this, total rainfall amounts were obtained for the rain gauges. These amounts were calculated by taking the total number of tips before it began to rain and subtracting it from the total number of tips transmitted after it had stopped raining (most of the gauges reported in the next day) and multiplying this number by .04 to obtain the total rainfall amount.

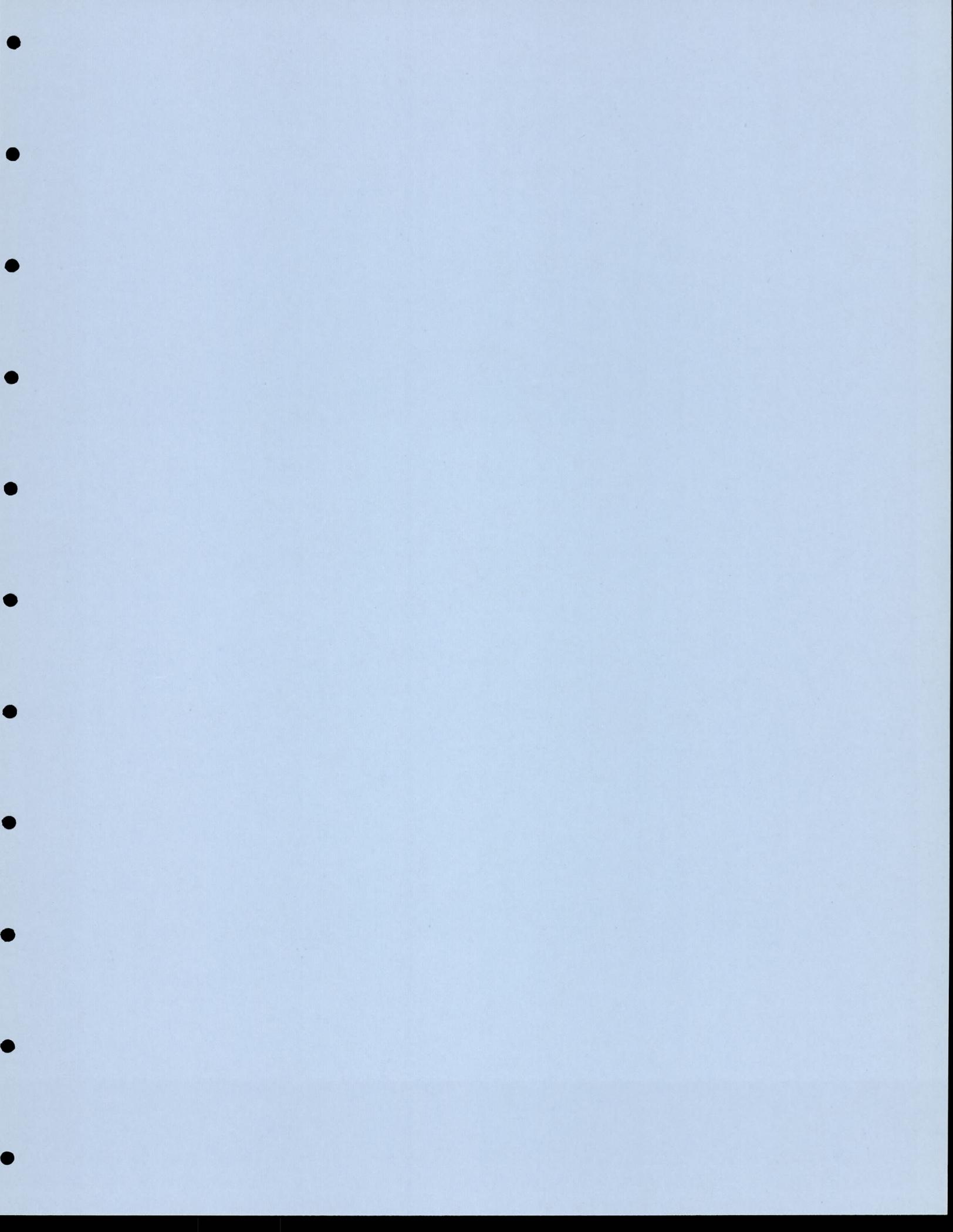
Stream flow and stage gauge stations experienced the same transmission problems as the rain gauges. Since this information is totally time dependent there is no way to reconstitute the flows or stages if no transmissions were received during the event. During the storm, four stream flow and stage gauges reported regularly enough to give adequate readings. There are sites that have recording stage gauges in addition to the telemetered stage gauges. For those sites that did have flows (not all stage gauge stations received flows) stage readings were obtained.



District Response

Since the storm developed quite suddenly, without any prior notice, there were no preliminary actions taken for the storm. When the storm did develop and it became apparent that there would be substantial rainfall amounts, observer teams were sent into the field. One team was to observe runoff flows in the Skunk Creek/ACDC/New River area and on the lower Agua Fria River. Another team was to observe flooding areas in and around the ACDC. A third team observed flood flows of Cave Creek at its confluence with the Arizona Canal and flooding downstream of this area.

District personnel were in contact with the Salt River Project, Corps of Engineers, Cities of Phoenix and Glendale, the Maricopa County Department of Civil Defense and Emergency Services and the news media during the event.



Rainfall

The rainfall amount for the 14th of October was the 9th largest 24 hour storm in history for Phoenix based on National Weather Service statistics. The National Weather Service reported 2.32 inches at Sky Harbor Airport. This made it the largest 24 hour rainfall in October, the previous record being 2.27 inches in 1972.

The largest rainfall amounts reported by telemetered rain gauges were 2.48 inches at Adobe Dam and 2.24 inches at Carefree Ranch. There were unofficial rainfall reports of as much as 3.00 inches. Recording rain gauge readings showed rainfall intensities ranging from 0.10 to 0.40 inches per hour over a 6-9 hour period. Figure 1 shows the rainfall mass curve for two of the recording rain gauges.

In general, Phoenix and surrounding areas received, on the average, better than one inch of rainfall. Figure 2 shows rainfall amounts for all telemetered rain gauges in Maricopa County. Appendix A contains information for all the telemetered rain gauges in regards to name and location. It should be noted that readings that appear out of the norm are a result of bad rain gauge transmissions. At the end of October these readings will be supplemented with rainfall readings provided by the FCD observer rain gauge network.

