HYDROLOGIC EVALUATION

OF THE

GILA BEND BASIN.

MARICOPA COUNTY. ARIZONA

by

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SUMMARY AND CONCLUSIONS

The Gila Bend basin lies in the southwest quarter of Maricopa County, Arizona. The Gila River enters the basin at Gillespie Dam, flows south, then curves west to exit the basin at Painted Rock Dam, forming the northwestern boundary of the basin. The southern half of the basin is within the Air Force Gunnery Range. Consequently, that half of the basin was excluded from the study, although the hydrologic effects of that half of the basin on the northern half of the basin are considered.

The basin is geologically divided into two portions: a trough extending from Gillespie Dam to the Sand Tank Mountains, called the north basin; and the broad basin west of the Town of Gila Bend, known as the Gila Bend-Theba area. The narrow north trough is filled with relatively clean sands and gravels with little clay. The Gila Bend-Theba area consists of a layer of sands and gravel resting on a thick sequence of playa lake clay deposits, overlying a thick conglomerate layer containing interbedded volcanics.

The volume of surface flow crossing Gillespie Dam after diversions either infiltrates into the river channel as ground water recharge or exits the basin at the Painted Rock Dam site. The net surface inflow, i.e., inflow exceeding outflow, was estimated at three (3) million acre-feet during the period 1951-1985.

The quality of the surface water improved during the period 1955 to 1979, when the total dissolved solids content decreased from 5434 milligrams per liter (mg/l) to 2996 mg/l. The total dissolved solids content fluctuated in the range of 2340 mg/l to 3484 mg/l in the period 1980-1986. Saline water wasted into the Hassayampa River is expected to degrade the quality of water reaching Gillespie Dam in the future.

Withdrawal of ground water caused declines in the water levels exceeding 100 feet during the dry years, 1952-1973. Flood flows in several years after 1973 have caused the water levels to rise over 75 feet, indicating large-scale recharge of the aquifer.

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The total withdrawal from the ground water reservoir in the Gila Bend basin during the period 1952-1987 was estimated to be 7.38 million acre-feet. As the water levels in 1987 were approximately the same as in 1952, the recharge during that period had to approach 7.38 million acre-feet, or an average of 210,857 acre-feet per year. Thus, the safe yield of the basin approaches 211,000 acre-feet per year.

The estimates of the volume of recoverable water in storage in the ground water reservoir of the Gila Bend basin range from 17 million acre-feet (Freethey and Anderson, 1986) and 35 million acre-feet (Manera, 1987).

Utilizing the smaller estimate of the volume of water in storage, the basin could supply 380,000 acre-feet of ground water per year for 100 years, after which the safe yield of 210,000 acre-feet per year would be available. Utilizing the larger estimate of the volume of water in storage, the basin could supply 560,000 acre-feet of ground water for 100 years, after which the safe yield of 210,000 acre-feet per year would be available. Potential basin yield of ground water would fall within the range of 380,000 acre-feet per year to 560,000 acre-feet per year. The volume of surface water presently being diverted for agriculture, 50,000 to 75,000 acre-feet per year, could be added to the ground water yield.

The ground waters of the Gila Bend basin contain varying amounts of total dissolved solids, ranging from 1000 mg/l to almost 4000 mg/l. In most cases, the waters contain fluoride contents exceeding 1.4 mg/l. In all cases, the water quality is unacceptable for permanent human consumption and should be processed to improve the quality for use as a public water supply.

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INTRODUCTION

Location and Extent of the Area

The Gila Bend drainage basin which lies in the southwestern quarter of Maricopa County, Arizona, is an irregularly oblong entity composed of fault block mountains with intervening alluvial basins extending from the Gillespie and Painted Rock Dams on the north, southeastward to the southern boundary of Maricopa County. The general location of the basin is illustrated on Figure 1.

The study area was limited to the northern half of the basin extending from Gillespie Dam downstream on the Gila River to Painted Rock Dam and the contiguous alluvial basins southward to the military reservation boundary. The southern portion of the Gila Bend drainage basin lies within the Williams Military Reservation and Luke Air Force Base Range; consequently, subsurface geologic and hydrologic data are severely limited in that area.

Scope of the Report

This report was designed to study the hydrologic regimen of the basin and to determine the long-term water supply available for development. As a requisite to this understanding, the geologic framework of the basin was synthesized from previous reports, literature, maps and raw field data, with minor field investigation by the author. Consequently, the emphasis concerning the geologic interpretation was placed on the alluvial fill of the basins rather than on the non-water-bearing rock types.

REGIONAL CHARACTERISTICS

Physical Setting

The Gila Bend drainage basin is located within the Basin and Range lowlands of southern Arizona. The basin is bounded by the Gila Bend Mountains and the Buckeye Hills on the north, the Maricopa and Sand Tank Mountains to the east, the Sauceda Mountains to the south, and the Painted

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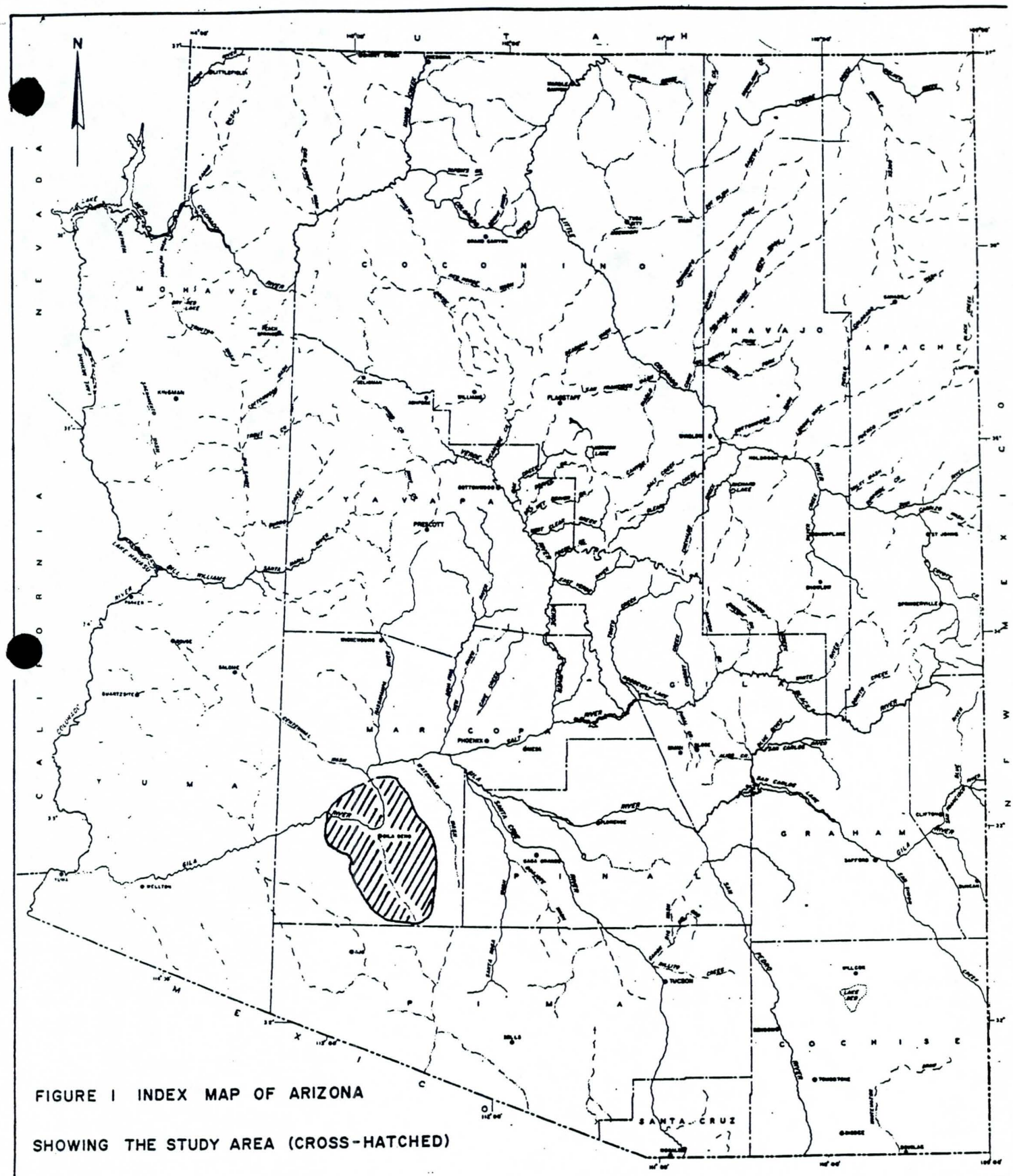

FIGURE I INDEX MAP OF ARIZONA

SHOWING THE STUDY AREA (CROSS-HATCHED)

Rock Mountains to the west. The drainage divide encompassing the Gila Bend basin is illustrated on Plate 1.

