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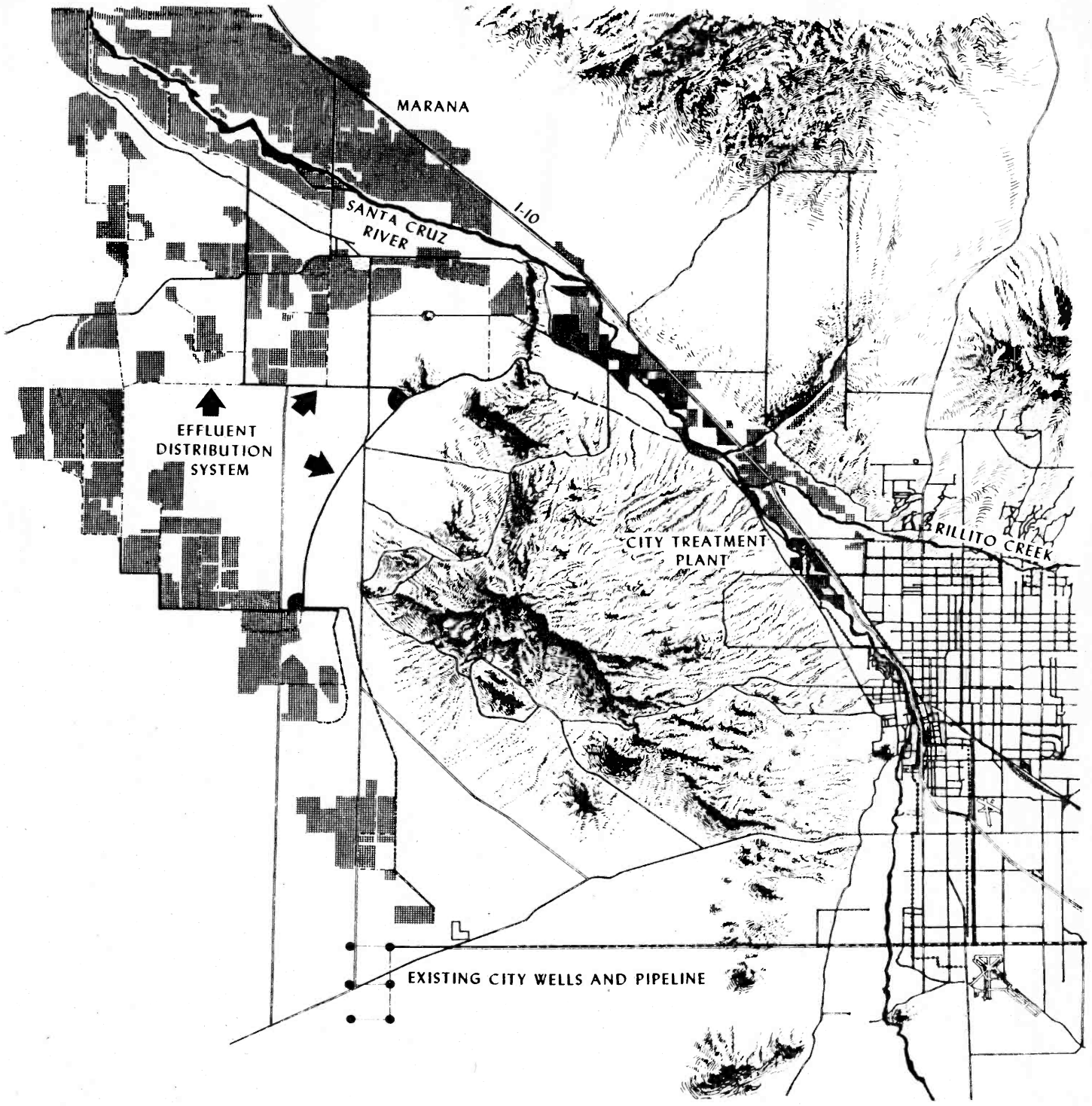

PROPOSED MUNICIPAL EFFLUENT-IRRIGATION WATER EXCHANGE SYSTEM, TUCSON-AVRA-MARANA REGION, ARIZONA.