Assuming an 8 hour storm, as indicated by recording rain gauge charts, the estimated return period for the October 14th storm was 15 years. This value was linearly interpolated from rainfall return period/duration tables for the

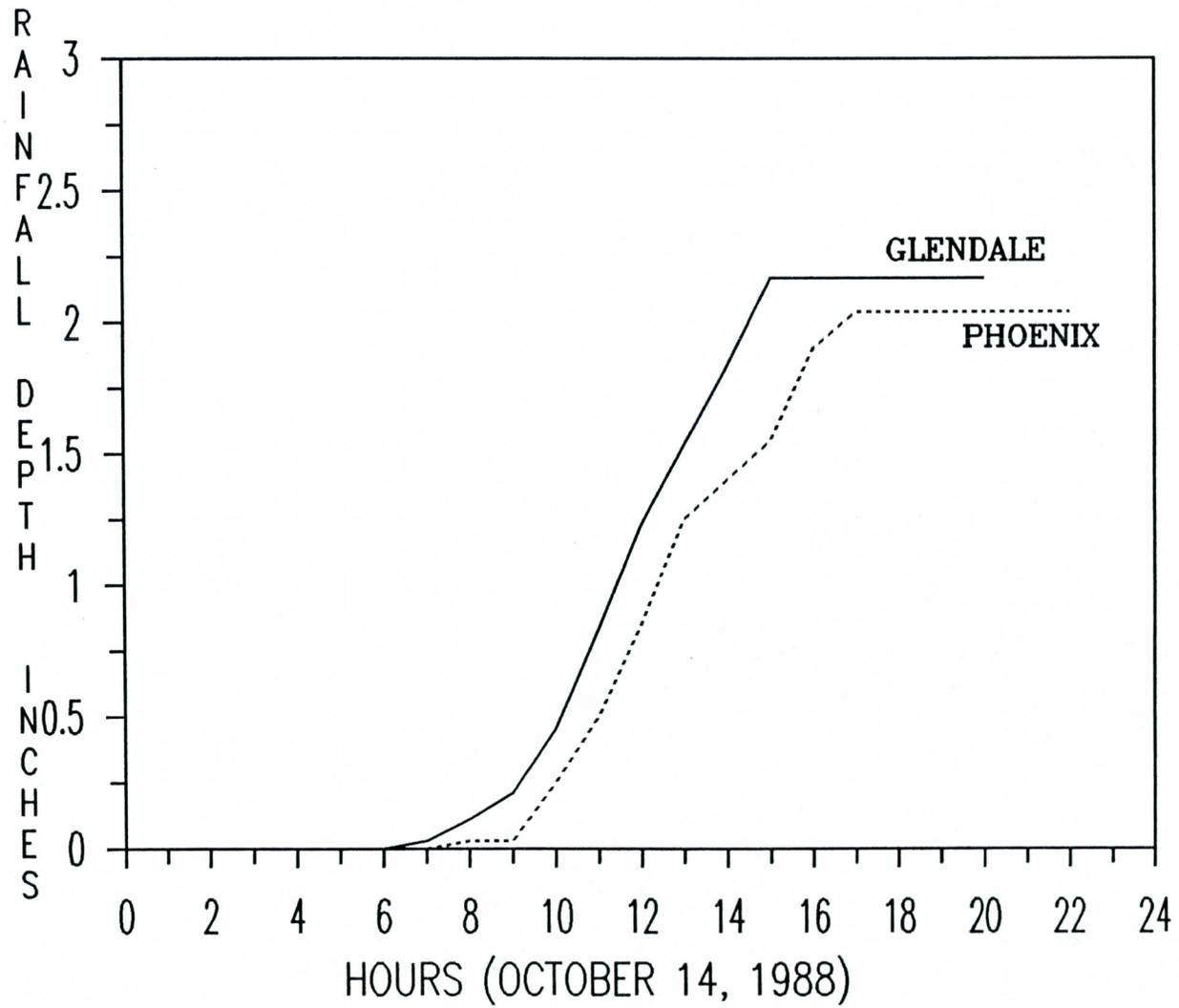
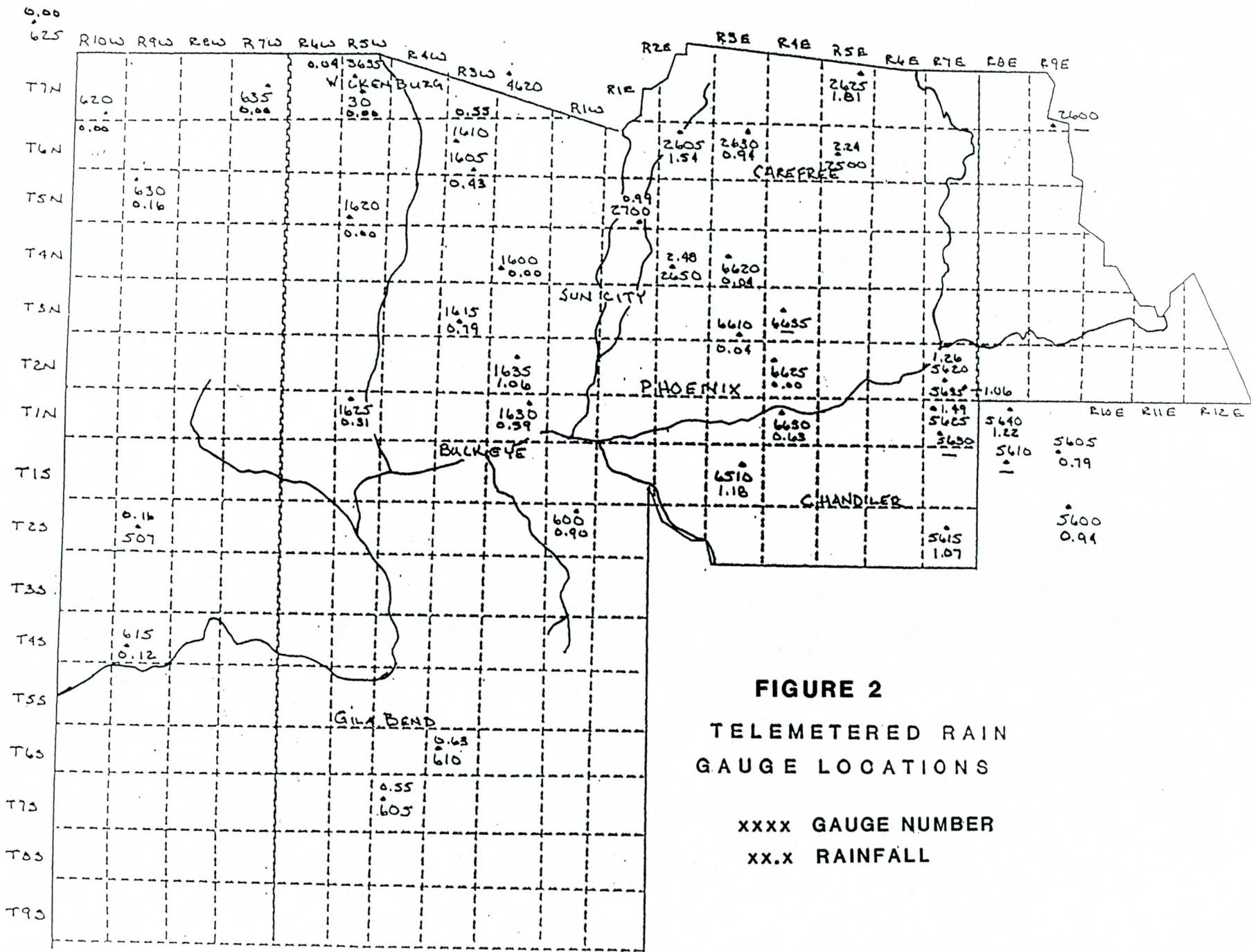
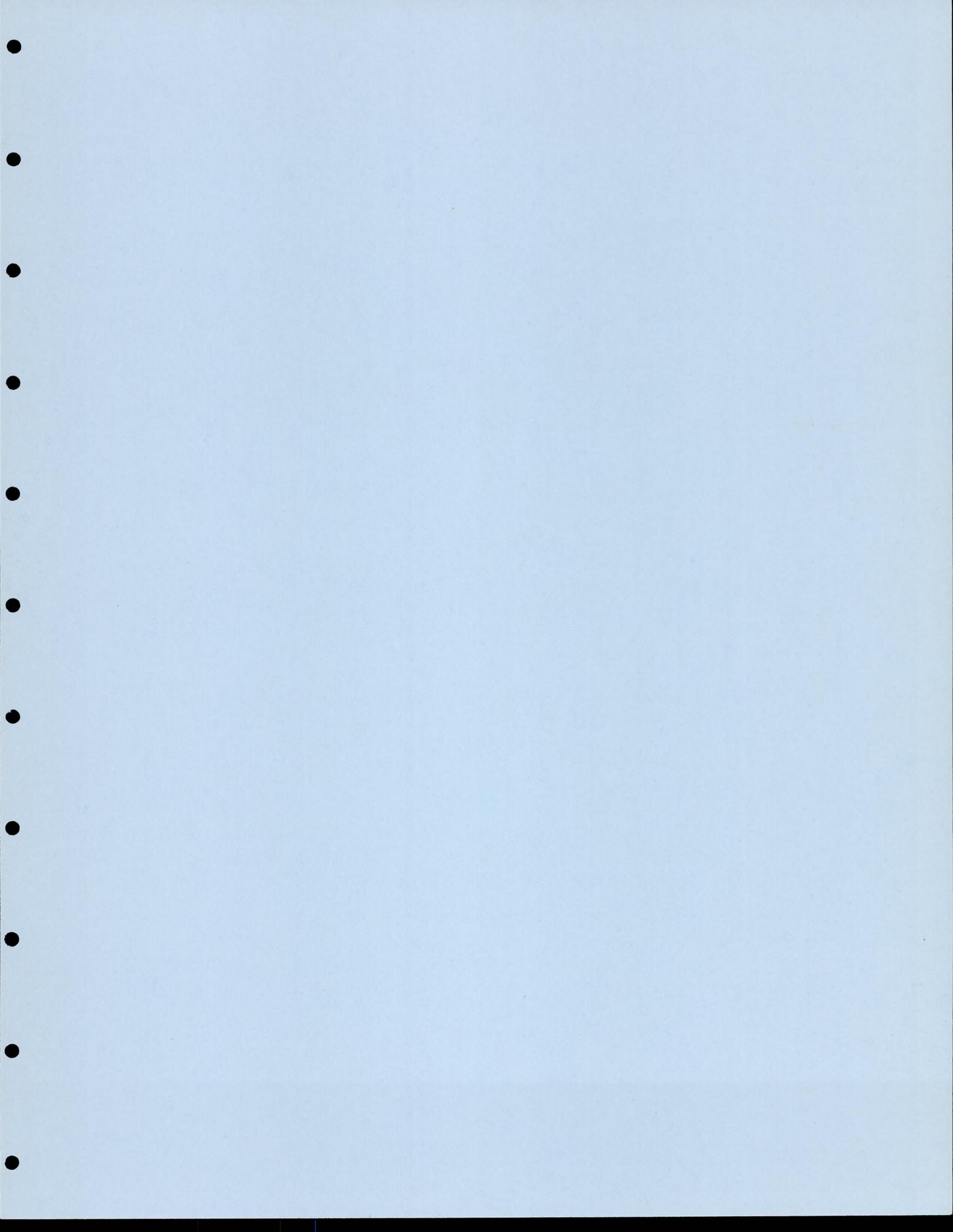