The developed portion of the Gila Bend basin consists of the narrow eastern neck of the basin extending from Gillespie Dam south to the Town of Gila Bend and the Gila Bend-Theba area extending from the Town of Gila Bend west to the Painted Rock Mountains, which is bounded on the north by the southern high-water line of the Painted Rock reservoir and on the south by the northern edge of the military reservation. The Citrus Valley area is now within the high-water line of the Painted Rock reservoir. In this report, the northeastern neck portion of the basin will be called the north basin and the western basin will be referred to as the Gila Bend-Theba area in accordance with local custom.

Alluvial fans extend westward and northward toward the basin center from the eastern and southern drainage divide, forming long slopes extending to the Gila River.

There are two outlets to the basin: the narrows at Painted Rock Dam for surface and subsurface flow; and the broad alluvial area between the Painted Rock Mountains and the Sauceda Mountains, which allows subsurface outflow.

Climate

The heat and dryness of the desert dominate the climate of Gila Bend. Precipitation is extremely scarce, particularly in the spring, falling mainly in widely-spaced showers of moderate intensity but short duration. Only in winter is an occasional day without any sunshine observed. At this time of the year cyclonic storms move into the state from the Pacific Ocean, generating widespread cloudiness and precipitation. A measurable amount of snow has been recorded only once at Gila Bend. Two inches fell on January 21, 1937, toward the end of an unusually cold month. Winter rains are extremely variable, perhaps even more so than those of summer, and can be of only limited value to crops.

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Most of the summer rain at Gila Bend falls from strongly heated moist air which advances into Arizona from the southeast and the Gulf of Mexico. Showers are most common in the late afternoon in July and August, when conditions are most favorable for intense convective activity. At times during the warmer months more extensive precipitation falls from disturbances which form in the Pacific Ocean off Mexico and move northward along the coast. These rare storms are very difficult to spot, but it is likely that they are responsible for a large fraction of the rain that falls on Gila Bend during the summer.

The winter climate at Gila Bend is almost ideal, the temperature rarely falling below freezing at night and usually rising into the high sixties or low seventies during the day. Readings of ninety degrees or higher have been reported in all months. This almost uninterrupted sequence of mild, clear, and dry days during the cooler season helps greatly to temper the heat of summer, which at times can be quite severe.

It is a rare day during the warmer months, from mid-May through mid-September, that the afternoon maximum temperature fails to reach 100 degrees. Fortunately, the air is very dry during the hottest weather, so that, in certain respects, the heat is no more unbearable than that in the eastern part of the country, where temperatures are lower but the humidity is higher. (Sellers, 1960, Station No. 02-3393-6)

The mean annual precipitation at Gila Bend is 5.84 inches, and the mean annual temperature is 72.2 degrees Fahrenheit, based on 73 years of data, 1912-1985. (ASU Climatological Laboratory, 1987)

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History of Development

The accounts of early explorers and settlers of the region tell of irrigation by the Indians in the Gila Bend basin:

> The first irrigation by white settlers took place in connection with the early overland stage lines. The first of these lines was established in 1857, and extended along the Gila River from Yuma to Sacaton. Small farming communities grew up around some of the stage stations. One of these stations was established south of the Gila River near Gila Bend. (Ross, 1923, Page 97)

Later, irrigation districts were organized, canals were dug, and brush diversion dams were built along the river. Canals constructed were the Enterprise Canal, 1886, the East Riverside Canal, 1893, the Lower Gila Canal, 1895, the Citrus Canal, early 1880's, Papago Canal, 1891, and the James Bent Canal, 1910. (Ross, 1923, Pages 97-103)

The brush diversion dams were frequently washed out or needed repair. Consequently, the Gillespie Dam was constructed in 1921 for diversion purposes with the Gila Bend Canal being completed about the same time.

> Most of these canals were constructed without adequate study of the quantity of water available for diversion, and were later abandoned. By 1940, the Enterprise Canal and the Gila Bend Canal, both diverting water at Gillespie Dam, were the only canals being used in the basin. (Babcock and Kendall, 1948, Page 2)

The irrigated acreage in the Gila Bend basin increased dramatically after 1960, and by 1986 the Gila Bend Canal carried roughly 200,000 acre-feet of water into the Gila Bend-Theba area, of which approximately 25 percent was surface water and the remainder was ground water.

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GEOLOGY

Structure

Structurally, the Gila Bend basin may be divided into two parts. Turner (1956, Page 4) describes a trough extending from Gillespie Dam southward between the Gila Bend Mountains and the Maricopa Mountains, then trending southward between the Sand Tank and southern Maricopa Mountains. Turner theorized that the fault forming the east face of the Gila Bend Mountains extended across the basin where it is exposed as the east face of the Sand Tank Mountains and that a parallel fault was present along the western boundary of the Maricopa Mountains, and these two faults formed the boundaries of this trough. This trough constitutes the majority of the eastern neck referred to as the north basin in this report. Turner recognized the fault forming the eastern boundary of the Painted Rock Mountains, but was less definitive of the remaining boundaries of the Gila Bend-Theba portion of the basin.

The U.S. Bureau of Reclamation (1976, Page 69 and Drawing No. 344-314-1259) strengthened this concept by stating:

> A gravity survey indicated at least two structural basins comprise the (Gila Bend basin) subarea: one basin defined by a gravity low east and southeast of (the Town of) Gila Bend which probably extends northward to the (gravity) low indicated south of Gillespie Dam; and a second poorly defined gravity low north and northeast of Theba. Extreme gravity mass anomalies within the basement rock surrounding this basin, however, may have obscured its delineation on the gravity map. The subarea (the Gila Bend-Theba alluvial basin) is generally enclosed by basement rock except for an arbitrary boundary on the southwest.

Sedimentary Sequence in the Alluvium

The thickness of the sedimentary sequence varies from zero at the mountain toes to more than 2000 feet, and may be significantly thicker in the centers of the basins. Wells drilled to total depths of 2070 feet in the Gila Bend-Theba area did not penetrate the total sedimentary sequence.

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The known sedimentary sequence from bottom to top consists of:

Lower Conglomerate

The Lower Conglomerate consists of moderately cemented to moderately hard cemented sands, gravels and clays. This unit is becoming increasingly important as the secondary aquifer.

Volcanic Series

The volcanic series consists of basalt extruded as flows or deposited as volcanic ash or tuff in the upper portion of the Lower Conglomerate.

Lakebed Clays (Middle Fine Grained Unit)

Lakebed or playa deposits consisting of clays with an occasional thin sand stringer form the middle fine-grained unit, which is normally considered an aquitard.

Recent Alluvium (Upper Alluvial Unit)

Recent alluvium, consisting predominantly of sands and gravels with some clays, forms the upper alluvium unit, which is the major aquifer in the Gila Bend basin.

History of Deposition of the Sedimentary Sequence

Following uplift of the mountain systems, erosion formed large alluvial fans which extended across both the north basin and the Gila Bend-Theba area. This alluvial fill consisting of sands, gravels and clays was cemented into a moderate to moderately hard conglomerate. The thickness of this Lower Conglomerate unit exceeds 1000 feet.

Interbedded in the upper layers of the Lower Conglomerate are volcanic flows, ash and tuffs indicating that the volcanic activity probably occurred during the latter part of the depositional period of the Lower Conglomerate unit. The volcanic series has been encountered more frequently in the Gila Bend-Theba area than in the north basin, perhaps because of the greater depths of the wells in the Gila Bend-Theba area.

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Perhaps by volcanic activity, perhaps by other means, the basin outlets were sealed. With the closed basin, a lake formed in the Gila Bend-Theba area in which over 1200 feet of fine-grained (clay) sediments were deposited. It appears that the center of the lake was near the present location of Theba, as the middle fine-grained unit becomes thinner in all directions from Theba.

After the closed basin was partially filled with lakebed clays, through drainage developed, allowing flow of the present Gila River. The Recent sands, gravels and clays were deposited by the river as it moved back and forth across the basin. It appears that throughflow was interrupted at various times, as terrace remnants indicate the river was higher than its present level. Following the terrace cutting, the Gila River incised the present valley fill approximately 80 feet, then refilled the incision with coarse sands, gravels and silts which form the present bed of the river.

The result of this depositional sequence again differentiates between the north basin and the Gila Bend-Theba area. In the north basin, the upper sands, gravels and clays rest directly on the Lower Conglomerate, while in the Gila Bend-Theba area the upper sands, gravels and clays are separated from the Lower Conglomerates with included volcanics by the variable thickness of the middle fine-grained unit (lakebed clays).

Plate 1 shows the locations of the wells on the Paloma Ranch and the wells utilized in the fence diagram. Plate 2 illustrates the results of the sedimentary history discussed above by means of a fence diagram.

SURFACE WATER

Gila River Discharge

Surface water in the Gila River flows into the Gila Bend basin at Gillespie Dam, down the river and out of the basin at Painted Rock Dam. The U.S. Geological survey has maintained gauging stations at Gillespie Dam for many years and at Painted Rock Dam since completion of the dam in 1959. Table 1 summarizes the data available for the inflow and outflow of the basin. Figure 2 illustrates in graphic form the discharge of the Gila River at Gillespie Dam.

GILA BEND BASIN
Discharge of Gila River, in Acre-Feet

Year	Diversions at Gillespie Dam	Gila River Below Gillespie Dam Sta. #09519500	Gila River Above Diversions at Gillespie Dam Sta. #09518000	Gila River Below Painted Rock Dam Sta. #09519800
1914			658,400	
1915			2,970,100	
1916			4,365,900	
1917			1,304,200	
1918			470,800	
1919			999,700	
1920			2,468,600	
1921			702,000	
1922	87,500	865,600	953,100	
1923	87,700	506,200	593,900	
1924	87,800	781,600	869,400	
1925	87,700	235,100	322,800	
1926	109,400	554,600	664,000	
1927	152,100	879,100	1,031,200	
1928	138,300	79,100	217,400	
1929	92,000	111,400	203,400	
1930	89,600	80,500	170,100	
1931	103,700	221,800	375,500	
1932	105,600	452,200	557,800	
1933	83,300	19,500	102,800	
1934	62,700	8,000	70,700	
1935	84,300	128,600	212,900	
1936	78,900	27,800	106,800	
1937	92,300	397,800	490,000	
1938	82,800	188,300	271,200	
1939	71,100	36,700	107,800	
1940	66,900	6,400	73,300	
1941	103,600	1,036,000	1,140,000	
1942	72,180	9,670	81,840	
1943	79,550	15,280	94,800	
1944	78,100	12,460	90,570	
1945	83,570	8,510	92,120	
1946	88,860	31,010	119,700	
1947	69,780	9,240	79,020	
1948	48,070	1,940	50,010	
1949	47,700	11,880	59,580	

TABLE 1

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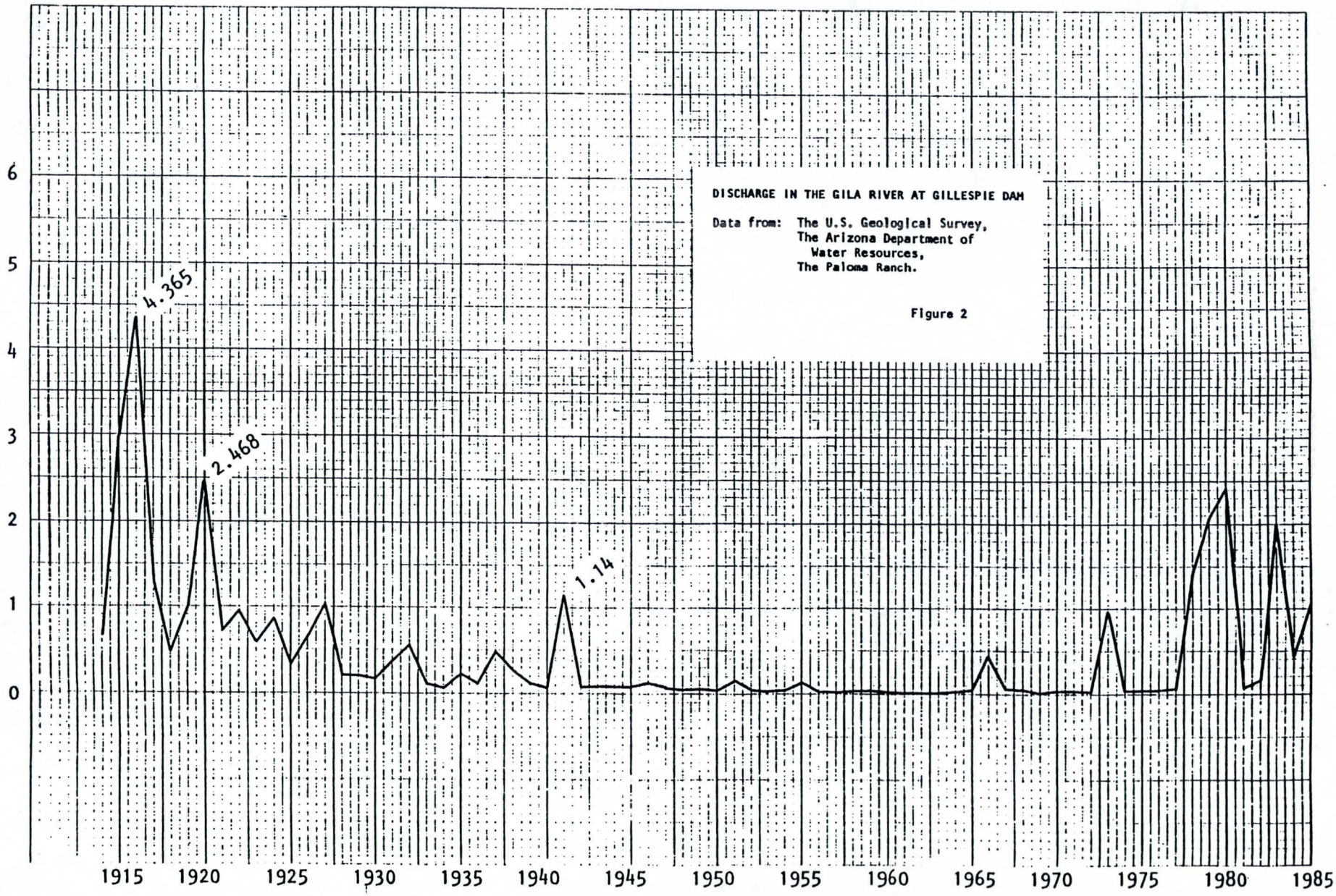
Year	Diversions at Gillespie Dam	Gila River Below Gillespie Dam Sta. #09519500	Gila River Above Diversions at Gillespie Dam Sta. #09518000	Gila River Below Painted Rock Dam Sta. #09519800
1950	36,810	2,810	39,620	
1951	43,960	106,040	150,000	
1952	44,070	2,990	47,060	
1953	24,580	70	24,650	
1954	26,780	18,040	44,820	
1955	22,330	101,970	124,300	
1956	17,390	0	17,390	
1957	13,860	3,130	16,990	
1958	15,490	6,310	21,800	
1959	14,350	14,580	28,930	
1960	15,760	4,520	20,270	
1961	9,000	170	9,170	245
1962	8,490	135	8,620	0
1963	10,220	1,170	11,320	77
1964	15,750	3,000	18,730	1,320
1965	14,060	25,710	39,770	524
1966	19,720	407,300	427,400	258,100
1967	8,490	63,580	72,080	1,590
1968	20,830	37,850	58,680	17,370
1969	14,730	992	15,730	652
1970	12,520	28,520	41,040	3,050
1971	15,400***	24,500***	39,900***	3,130
1972	12,900***	16,110	29,010***	1,180
1973	12,900***	941,100***	953,000***	445,300
1974	12,110	21,980	34,090	110,400
1975	15,280	18,810	34,090	1,790
1976	15,760	29,860	45,620	4,650
1977	27,540	43,740	71,280	201
1978	31,820*	1,368,000	1,413,000	185,400
1979	41,320*	2,027,000	2,074,000	2,036,000
1980	54,370*	2,342,000	2,405,000	2,192,000
1981	51,530*	25,420	84,850	21,150
1982	61,250*	100,900	170,900	8,670
1983	83,650*	1,893,000	1,982,000	1,435,000
1984**	74,040*	343,000	425,900	265,000
1985**		946,100	1,039,000	910,600
1986**				43,275

Records of 1914-1941 taken from ADWR, 1981 (Table 1)
Records after 1941 taken from U.S.G.S. Water Resources Data, Arizona
* Data from Robert Steil - Paloma Ranch Engineer
** Provisional data - subject to change
*** Data from ADWR, 1981 (Table 1)

TABLE 1



DISCHARGE IN THE GILA RIVER AT GILLESPIE DAM

Data from: The U.S. Geological Survey,
The Arizona Department of Water Resources,
The Paloma Ranch.