Figure 1: Rainfall mass curves for October 14, 1988 storm.



Phoenix and Carefree areas based on rainfall amounts of 2.32 and 2.6 inches, respectively. The return period will vary for other areas based on storm duration and rainfall amount.



Runoff

Due to the poor transmissions during the storm, data available from telemetered stream gauges was sparse and of poor quality. The majority of the telemetered stream gauges are on Flood Control District structures. Of these structures Cave Buttes Dam, Dreamy Draw Dam and Rittenhouse Dam gauges reported information of good quality. Figures 3 through 5 are stage readings for these structures. As can be seen, these structures had rapid ponding behind them with a more gradual drawdown time. Many of the other FCD structures had minor ponding behind them.

Flows from Cave Creek into the Arizona Canal reached a maximum discharge of 900 cfs according to SRP. Figure 6 shows a view of Cave Creek at its confluence with the Arizona Canal. Of this discharge, SRP measured, using a propeller meter, 690 cfs spilling over Spillway #8 of the Arizona Canal directly south of the Cave Creek confluence during peak flows. Figure 7 shows flows passing over Spillway #8, heading south. The flows from Cave Creek, along with other local inflows into the Arizona Canal, caused the Arizona Canal to start overtopping. Upon consultation with the Maricopa County Flood Control District and receiving permission to breach the Arizona Canal into the ACDC, SRP breached the Arizona Canal between 51st and 59th Avenues allowing water in the canal to flow directly into the ACDC. Maximum flows into the ACDC from this breach was estimated to be 200 cfs by SRP officials. Water levels in the Arizona Canal were lowered about 4 inches about an hour after breaching. Figures 8 and 9 show the breaching of the Arizona Canal. Figures 10 and 11 show the water running down the embankment of the ACDC and the erosion caused by the breach. The maximum flow in the

cave Buttes Pool

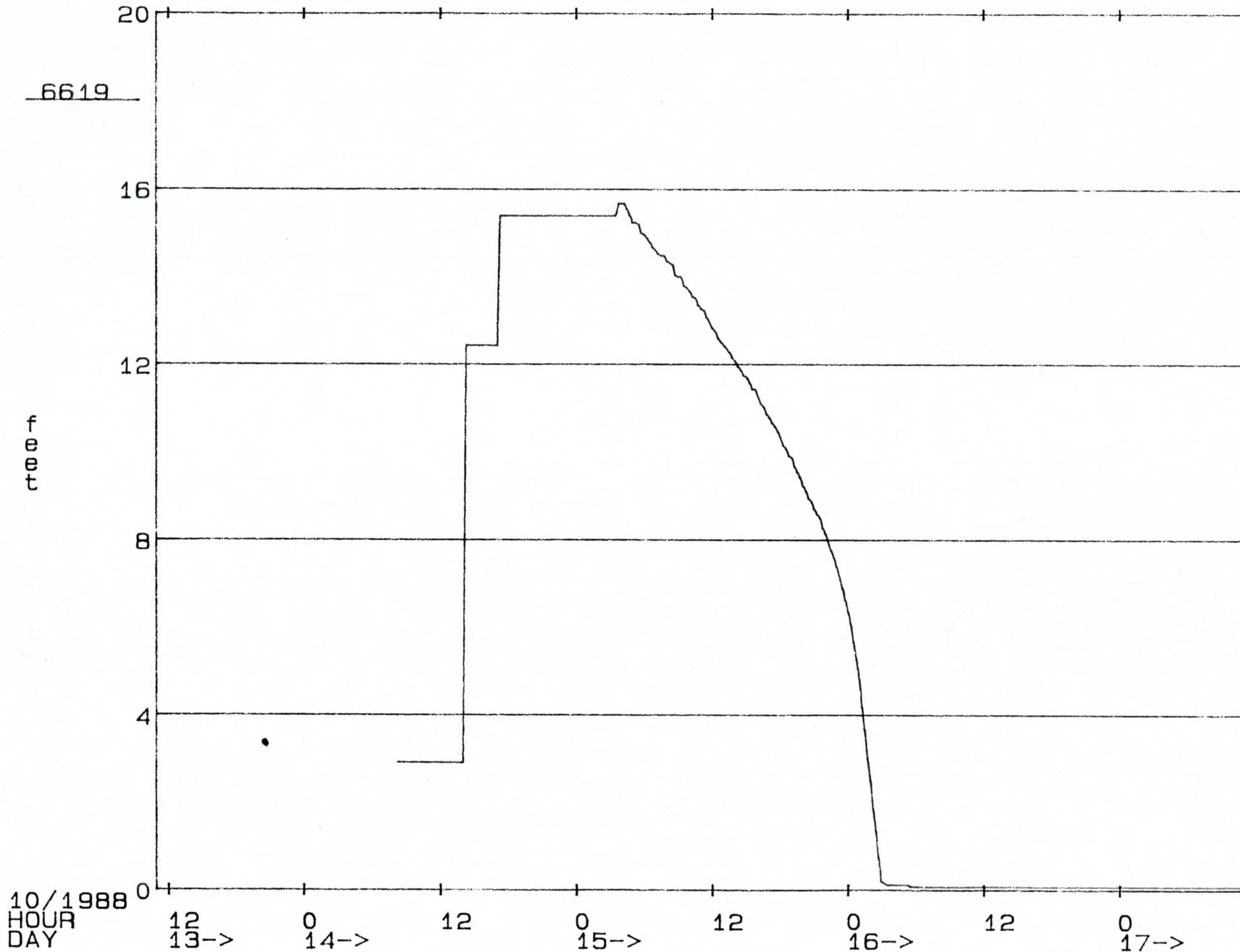


FIGURE 3

Dreamy Draw Stage

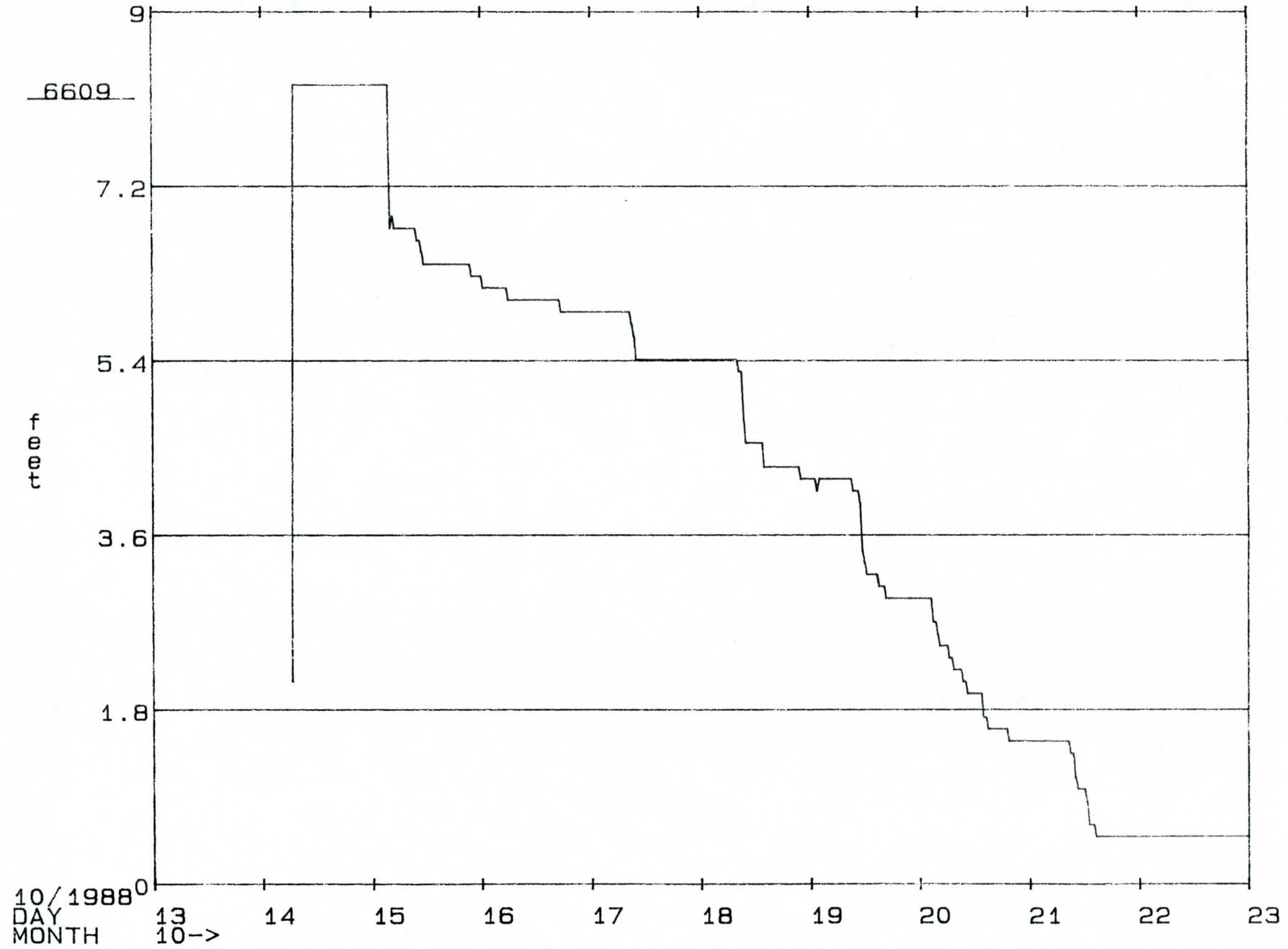


FIGURE 4

Ritten Stage

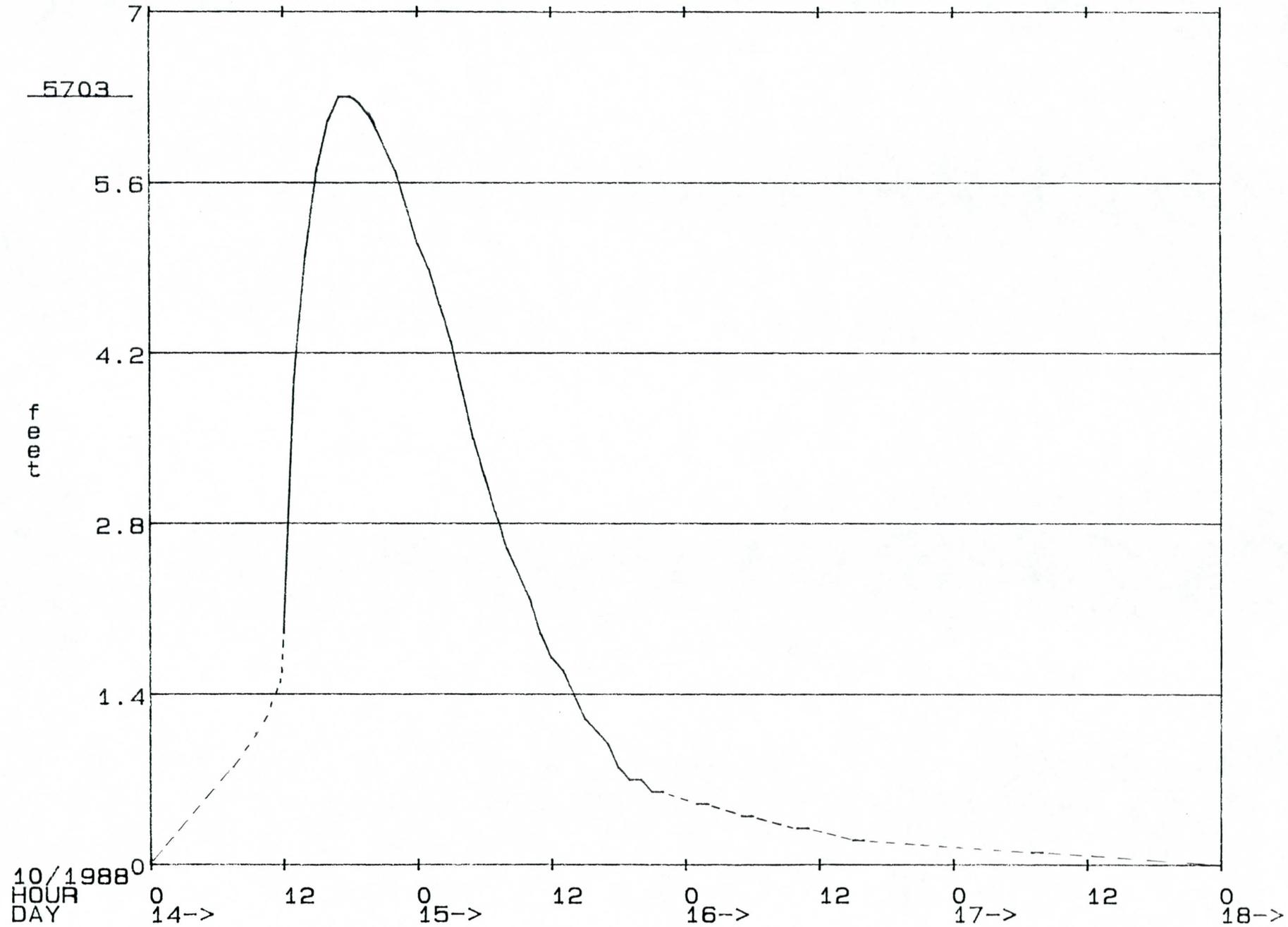


FIGURE 5



Figure 6: Cave Creek at the confluence of the Arizona Canal looking south.
($Q=900$ cfs)

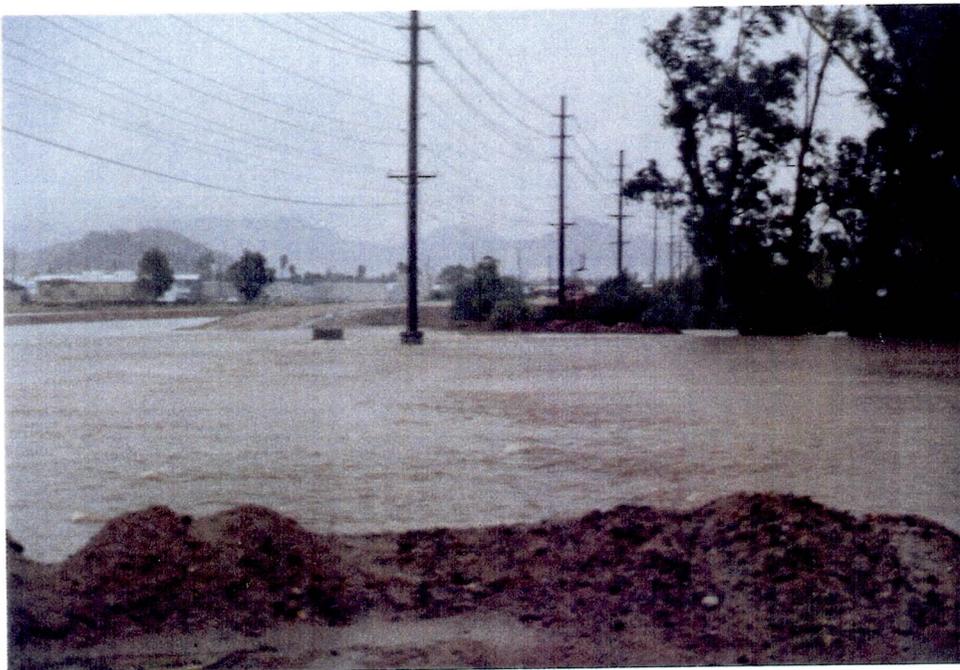


Figure 7: Flood waters from Cave Creek passing over Spillway #8 of the
Arizona Canal. ($Q=690$ cfs)



Figure 8 & 9: Breaching of the Arizona Canal between 51st and 59th Avenues. Maximum flow was estimated at 200 cfs.



Figure 10: Breach water of Arizona Canal flowing down south embankment of ACDC (Arizona Canal Diversion Channel).



Figure 11: Erosion of ACDC caused by breach waters from Arizona Canal.

ACDC at the confluence with Skunk Creek was around 2500 cfs based on field estimates. Skunk Creek above the ACDC confluence was minimal, estimated to be only 200 cfs.

Flows in New River at Bell Road were also minimal, less than 500 cfs. Downstream of Bell Road, New River received the flows from Skunk Creek and the ACDC. These flows passed on down New River with no significant impact. However flows were large enough to close the roads at the dip crossings of Northern and 99th Avenues.

Flows in the lower Agua Fria River below the New River confluence were minimal. Flows were mostly following the braided channels of the river bottom.

General flooding occurred throughout most of the metropolitan Phoenix area. Many roads and intersections were closed due to accumulation of runoff waters. As much as two feet of water had to be drained from underpasses on the Black Canyon Freeway from Camelback Road north to Union Hills Drive. All unbridged crossings of Indian Bend Wash in Scottsdale and the Salt River in Tempe were closed due to running water.