Figure 2

The table reflects several events important for an understanding of the hydrology of the basin:

1. Annual flow exceeding one million acre-feet occurred 11 times in the 73 years of record. In six of these years the flow exceeded 2.7 million acre-feet.

2. The volume of surface outflow at Painted Rock Dam is significantly less than the surface inflow at Gillespie Dam during the series of "wet" years. As an example, the differential between inflow and outflow for the years 1978, 1979 and 1980 is 1,323,600 acre-feet.

3. There was a major reduction of inflow into the basin during the period 1956-1964, resulting from drought and reduced river flows by construction of dams upstream.

Surface water is diverted at Gillespie Dam into the Enterprise Canal for use in the northern portion of the basin and into the Gila Bend Canal for use on the Paloma Ranch in the Gila Bend-Theba portion of the basin. The volumes of diversion were largest in the 1930's and early 1940's before ground water was pumped into the Gila Bend Canal. Early diversions were as high as 152,000 acre-feet per annum and were frequently in excess of 100,000 acre-feet per annum. After the initiation of ground water pumping into the canal, the volume of water diverted from the river varied and decreased as a result of reduced surface flow in the river. The volume of diversion increased to more than 50,000 acre-feet per annum after 1980 with a high of 83,650 acre-feet in 1983.

In 1971 the Gila Bend Canal was washed out by large runoff flows from the mountains, particularly but not limited to Sauceda and Quilotosa Washes. Available water in the Gila River was diverted into the Gila Bend Canal and utilized in the northern part of the north basin above the wash out. Reconstruction and cement lining of the canal occurred from 1971-1975.

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Net Surface Inflow

The differential between the flow of the Gila River below Gillespie Dam (after all diversions) and the Gila River below Painted Rock Dam was the volume of water that remained in the basin (net surface inflow). The net surface inflow to the Gila Bend basin since surface water flow measurements were initiated at Painted Rock Dam (1961) through 1985 was 2,289,378 acre-feet. The net surface inflow from 1951-1985 was estimated to have approached three (3) million acre-feet.

Surface Water Quality

The quality of the surface water passing the Gillespie Dam improved markedly from 1955 to 1979, during which time the total dissolved solids content decreased from 5434 milligrams per liter (mg/l) to 2996 mg/l. During the period 1980-1986 the total dissolved solids content fluctuated within the range of 2340 mg/l to 3484 mg/l. Table 2 lists the chemical analysis of water samples collected at Gillespie Dam for selected years between 1955 and 1986. The specific conductance on Table 2 should be multiplied by 0.65 to obtain the total dissolved solids content in milligrams per liter.

The reduction in total soluble salts content is believed to be a combination of dilution by flood runoff and dilution by the dumping of sewage effluent into the river system by the City of Phoenix. Waste water from drainage wells near the City of Buckeye is dumped into the Hassayampa River, then flows down to the Gillespie Dam. This highly saline water will degrade the quality of the water passing the dam.

GROUND WATER

Water Levels

Water level contour maps for 1952, 1966, 1973, 1980 and 1987 are included as Plates 3 through 7. Maps of water level contours for 1952, 1966, 1973 and 1980 were taken from the files of the Arizona Department of Water Resources. The data bases for these maps are:

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AGRICULTURAL WATER SAMPLE MEASUREMENTS
FOR
GILA BEND CANAL AT GILLESPIE DAM

	Accepted Standard	1955	1965	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
CARBONATE(mg/l)		-	-	-	-	-	-	-	-	-	-	-	-	-	1.0
BICARBONATE(mg/l)	90	340	250	340	360	300	-	-	-	-	-	-	-	-	301
CALCIUM(mg/l)		360	350	300	300	220	240	180	170	190	180	140	210	150	170
MAGNESIUM(mg/l)		150	150	150	130	96	95	81	72	82	100	62	89	65	80
SODIUM(mg/l)	70	1400	1200	1000	990	800	900	650	600	680	790	520	680	500	640
NITRATE(mg/l)	10	31	0.7	10.7	12.5	-	-	-	-	-	-	-	-	-	7.75
SULFATE(mg/l)	200	1200	900	1100	980	780	820	630	520	560	790	480	630	430	560
PHOSPHATE(mg/l)		-	-	0.98	1.9	4.0	-	-	0.6	-	0.58	0.89	0.43	2.1	2.4
ZINC(g/l)	2000	-	-	40	40	40	50	40	50	20	30	10	10	10	20
COPPER(g/l)	200	-	-	-	-	20	15	13	22	15	50	30	15	7	3
MANGANESE(g/l)	200	-	-	210	-	200	180	190	280	280	180	20	50	110	140
IRON(g/l)	5000	10	80	50	20	30	-	-	10	50	70	10	20	20	20
BORON(g/l)	1000	3300	2300	3400	1400	2500	2900	1900	1800	370	2600	1600	2000	1400	1400
CHLORIDE(mg/l)	140	2100	1300	1500	1400	1100	1400	930	910	1100	1200	770	1100	780	920
pH	6.5 TO 8.5	7.8	7.8	8.4	8.2	7.6	7.8	7.8	9.0	8.7	8.8	8.9	8.8	8.6	8.7
SPECIFIC CONDUCTANCE(us/cm)	750	8360	7800	7000	7400	5300	5780	4610	3900	4140	5360	3850	4450	3600	4100
SODIUM ABSORPTION RATIO	6	16	14	12	12	12	13	10	10	11	12	9	10	9	10

Data from Franzoy-Corey (1986)

TABLE 2

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Plate 3, 1952 (Coates, 1952)
Plate 4, 1966 (Stulik and Mooseburner, 1969)
Plate 5, 1973 (Nemecek, 1975)
Plate 6, 1980 (Arizona Department of Water Resources, 1981)
Plate 7, 1987 (Field data for this report)

Plate 3 - 1952

Withdrawal from the ground water reservoir during the period 1935-1952 had established a 60-foot cone of depression in the northern end of the north basin.

Recharge from the Gila Bend Canal maintained a gradient on the water table downstream to the outlet at the Painted Rock Dam site. All ground water flow directions in 1952 were towards the Gila River.

Plate 4 - 1966

The water level map of 1966 shows an elongation and deepening of the cone of depression during the period 1952-1966 in the north basin. The water level in the cone of depression had declined more than 80 feet in the 14-year period 1952-1966. Reversal of flow can be observed as far south as the Town of Gila Bend.

In the Gila Bend-Theba area recharge from the canal had formed a noticeable ground water mound under the Gila Canal. The ground water mound under the canal initiated ground water flow to the southwest as well as towards the river. The flow towards the southwest left the basin through the subsurface outlet between the Sauceda Mountains and the south end of the Painted Rock Mountains.

Plate 5 - 1973

By 1973 the cone of depression in the north basin had elongated to a distance 14 miles extending from six miles below Gillespie Dam to the Town of Gila Bend.

Outflow from the Gila Bend-Theba area, reversal of flow towards the cone of depression, and no recharge from the canal due to non-use of the canal since 1967 all contributed to the lowering of the water level by more than 60 feet in the Gila Bend-Theba area by 1973.

PILP 006728

Plate 6 - 1980

Flood flows in the Gila River during and following the years 1973, 1978, 1979 and 1980 resulted in large volumes of recharge to the ground water aquifer in the north basin. This extreme recharge caused the water levels under the river to rise in excess of 65 feet. The impermeable boundary of the Gila Bend Mountains to the west of the river caused a steep gradient in the ground water level to the east and south. The recharge and resulting ground water movement filled the major portion of the cone of depression which existed in the north basin in 1973, leaving only a remnant of the cone near the Town of Gila Bend.

The filling of the Painted Rock reservoir resulted in a rapid increase in the water level in the Gila Bend-Theba area. The ground water gradient was changed to south and southwest, with the reservoir acting as the recharge source. This new gradient dramatically increased the outflow of the basin south of the Painted Rock Mountains.

Plate 7 - 1987

Continued flood flows in the Gila River in 1983, 1984 and 1985 contributed large volumes of additional recharge to the ground water aquifer in the north basin. The water mound under the river bed rose an additional 25 feet while a rise of more than 50 feet east of the river completely obliterated the remains of the cone of depression developed prior to 1973.

The water levels in the Gila Bend-Theba area dropped 50 feet after the Painted Rock Reservoir was drained. Although the recharge source of the reservoir is no longer present, the volume of underflow in the river channel still maintains the mounding of the ground water under the river and the south and southwest flow of the ground water towards the south outlet of the basin; however, the gradient of the water level is much less than in 1980.

PILP 006729

Hydrographs of selected wells in the Gila Bend basin, Figure 3, illustrate two aspects of the ground water levels -- the long-term upward trend from 1968 to 1986, and the cyclic nature of the volume of recharge to the aquifer. Rapid reversal in the direction of the water levels during "wet" years and "dry" years in the north basin are graphically illustrated by the well in Section 8, T. 4 S., R. 4 W. The change between "wet" years and "dry" years is modulated to a much higher degree in the remainder of the basin.

Aquifer Characteristics

Pumping tests were run in 1986 on all active wells in the basin owned by the Paloma Ranch. The tests were conducted by Arizona Engine and Pump Company, Gilbert Pump Company, Layne-Western Company, Inc., and Franzoy-Corey Engineering Company. A summary of results of these tests, the perforated area in the well and a Theis estimation of the transmissivity is included as Table 3. The field data sheets of the pumping tests, well schedules and drillers' logs of the wells are available under separate cover, Volume 2, of this report.

The discharge (Q) of the well in gallons per minute (gpm), the pumping level, and the static water level were measured during the test unless otherwise specified on Table 3.

The term "drawdown" (dd) refers to the difference between the static water level (SWL) and the pumping level (PL). This head differential causes water to flow towards the well.

The specific capacity (SC) of the well is defined as the yield of the well in gallons per minute per foot of drawdown (gpm/ft of dd). Dividing the discharge by the drawdown gives the specific capacity.

PILP 006730

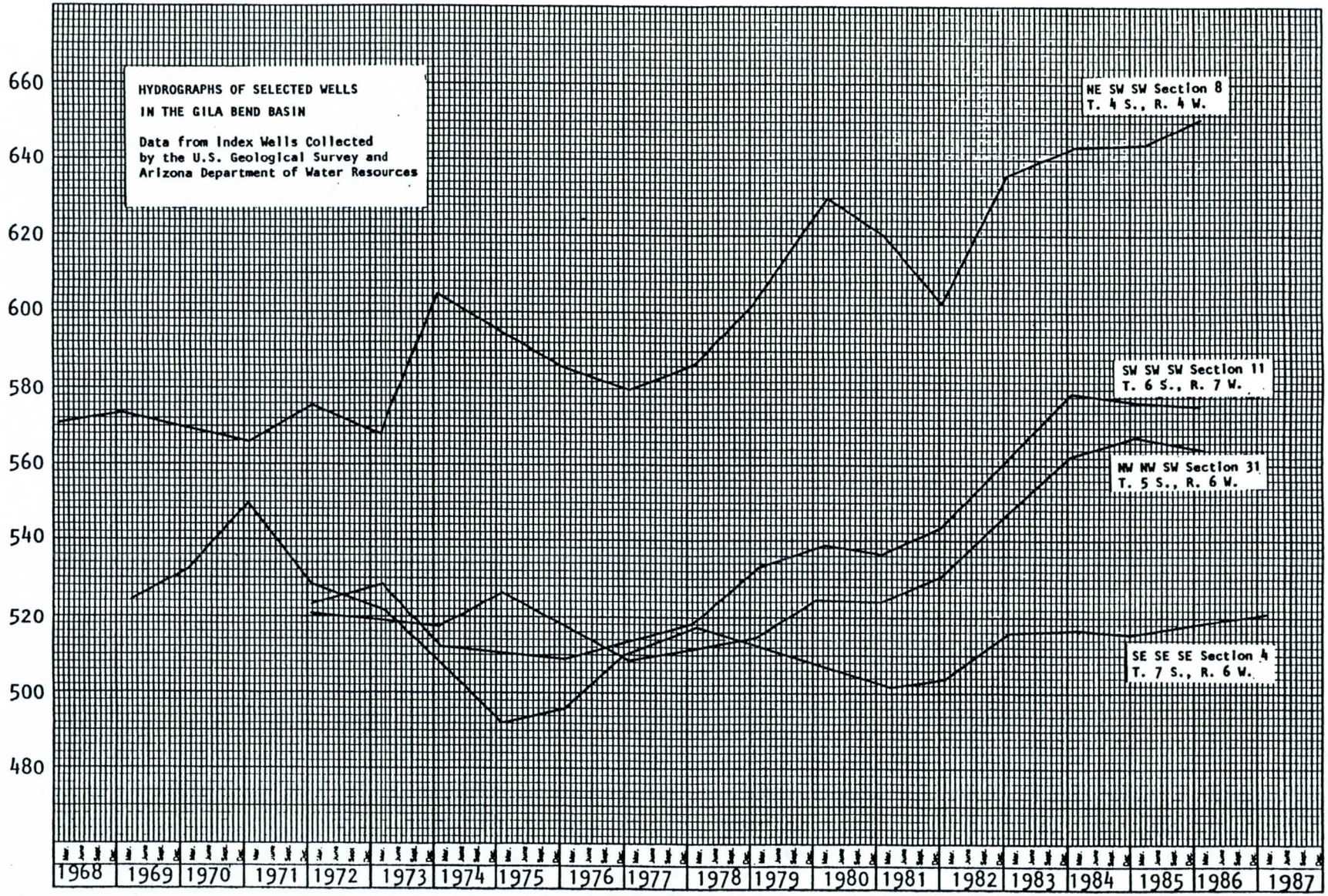

Figure 3

PILP 006731

PALOMA RANCH WELLS

Discharge Characteristics, Perforated Area of the Wells & Theis Estimation of the Transmissivity
Measurements Summer 1986

Well No.	Location	Perforated Area From	Perforated Area To	Discharge, Q, in gpm	Pumping Level, Feet	Static Water Level, Feet	Drawdown, feet	Specific Capacity, gpm/ft/dd	T. Theis Estimation (1700), gpd/ft
1	NW NE NW Sec 35 (2-5)	50	372	4200	143				
2	NW SE NE Sec 35 (2-5)	50	365	2865	190	95	95	30	51,000
3	SE NW SW Sec 36 (2-5)	155	885	2170	111	95	16	136	231,000
4	NE NW NW Sec 6 (3-4)	100	525						
5	NE NE SW Sec 6 (3-4)	100	815	3510					
7	NE NE SW Sec 8 (3-4)	135	356	3430	167	138	29	118	201,000
8*	NW SW SE Sec 8 (3-4)			3035	173	145	28	108	184,000
9*	NE NE NE Sec 17 (3-4)	120	755	3850	171	140	31	124	211,000
11	NE NW NW Sec 21 (3-4)	115	288	1590	150	145	5	318	541,000
12*	NW SE NW Sec 21 (3-4)			3605	159	144	15	240	409,000
13*	NW NE SW Sec 21 (3-4)	115	550	3430	179	136	43	80	136,000
14	NE SE SW Sec 21 (3-4)	140	800	3500					
15*	NW NW NE Sec 28 (3-4)	160	906	4445	178	134	44	101	172,000
16	SW SW NE Sec 28 (3-4)	130	985	3573	161	131	30	119	202,000
17*	NE NW NE Sec 33 (3-4)	100	780	4465	184	131	53	84	143,000
18	NW SE NE Sec 33 (3-4)	125	760	4520	170	129	41	110	187,000
19*	SW SE NE Sec 33 (3-4)	100	780	3955	185	131	54	73	125,000
20*	SE SE SE Sec 33 (3-4)			4315	206	136	70	62	105,000
21	SW SW NW Sec 3 (4-4)	120	608	3300	278	155	123	27	46,000
22	NE NW NW Sec 10 (4-4)	130	780	3405	247	139	108	32	54,000
23	SE SW NW Sec 10 (4-4)	80	1000	4400	188	140	48	92	156,000
24	SW SE SW Sec 10 (4-4)	80	500						
25	SE NW SW Sec 21 (5-4)	80	1000						
26*	NE SW SW Sec 21 (5-4)	40	954	1350	304	177	127	11	18,000
28	SE SE NE Sec 31 (5-4)	80	1100	2265	279	190	89	25	43,000
29	SW NE SE Sec 31 (5-4)	150	1000	925	220	189	31	30	51,000
30*	SW SE NE Sec 2 (6-5)	0	1000	2380	259	185(e)	74	32	55,000
31*	NW NE SW Sec 2 (6-5)	150	985	2445	272	185	87	28	48,000
34*	SE SW SW Sec 34 (5-6)	150	766	2115	221	136	85	25	43,000
37	NW SW SE Sec 34 (4-4)	0	800						
38	SE SE SW Sec 3 (5-4)	107	841	3783	218	164	54	70	119,000
39*	NE NW NE Sec 34 (4-4)	0	953	3710	252	172	80	46	79,000
40*	SW SE NE Sec 27 (4-4)	118	880	3620	239	165	74	49	83,000
41*	SW SE SE Sec 22 (4-4)	96	982	3525	216	157	73	48	82,000
42*	NW NW SW Sec 10 (5-4)	110	1133	3720	223	165(e)	58	64	109,000