Rainfall amounts were great enough to cause most of the smaller washes and some of the larger washes to have significant flows. Flows in Cave Creek and Dreamy Draw were mitigated greatly due to the presence of Cave Buttes and Dreamy Draw Dams. Flows from Cave Creek greatly attributed to flooding south of its confluence with the Arizona Canal. As mentioned earlier, the majority of the flows going into the Arizona Canal continued on south through the spillway. Most of this flow continued south down 23rd Avenue until it reached Northern

Avenue. From here, flows gradually shifted east, heading south between 19th and 21st Avenues. Most of the flow had dissipated by the time it reached Bethany Home Road. It should be noted that some flooding had occurred earlier due to storm sewer surcharges. Flood flows from Cave Creek only augmented these flood waters. Estimated depth of flood waters were 3-4 feet at 23rd Ave. and Alice, 4 feet at 23rd Av. north of Northern Ave. and 4 feet at 19th Ave. and Orangewood. There was particular heavy flooding in the vicinity of 19th Ave. and Hatcher. This flooding was attributed to the ponding of local runoff waters in area, not as a result of the Arizona Canal overtopping. Figures 12 and 13 show the magnitude of flooding at a couple of intersections in north Phoenix.

The Arizona Canal overtopped its south bank several hundred yards east of 43rd Avenue giving cause for the mechanical breaching of the canal mentioned previously. Figure 14 shows the main area of overtopping and the flooding caused as a result. The subdivision west of 39th Avenue was flooded, with water halfway up the lawns of the houses, but there was no flood damage to the houses. Grading within the subdivision directed the flood water west toward 43rd Avenue.



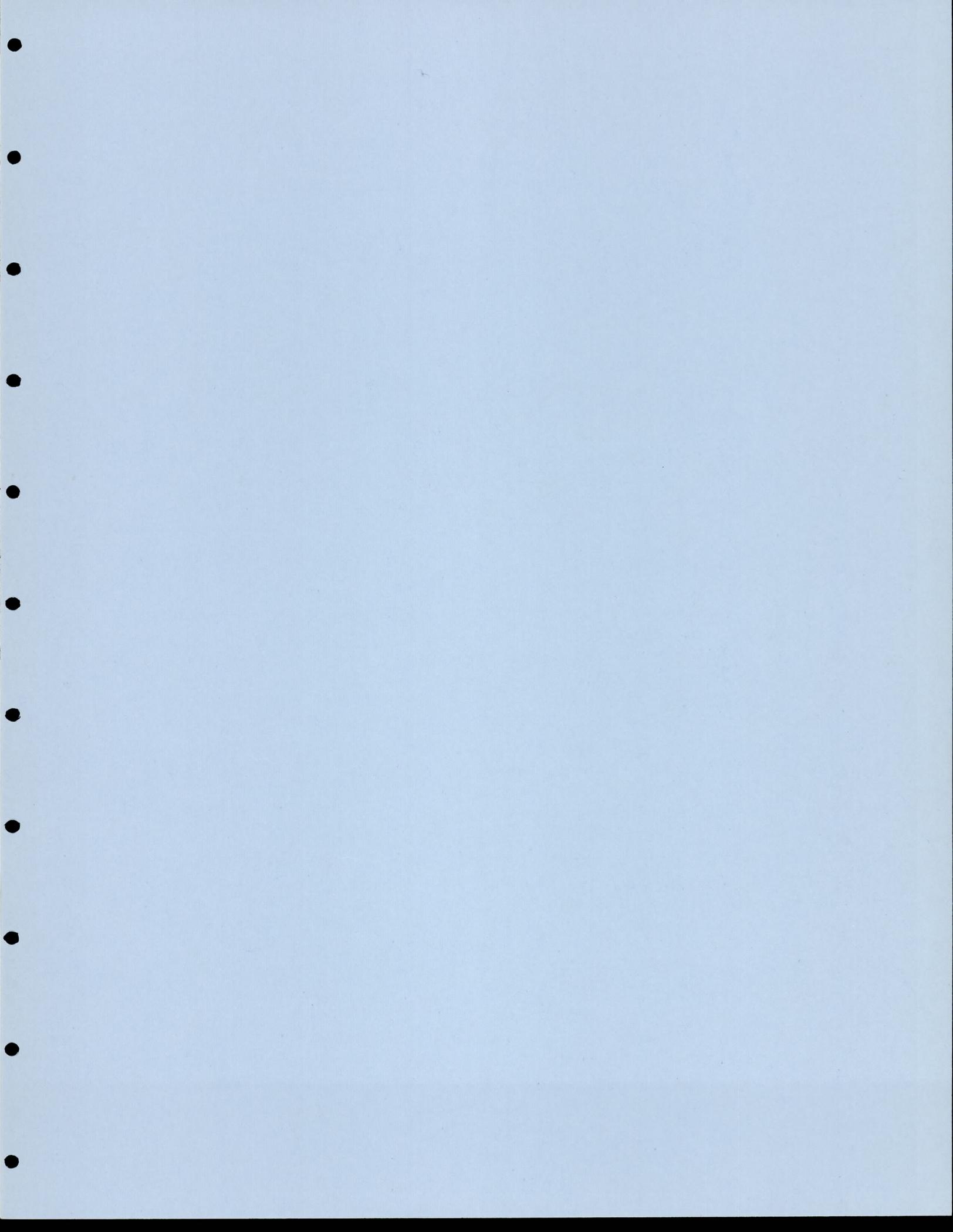
Figure 12: Flooding at 19th Avenue and Hatcher, Phoenix.



Figure 13: Storm sewer surcharge causing flooding at 23rd Avenue and Alice.



Figure 14: Arizona Canal overtopping it's south banks several hundred yards east of 43rd Avenue