TABLE 3

PILP 006732

Well No.	Location	Perforated Area From	Perforated Area To	Discharge, Q, in gpm	Pumping Level, Feet	Static Water Level, Feet	Drawdown, feet	Specific Capacity, gpm/ft/dd	T, Theis Estimation (1700), gpd/ft
43*	SW SE SE Sec 15 (4-4)	95	846	4025	188	151	37	109	185,000
51	SW NE NW Sec 10 (5-4)	80	1031	3733	202	161	41	91	155,000
52*	SE NW NW Sec 3 (5-4)	88	986	4065	235	162	73	56	95,000
53*	NE NE NE Sec 16 (5-4)	107	1090	2420	261	165(e)	96	25	43,000
54*	SE SW SE Sec 27 (4-4)	118	936	2345	242	174	68	34	59,000
55*	SE SW NE Sec 22 (4-4)	30	915	3700	201	155(e)	46	80	137,000
56*	SW NW SE Sec 4 (6-5)	130	1061	2520	235	185	50	50	86,000
57	NE NW SE Sec 16 (5-4)	109	1400						
59	SW SW NE Sec 15 (4-4)			3390	186	137	49	69	118,000
60*	SE SE SE Sec 6 (6-5)			2545	319	142	177	14	24,000
69-4*	NW SW Sec 31 (5-6)	906	1771	1970	387	204	183	11	18,000
70-1	SE SE SE Sec 4 (6-6)	1000	1540						
70-3*	SW SW NE Sec 36 (5-7)	720	1380	1550	356	185(e)	171	9	15,000
70-7*	SW SW SW Sec 2 (6-7)	500	1040	3610	229	185(e)	44	82	139,000
70-8	SW SW SW Sec 11 (6-7)	490	850	1590	312	153	159	10	17,000
70-9*	NW NW SW Sec 20 (5-5)	698	968	1480	431	80	351	4	7,000
71-6*	SW SW SE Sec 11 (6-7)	600	920	1995	221	172	49	41	69,000
71-7*	SW SW SW Sec 12 (6-7)			2525	357	170(e)	87	29	49,000
71-8	SW SW NE Sec 2 (6-7)	600	1000	4040			46	88	149,000
71-9	SW SW SW Sec 30 (5-6)			2174	390	172	218	10	17,000
71-10	SE SE NE Sec 4 (5-4)	500	900	2750					
71-11	SE SE SE Sec 33 (4-4)	380	880	2200					
71-12*	SE SE SE Sec 28 (4-4)	390	870	1900	250	187	63	30	51,000
71-13	SE SE NE Sec 33 (4-4)	390	816	2900	190	103	87	33	57,000
71-14	NW SE SE Sec 4 (5-4)	400	840	1850	232	178	54	34	58,000
71-16*	NW NW NW Sec 12 (6-7)	685	1325	3270	271	185(e)	86	38	65,000
71-17*	SW SW SW Sec 36 (5-7)	680	1300	2680	208	162	46	58	99,000
71-18	SE SE NW Sec 35 (5-7)	521	1121	3945	236	182	54	73	124,000
71-19*	NW NW SE Sec 1 (6-7)	837	1337	3219					
72-2*	SW SW SW Sec 6 (6-6)	933	1533	2450	311	174	138	18	30,000
72-4*	SW NW NE Sec 11 (6-7)	590	1230	2780	208	185(e)	23	121	205,000
72-5*	SE SE SE Sec 5 (6-5)	480	1100	2095	351	190(e)	161	13	22,000
72-7	NW NW NE Sec 8 (6-5)	500	1100						
72-10*	SW SW NE Sec 29 (5-4)	460	980	1380	198	184	14	99	168,000
72-11	NW NW NE Sec 1 (6-5)			2256	321	210	111	20	35,000
72-13*	SW SW NW Sec 36 (5-7)	590	1190	3295	216	180(e)	36	91	156,000
72-14*	SW SW SE Sec 26 (5-7)	550	1500	2520	210	167	43	59	100,000
72-15*	SW NW NW Sec 13 (6-7)	580	1060	1830	332	183	149	12	21,000
73-1*	NE SW SW Sec 3 (6-5)	460	1300	1240	280	182	79	16	27,000
73-2	SW NE SE Sec 3 (6-5)	200	980	1895	262	183	79	24	41,000

TABLE 3

PILP 006733

Well No.	Location	Perforated Area From	Perforated Area To	Discharge, Q, in gpm	Pumping Level, Feet	Static Water Level, Feet	Drawdown, feet	Specific Capacity, gpm/ft/dd	T, Theis Estimation (1700), gpd/ft
73-4	NE NE SE Sec 16 (5-4)								
74-2*	SE SE SW Sec 9 (5-4)	530	940	3070					
74-6*	NW NW SW Sec 9 (5-4)	492	744	3380					
76-1	SW SW SE Sec 11 (6-6)	250	1548	2035	436	214	222	9	16,000
76-2	SE NW SE Sec 11 (6-6)								
77-1	SW SW SW Sec 2 (6-5)	203	1006	3260	272	194	78	42	71,000
77-2	NW SE NE Sec 7 (3-4)	153	756	3400	169	127	42	81	138,000
77-3	SW SW SE Sec 2 (6-5)	205	1130						
77-4*	SE SE SE Sec 2 (6-5)	212	1123	3360	242	191	50	67	114,000
77-5*	NW NW NE Sec 2 (6-5)	175	1021	3240	245	173	72	45	77,000
77-6*	SE NE NE Sec 3 (6-5)	195	1201	2825	247	191	56	50	86,000
77-7*	SE SE NE Sec 4 (6-5)	203	2084	2800	278	164	113	25	42,000
77-8*	NW SW NE Sec 3 (6-5)	203	1553	2180	493	164	329	7	11,000
77-9*	SW SW SE Sec 4 (6-5)	208	1493	3130	298	191	107	29	50,000
77-10*	SW SW NE Sec 4 (6-5)	176	1852	3120	271	180(e)	91	34	58,000
77-11	NE SW SE Sec 20 (5-5)	387	1798	3225	245	94	151	21	36,000
80-1	NW SW NW Sec 10 (6-6)	994	1394						
80-2	SE SE SE Sec 35 (2-5)	242	643	4035	200	129	71	57	97,000
80-3*	NE NE SW Sec 7 (3-4)	200	800	5265	162	110	52	101	172,000
80-4	NW NW SW Sec 6 (3-4)	243	763	5505	220	144	76	73	124,000
81-1*	SW SE SW Sec 15 (4-4)	274	795	2450	305	69	236	10	17,000
81-2*	SW SW SW Sec 21 (3-4)	257	818	4465	235				
81-3	NW NW SE Sec 7 (3-4)	224	787	5210					
81-4	SW SW NE Sec 29 (5-4)	279	1001						
81-5*	NW SW SE Sec 29 (5-4)	263	944	1705	173	117	56	24	41,000
81-6	SE SE SW Sec 21 (5-4)	275	959	4217	277	191	86	49	83,000
81-7	SW NE NW Sec 34 (4-4)	268	704	3920	229	132	97	40	69,000
81-8	NE NW SW Sec 27 (4-4)	274	626	4065	228	110	118	34	59,000
81-9*	SW NE SW Sec 34 (4-4)	241	563	3685	229	165(e)	64	58	98,000
81-10	NW SW SW Sec 10 (4-4)	258	442	4665	208	137	71	66	112,000
81-11*	NW NW NE Sec 4 (4-4)	249	523	4150	211	91	120	35	59,000
81-12*	NW NE NW Sec 33 (3-4)	308	725	5370	203	177	26	207	351,000
81-13	SE SW NW Sec 33 (3-4)	252	755	4933	199	101	98	50	86,000

* - Indicates Franzoy-Corey Measurements (If no *, Layne-Western, Gilbert Pump, or Arizona Engine & Pump measurement).
(e) - Estimated Water Level by Franzoy-Corey.
(2-5) - Indicates Township and Range, with all Townships South and all Ranges West.
Well Schedules, Drillers' Logs and Pump Test Data Sheets are available under separate cover.

PILP 006734

Transmissivity (T) is a term widely employed in ground water hydraulics. It may be defined as "the rate at which water of prevailing kinematic viscosity is transmitted through a unit width of aquifer under a unit hydraulic gradient" (Todd, 1980, Page 69). Normally, the transmissivity is calculated from constant rate discharge and pumping level data measured during several days of pumping and/or measurements of the recovery of the water level from the pumping level to the static water level following a constant rate discharge test.

When constant rate discharge data are not available for use in calculating the value of transmissivity, the specific capacity of a well can be used as a basis for estimating transmissivity (Theis, Brown and Meyer, 1963, Pages 331-341). These estimates are not as precise as transmissivity values calculated from constant rate discharge data; however, they do give a reasonable approximation of the transmissivity value and relative values when used with large groups of wells.

Multiplying the specific capacity by a constant ranging from 1700 to 2000 gives an acceptable value of transmissivity. The value of the constant used in the estimation of transmissivity in the Gila Bend basin was 1700.

The transmissivity value of the aquifer ranges from 17,000 gallons per day per foot (gpd/ft) to 541,000 gpd/ft along the river bed and Gila Bend Canal from the Gillespie Dam to four miles west of the Town of Gila Bend. The aquifer transmissivities exceed 100,000 gpd/ft in 27 wells, range from 50,000 to 100,000 gpd/ft in 26 wells, and are less than 50,000 gpd/ft in only eight wells in the north basin and the eastern part of the Gila Bend-Theba area.

The transmissivities of the aquifers in the western portion of the Gila Bend-Theba area are relatively low across much of the basin, with the exception of a small area on the extreme western side of the basin. These low values of transmissivity, 42,000 - 70,000 gpd/ft, are the result of the thick middle clay layer and underlying conglomerate described under "Geology" earlier in this report.

PILP 006735

The small area on the extreme western edge of the basin is underlain by volcanic fill between 500 feet and 1500 feet. Wells penetrating this alluvial layer have values of transmissivity ranging from 49,000 gpd/ft to 205,000 gpd/ft.

Values of transmissivity of the aquifer on the Golden Sands property in Sections 4, 5, 8 and 9, T. 7 S., R. 6 W., range from 24,000 gpd/ft to 36,000 gpd/ft in five wells, for an average value of 30,000 gpd/ft. These values of transmissivity reflect the probable transmissivity of the south outlet between the Painted Rock Mountains and the Sauceda Mountains.

Ground Water Withdrawal

Withdrawal from the ground water reservoir has increased from 2000 acre-feet per annum in the middle 1930's, when withdrawal first occurred, to 316,000 acre-feet in 1984 (U.S.G.S., 1986). Approximately 35 percent of this withdrawal is applied to irrigated land on the Paloma Ranch and the remaining 65 percent applied to the other irrigated land in the Gila Bend basin. Table 4 shows the estimated annual ground water withdrawal.

The total estimated withdrawal from the ground water reservoir in the basin is 7.871 million acre-feet (Table 4).

The 1987 water levels are approximately 25 feet lower than predevelopment hydrologic conditions in the Gila Bend basin, as defined by Freethey and Anderson (1986, Sheet 2 of 3).

Recharge to the Ground Water Reservoir

Recharge to the ground water reservoir in the Gila Bend basin occurs from infiltration from flows in the Gila River and its tributary washes, infiltration from canals, infiltration from irrigation water applied to land in the basin, underflow into the basin and recharge from rainfall.

PILP 006736

GILA BEND BASIN
Estimated Annual Ground Water Pumpage
in Thousands of Acre-Feet

Year	Amount	Year	Amount
1935	2	1960	250
1936	2	1961	200
1937	2	1962	170
1938	2	1963	130
1939	2	1964	130
1940	19	1965	115
1941	19	1966	145
1942	19	1967	198
1943	20	1968	153
1944	20	1969	166
1945	20	1970	162
1946	33	1971	212
1947	40	1972	238
1948	61	1973	198
1949	67	1974	249
1950	59	1975	288
1951	104	1976	287
1952	120	1977	300
1953	145	1978	292
1954	139	1979	218
1955	140	1980	275
1956	180	1981	308
1957	180	1982	253
1958	200	1983	141K
1959	250	1984	316
		1985*	316
		1986*	316

Data from U.S.G.S. OFR 86-422W

* Estimated to equal 1984

TABLE 4

The physical separation between the ground water level and the surface water exceeds 100 feet except in the river just above the Painted Rock Dam. Thus, once recharge occurs the water is separated from surface water.

Turner (1956, Pages 9-12) estimated the recharge to the Gila Bend basin prior to 1956 as:

Recharge from stream flow based on U.S.G.S. estimates less evapotranspiration	12,000 ac/ft
Infiltration from tributary streams to the Gila River within the Gila Bend basin	16,000 ac/ft
Infiltration from canals (1921-1970)	11,000 ac/ft
Subsurface inflow under Gillespie Dam less outflow at Painted Rock Dam site and south of Painted Rock Mountains	10,500 ac/ft
Infiltration from irrigated lands	10,500 ac/ft
Total estimated annual recharge, 1935-1970	60,000 ac/ft

The Arizona Department of Water Resources (1981) considered the underflow and incoming ground water to equal 70,000 acre-feet per year.

The water levels were lowered by withdrawal from the ground water reservoir and by 1987 had risen approximately to the 1952 levels. One method to determine the recharge is to balance withdrawal and recharge.

Since the 1952 and 1987 water levels were roughly the same, the volume of recharge occurring during that period had to equal the volume of withdrawal. In the case of the Gila Bend basin, the volume of recharge was not equal every year but highly skewed towards the end of the 35-year period.

PILP 006738

The volume of withdrawal from 1952 to 1987 was estimated at 7.38 million acre-feet (Table 4). Dividing 7.38 million acre-feet by 35 years gives an average annual rate of recharge of 210,857 acre-feet. This recharge could have been through infiltration from flood flow, infiltration from irrigation, or mountain front recharge, as well as other sources.

Kienlen (1969, Page 21) estimated an average annual recharge of 156,000 acre-feet for the period 1953-1966 based on a water budget methodology. Considering that Kienlen's study period consisted of all dry years, the correlation between his estimate of recharge and the author's estimate of recharge is significant.

Inflow - Outflow

Underflow into the basin beneath Gillespie Dam was calculated by Turner (1956, Page 12). Based on surface electrical resistivity (geophysical) data and test wells, Turner conceptualized a geologic cross section under the dam containing two aquifers -- 30 to 60 feet of sand and gravel above a volcanic flow layer, and 240 feet of sand and gravel below the volcanic flow layer. The calculated volume of inflow by Turner was 2,500 acre-feet per annum in the upper aquifer, and 10,000 acre-feet per annum in the lower sand and gravel layer.

Historically, it was believed that subsurface inflow occurred from the Waterman Wash basin through Rainbow Valley. Although this may have been the case when the basins were in equilibrium, declining water levels in the Waterman Wash basin eliminated this inflow. The 1987 water level contour map, Plate 7, does not indicate inflow through Rainbow Valley.

Subsurface underflow out of the Gila Bend basin may occur in two places -- at Painted Rock Dam, and in the area between the Painted Rock Mountains and the Sauceda Mountains.