Summary

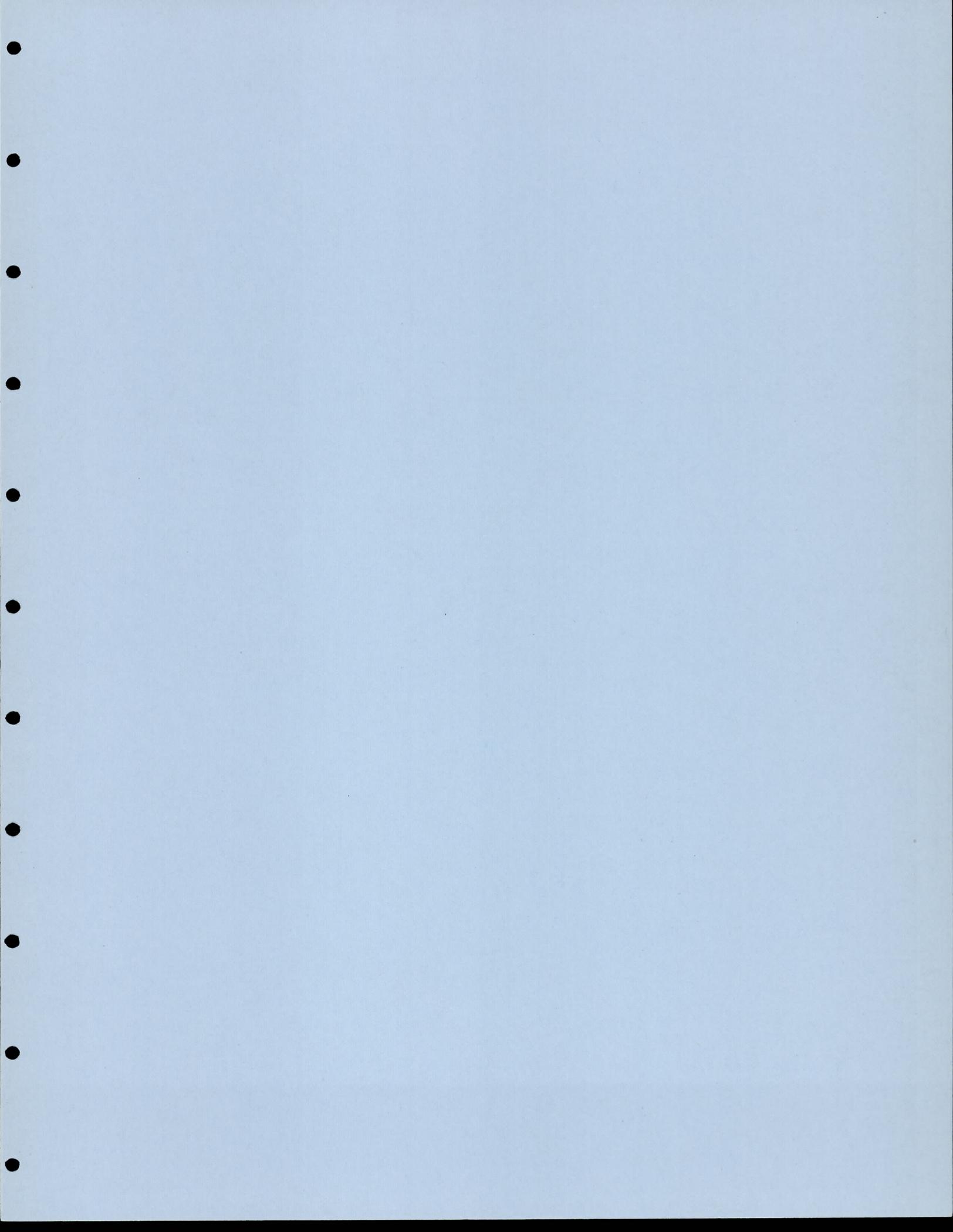
The storm of October 14, 1988, according to one weather forecaster, "came out of nowhere" producing an official 2.32 inches of rainfall, the largest 24 hour amount in October. Rainfall depths varied from 1.0 to 2.50 inches over a 6-9 hour time period with intensities ranging from 0.10 to 0.40 inches per hour.

General flooding occurred throughout most of the metropolitan Phoenix area. The Arizona Canal was overtopped due to inflows from Cave Creek (SRP estimated a peak flow 900 cfs) and local areas along the canal. This prompted SRP to breach the Arizona Canal, spilling flood waters from the canal directly into the ACDC. The maximum flow in the ACDC at the confluence with Skunk Creek was around 2500 cfs. Flood waters reached depths of 2-3 feet north of Northern Avenue between 19th and 21st Avenues, as was typical for many other areas of the valley.

Although flows from Cave Creek contributed to flooding, peak flows were reduced due to the impoundment of runoff waters behind Cave Buttes Dam. Stage readings at Cave Buttes Dam showed a water depth of over 15 feet. Flooding from other streams, Skunk Creek and Dreamy Draw, were also reduced due to flood control structures, Adobe and Dreamy Draw Dams. Runoff water from all these streams would have drained into the Arizona Canal greatly increasing the extent of flooding due to the canal overtopping.

Although during the storm the flood warning system did not perform up to previous capabilities it still provided useful information. Due to low or lost

transmission signals not all rainfall data, intensities and durations, from telemetered stations were received. However, total rainfall amounts were able to be determined from telemetered and recording rain gauge stations.



APPENDIX A

STATION INDEX

	OLD TELE	NEW TELE	STATION	SEC	TWN	RNG	ELEV	GROUP
1	7	07	YARNELL HILL	11	10N	5W	5128	12
2	16	16	SUNSET POINT REST AREA	23	9N	2E	3378	10
3	26	26	PRESCOTT VALLEY NORTH	16	15N	1E	5228	10
4	27	30	SUNSET DAM	15	7N	5W	2311	12
5	25	35	SOLS WASH	13	8N	7W	2771	12
6	24	36	WILHOIT	32	13N	3W	5043	12
7	20	40	MINNEHAHA	31	10N	1W	5602	12
8	83	45	BOX CANYON PRECIP	7	8N	4W	2245	12
9	86	48	BOX CANYON STAGE	7	8N	4W	2244	2S
10	61	50	HASSY BRIDGE PRECIP	9	11N	3W	3785	12
11	62	51	HASSY BRIDGE STAGE	9	11N	3W	3744	2S
12		507	GILA BEND MTS. WIND	17	2S	9W	1560	9
13	~	510	GILA BEND MTS. PRECIP	17	2S	9W	1560	9
14	~	511	GILA BEND MTS. RELATIVE HUMIDITY	17	2S	9W	1560	9
15	~	512	GILA BEND MTS. TEMP	17	2S	9W	1560	9
16	~	513	GILA BEND MTS. SOLAR RADIATION	17	2S	9W	1560	9
17	~	514	GILA BEND MTS. BAROMETRIC PRES	17	2S	9W	1560	9
18	43	600	WATERMAN WASH	5	2S	1W	1263	5
19	38	605	SAND TANKS WASH	14	7S	4W	1108	5
20	34	610	BENDER WASH	14	6S	3W	1243	5
21	04	615	MT OATMAN	25	4S	9W	1720	5
22	39	620	GLADDEN	33	7N	10W	2198	9
23	05	625	SMITH PEAK OBSERVATORY	1	8N	11W	5131	~
24	30	630	TIGER WASH	2	5N	9W	2198	9
25	31	635	CENTENNIAL WASH 03	16	7N	7W	2417	9
26	49	640	CENTENNIAL LEVEE 1	17	2N	10	1298	9
27	46	1600	MCMICKEN DAM PRECIP	24	4N	2W	1361	3
28	47	1603	MCMICKEN DAM STAGE	24	4N	2W	1361	~
29	41	1605	CIRCLE CITY	32	6N	3W	1890	3
30	28	1610	CASTLE HOT SPRINGS	24	6N	3W	2683	3
31	2	1615	WHITETANKS EAST PEAK	27	3N	EW	4031	~
32	40	1620	JACK RABBIT WASH	31	5N	6W	1798	9
33	48	1625	BUCKEYE FRS 1 PRECIP	3	1N	5W	1097	7
34	~	1628	BUCKEYE FRS POOL	3	1N	5W	1097	4S
35	81	1630	WHITE TANKS 4 PRECIP	5	1N	2W	1044	7
36	84	1633	WHITE TANKS 4 STAGE	5	1N	2W	1044	4S
37	82	1635	WHITE TANKS 3 PRECIP	9	2N	2W	1190	7
38	85	1638	WHITE TANKS 3 STAGE	9	2N	2W	1190	4S
39	~	2497	CAREFREE RANCH WIND	16	6N	5E	3200	3S
40	~	2500	CAREFREE RANCH PRECIP	16	6N	5E	3200	2
41	~	2503	CAREFREE RANCH TEMP	16	6N	5E	3200	3S
42	~	2504	CAREFREE RANCH STAGE	16	6N	5E	3200	3S
43	3	2600	MT ORD	34	7N	9E	7139	8
44	18	2605	SUNUP RANCH	3	6N	2E	2141	8
45	29	2610	BLOODY BASIN	8	8N	5E	4595	8
46	52	2615	COOKS MESA	4	8N	4E	4565	8
47	21	2625	HUMBOLT MTN	6	7N	5E	5198	8
48	19	2630	SKUNK CREEK IN N. RIVER	5	6N	3E	2109	8
49	51	2649	ADOBE DAM POOL	21	4N	2E	1413	~
50	44	2650	ADOBE DAM PRECIP	21	4N	2E	1413	2
51	~	2698	NEW RIVER DAM OUTLET	35	5N	1E	1498	1S
52	92	2699	NEW RIVER DAM POOL	35	5N	1E	1498	1S
53	93	2700	NEW RIVER DAM PRECIP	35	5N	1E	1498	2
54	~	2800	AGUA FRIA @ BUCKEYE PRECIP	14	1N	1W	940	~
55	~	2803	AGUA FRIA @ BUCKEYE STAGE	14	1N	1W	940	~
56	60	3510	MT UNION PRECIP	1	12N	2W	7495	11
57	63	3513	MT UNION TEMP	1	12N	2W	7495	5S