PILP 006739

The volume of outflow south of the Painted Rock Mountains was calculated by the formula, TiL,

where:

T = transmissivity of the Golden Sands Wells in Sections 4 & 9, T. 7 S., R. 6 W.; = 32,000 gpd/ft

i = the gradient of the water level taken from Plate 7, the 1987 water level contour map; $= \frac{25}{15840} = 0.0016$

L = the length of the cross section between the Painted Rock Mountains and the Sauceda Mountains. = 30,000 feet

Thus:

32,000 x 0.0016 x 30,000 = 1,536,000 gpd, or 1,720 ac/ft/yr.

The volume of underflow out of the basin at the Painted Rock Dam site prior to construction of the dam was considered negligible by both the Army Corps of Engineers and the U.S.G.S. The U.S.G.S. estimated an outflow of five to six acre-feet per year in "dry" years up to 30 acre-feet per year in "wet" years. The seepage underflow may or may not have been cut off due to construction of the dam (Donnan and Aronovici, 1960, Page 31).

Turner (1956, Page 17) states that early U.S.G.S. estimates of outflow at the Painted Rock Dam site averaged less than 4500 acre-feet per year, and he could see no reason to change that estimate as computations indicate that the estimate is still reasonable.

Permanent surface water below Painted Rock Dam clearly indicates underflow beneath the dam is occurring, although the volume cannot be calculated.

It appears that inflow and outflow of the basin are roughly equal.

PILP 006740

Water in Storage

The alluvial basin contains a minimum of 500 square miles in which the alluvium exceeds a thickness of 1200 feet. Assuming that one-half of this has a specific yield of 14 percent (ADWR, 1981, Page 2, Appendix A) and the remaining one-half has a specific yield of 8 percent due to the presence of the fine-grained middle unit, then the probable volume of water in storage in the ground water reservoir from the water level, approximately 200 feet to 1200 feet, is:

500/2 x 640 x 1000 x .14 = 22,400,000 ac/ft

500/2 x 640 x 1000 x .08 = 12,800,000 ac/ft

Total volume in storage = 35,200,000 ac/ft

Freethey and Anderson (1986, Sheet 2 of 3) project the volume of recoverable water above 1200 feet in the Gila Bend basin to be 17 million (rounded) acre-feet.

Safe Yield

The safe yield of the Gila Bend basin is equal to the volume of long-term recharge, which is 210,000 acre-feet per year. Withdrawal of this volume will cause a decline in the water level in dry years and a rise in the water level in wet years during rapid recharge.

Evapotranspiration

Evapotranspiration by natural vegetation is limited to areas in the Gila River channel and the Painted Rock Reservoir area. A thick covering of salt cedar (Tamarix pentandra Pall) is now present on the reservoir bottom in what was known as Citrus Valley. The area covered by the Tamarix is approximately 20,000 acres. The remainder of the river bed is sand with minimal vegetation.

PILP 006741

Consumptive use of Tamarix in the Lower Colorado basin is 4.77 acre-feet per acre (Blaney and Harris, 1952, Page 79). Thus, in periods of no water in storage behind Painted Rock Dam, the volume of evapotranspiration by the Tamarix is 95,400 (20,000 x 4.77) acre-feet per annum. When there is water in storage behind the dam, the free surface evaporation is 75 inches (Anderson, 1976, Page 24). Assuming the water covers the 20,000 acres, then the evaporation would approach 125,000 acre-feet per annum.

Thus, the annual evapotranspiration from the river bed and the reservoir bed could range from 100,000 acre-feet (Tamarix plus wetted sand evaporation losses) to 150,000 acre-feet when water is stored behind the Painted Rock Dam.

Tail water entering the river bed from the south, i.e., the Paloma Ranch, and/or water in storage in the reservoir probably satisfy the demand of the phreatophyte vegetation in the river bed.

Ground Water Quality

The quality of the ground water in the Gila Bend basin varies greatly both areally and with depth. This variation in quality can be directly related to the source of recharge; consequently, a third dimension of variation, time, can be added to the equation.

Sebenik (1981, Sheet 3 of 4) plotted the chemical characteristics of the ground waters in 1979. The total dissolved solids contents in the north basin from Gillespie Dam to the Town of Gila Bend then west to Citrus Valley Road ranged from 1690 milligrams per liter (mg/l) to 8200 mg/l. Much of the ground water in the northern half of the north basin contained more than 4000 mg/l of total dissolved solids. This was the result of recharge and diversions of the poor quality water reaching the Gillespie Dam (Table 1).

The quality of the water in the upper aquifer in the Gila Bend-Theba area in 1979 was very saline as a result of spreading the poor quality surface water flowing down the Gila Canal across the irrigated acreage.

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The poor quality surface water plus fertilizer residue and salts leached from the soil recharged the upper aquifer of the Gila Bend-Theba area, causing total dissolved solids contents of 6500 mg/l to 8500 mg/l.

The waters from the lower conglomerate aquifer which has been protected from surface recharge by the middle fine-grained layer (clay) contains waters having total dissolved solids contents of 1000 mg/l to 1500 mg/l.

Analysis of ground water samples collected in 1985-86 indicates a different picture from that described by Sebenik (1981) for 1979. The total dissolved solids content in ground waters between Gillespie Dam to Citrus Road range from 1050 mg/l to 2200 mg/l. In the Gila Bend-Theba area, the waters from the lower conglomerate aquifer remains nearly the same and the quality of the waters from the upper aquifer has a lower total soluble salts content which approaches 4000 mg/l.

This major change in the quality of the ground water may have been a result of the recharge which occurred in the flood flows and storage in Painted Rock Dam in 1978, 1979, 1980 and 1983. In addition, the quality of the surface water diverted from the Gila River at Gillespie Dam is better than it was prior to 1979 (Table 2).

Table 5 summarizes the water quality data collected in 1985 and 1986. The analysis data sheets are included in Volume 2 of this report.

The majority of the ground water in the Gila Bend basin does not meet the National Interim Drinking Water Standards of 1977. In addition to the high total dissolved solids content, the ground waters in most of the basin are high in fluorides and in some areas, nitrates. The fluorides occur naturally and in some cases exceed 4.0 mg/l, the proposed new standard for fluoride in drinking water. Nitrates in the ground waters are the result of fertilizers dissolved in irrigation waters, which recharge into the aquifer. Consequently, the nitrates are localized in irrigated areas. The fluoride content of waters analyzed in 1985 and 1986 are given as part of Table 5.

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TOTAL DISSOLVED SOLIDS CONTENT
OF SELECTED WELLS IN THE GILA BEND BASIN

No.	Location	Perforations from	Perforations to	Date	TDS	Fl
1	NW NE NW Sec 35 (2-5)*	50	372	1986	2200	1.0
28	SE SE NE Sec 31 (5-4)	80	1100	1986	1410	4.2
34	SE SW SW Sec 34 (5-6)	150	766	1985	3894	
43				1986	1360	3.5
52	SE NW NW Sec 3 (5-4)	88	986	1982	2200	4.2
54	SE SW SE Sec 27 (4-4)	118	936	1986	1338	3.3
56	SW NW SE Sec 4 (6-5)	130	1061	1986	1140	6.2
70-1	SE SE SE Sec 4 (6-6)	1000	1540	1986	1126	5.7
71-6	SW SW SE Sec 11 (6-7)	600	920	1986	1450	5.0
71-10	SE SE NE Sec 4 (5-4)	500	900	1985	1107	
71-18	SE SE NW Sec 35 (5-7)	521	1121	1986	1440	4.6
74-6	NW NW SW Sec 9 (5-4)	492	744	1986	1770	2.7
77-1	SW SW SW Sec 2 (6-5)	203	1006	1986	1110	5.7
77-6	SE NE NE Sec 3 (6-5)	195	1201	1985	1348	
77-7	SE SE NE Sec 4 (6-5)	203	2084	1985	1220	
77-8	NW SW NE Sec 3 (6-5)	203	1553	1985	1147	
77-9	SW SW SE Sec 4 (6-5)	208	1493	1985	1079	
77-10	SW SW NE Sec 4 (6-5)	176	1852	1985	1101	
77-11	NE SW SE Sec 20 (5-5)	387	1798	1986	1050	4.5
80-1	NW SW NW Sec 10 (6-6)	994	1394	1986	1010	5.5
81-9	SW NE SW Sec 34 (4-4)	241	563	1986	1690	3.9
81-12	NW NE NW Sec 33 (4-4)	308	725	1986	1820	2.4
81-13	SE SW NW Sec 33 (3-4)	252	755	1986	2050	0.4

* Township and Range in parentheses, with all Townships South and all Ranges West

TABLE 5

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