	OLD TELE	NEW TELE	STATION	SEC	TWN	RNG	ELEV	GROUP
58	23	3610	OBRIEN	21	9N	3W	2798	12
59	77	3635	HASSY 10 SUNNY COVE	11	7N	5W	2200	~
60	80	3637	HASSY 10 SUNNYCOVE STAGE	11	7N	5W	2200	~
61	~	4507	HORSETHIEF BASIN WIND	33	9N	1E	6702	5S
62	98	4510	HORSETHIEF BASIN PRECIP	33	9N	1E	6702	11
63	~	4511	HORSETHIEF BASIN REL HUMIDITY	33	9N	1E	6702	5S
64	~	4512	HORSETHIEF BASIN TEMP	33	9N	1E	6702	5S
65	~	4513	HORSETHIEF BASIN SOLAR RAD	33	9N	1E	6702	5S
66	53	4530	CROWN KING PRECIP	15	10N	1W	6783	11
67	56	4533	CROWN KING TEMP	15	10N	1W	6783	5S
68	10	4600	I-17 & 169	3	13N	3E	4750	10
69	11	4605	HORNER MT RANCH	4	11N	4E	4407	10
70	12	4610	AZ HUNT CLUB	27	12N	2E	3805	10
71	13	4615	HORSESHOE RANCH	24	10N	3E	3805	10
72	14	4620	GARFIAS MT RANCH	1	7N	2W	2645	11
73	15	4625	DEWEY	8	13N	2E	4775	10
74	17	4635	COLUMBIA HILL	22	8N	1W	2393	11
75	37	5600	RITTENHOUSE 1	35	1S	9E	1840	4
76	22	5605	KING'S RANCH	33	1N	9E	2145	4
77	72	5610	VINEYARD DAM PRECIP	9	1S	8E	1582	~
78	75	5613	VINEYARD DAM STAGE	9	1S	8E	1582	1S
79	36	5615	QUEEN CK/RITTENHOUSE	10	2S	7E	1409	4
80	88	5620	USERY MTN NORTH	26	2N	7E	2292	6
81	89	5625	USERY MTN SOUTH	1	1N	7E	1799	6
82	95	5630	SIGNAL BUTTES DAM	13	1N	7E	1650	6
83	99	5633	SIGNAL BUTTES STAGE	13	1N	7E	1650	1S
84	35	5635	MICROWAVE TOWER	28	2N	7E	2552	6
85	33	5640	BULLDOG FLOODWAY	5	1N	8E	1989	6
86	76	5645	SPOOKHILL DAM	31	2N	7E	1595	6
87	79	5648	SPOOKHILL DAM STAGE	31	2N	7E	1595	1S
88	~	5700	RITTENHOUSE DAM PRECIP	2	2S	8E	1580	4
89	~	5703	RITTENHOUSE DAM STAGE	2	2S	8E	1580	4
90	~	6507	SOUTH MOUNTAIN WIND	11	1S	3E	2135	6S
91	42	6510	SOUTH MOUNTAIN PRECIP	11	1S	3E	2135	2
92	~	6511	SOUTH MOUNTAIN REL HUMIDITY	11	1S	3E	2135	6S
93	~	6512	SOUTH MOUNTAIN TEMP	11	1S	3E	2135	6S
94	~	6513	SOUTH MOUNTAIN SOLAR RAD	11	1S	3E	2135	6S
95	67	6609	DREAMY DRAW DAM POOL	34	3N	3E	1407	1S
96	68	6610	DREAMY DRAW DAM PRECIP	34	3N	3E	1407	2
97	71	6617	CAVE BUTTES DAM POOL	15	4N	3E	1649	1S
98	73	6619	CAVE BUTTES DAM OUTLET	15	4N	3E	1649	1S
99	74	6620	CAVE BUTTES DAM PRECIP	15	4N	3E	1649	2
100	54	6624	IBW @ INDIAN BEND RD STG	12	2N	4E	1071	2S
101	55	6625	IBW @ INDIAN BEND ROAD	12	2N	4E	1089	1
102	96	6629	IBW @ BROWN RD STAGE	11	1N	4E	1187	2S
103	97	6630	IBW @ BROWN RD PRECIP	11	1N	4E	1187	1
104	32	6635	THUNDERBIRD ACADEMY	14	3N	4E	1448	1
105	~	REC	CASTLE HOT SPRINGS ROAD	24	7N	3W	2683	~
106	~	REC	DOGGY JONES	33	5N	3W	2683	~
107	~	REC	DREAMY DRAW	34	3N	3E	1382	~
108	~	REC	DREAMY DRAW STAGE	18	4N	1E	1337	~
109	~	REC	MCMICKEN NORTH PRECIP	18	4N	1E	1337	~
110	~	REC	MCMICKEN NORTH STAGE	18	4N	1E	1337	~
111	~	REC	MORRISTOWN	13	6N	4W	1978	~
112	~	REC	WITTMAN	13	5N	3W	1653	~