WATER RESOURCES RESEARCH CENTER AND AGRICULTURAL EXPERIMENT STATION
-UNIVERSITY OF ARIZONA 1971-

PROPOSED MUNICIPAL WASTE WATER - GROUNDWATER EXCHANGE

CITY OF TUCSON: AVRA-MARANA VALLEY

THE OPPORTUNITY

The City of Tucson, Pima County and Agricultural interests in the Avra Valley have an opportunity to work together for their own benefit and that of the entire community.

University of Arizona Water Resources Research Center Hydrologists Brent Cluff and Jim DeCook and Gerald Matlock of the Agricultural Engineering Department have proposed a plan for treated waste water produced by the Tucson metropolitan area to be allocated to farmers in the Avra-Marana area in exchange for groundwater now used for irrigation. The waste water would be used only on land presently under irrigation. This plan has been formulated under an allotment grant from the Office of Water Resources Research of the U.S. Department of the Interior.

University of Arizona College of Agriculture Scientists Day, Tucker, and Vavich have studied the use of Tucson municipal waste water for irrigation of crops and report favorable results.

The Avra Valley groundwater is of high quality for municipal use.

THE PRESENT

Tucson Water Supply

Tucson's entire water supply is from groundwater. Pumping in the Tucson basin has exceeded natural recharge and resulted in a persistent decline of groundwater levels. Maps prepared by the Agricultural Engineering Department show that water levels in much of the Tucson metropolitan area have declined a total of about 50 feet since 1947 with continuing local declines of 5 feet or more

per year in areas of heavy pumping and little natural recharge. In view of this trend, the City of Tucson has initiated a plan for utilization of groundwater from the Avra Valley west of the Tucson Mountains.

Tucson Waste Water Disposal

At the present time approximately 33,000 acre-feet per year of treated waste water are being discharged into the otherwise dry bed of the Santa Cruz River. According to the City of Tucson's projections of metropolitan area waste water flows, by 1975 there will be 40,000 acre-feet, 52,000 acre-feet by 1985, and 70,000 acre-feet by 1995. These quantities of water represent a valuable resource to our desert region. Technically, many alternative uses could be made of this resource, ranging from piping to the mines to treatment and direct recycling through the municipal system; however, none of these uses has been demonstrated as economically attractive, in the sense that they could provide water at a cost less than alternative methods of obtaining water. As a result, no comprehensive plan has been implemented for utilizing the waste water.

In the past, some of the treated waste water has been used for irrigating approximately 2,000 acres in the Cortaro area. The ever-increasing supply has greatly exceeded the declining irrigation demand of this land in recent years. At the present time, the 30-inch supply line to the 2,000 acres is inoperative and all the waste water is being released to the river, flowing at times more than 27 miles downstream into Pinal County. The resulting recharge is causing an increase in nitrates in groundwater along the river in the Cortaro area. This concentration of nitrates is extending into the Marana area as the flow increases.

Avra Valley - Marana Irrigation

Farmers in the Avra Valley-Marana area are pumping groundwater for irrigation and purchasing commercial fertilizers for production of their crops.

THE PLAN

The same nutrients which under present practices are contributing to pollution of our groundwater basins as far as drinking

water is concerned would be beneficial to the farmer who properly used the waste water in irrigation. Under efficient irrigation practices, the crop and soil will effectively remove almost all the nutrients, including nitrate, from the applied water. It seems sensible, from a water management viewpoint, to make an exchange of treated municipal waste water, containing nutrients valuable to the farmer, for groundwater ideally suited for municipal use. In effect, the farmer would cycle his irrigation water through the municipal system before using it on the farm. The proposed exchange should be of benefit to both the farmer and the metropolitan community.

Two alternative plans for delivering waste water to land presently under irrigation in the Avra Valley outside of the Cortaro-Marana Irrigation District have been studied in some detail by Cluff and DeCook (see map):

(1) Serve the upper 13,300 acres in Avra Valley extending from the Ryan Field area northward to the vicinity of Western Avra Gin at Tucker and Anway Roads (northernmost regulating reservoir, on map). This would provide the most economic area from which to pump groundwater to the metropolitan area for municipal use through an existing pipeline. To serve the upper 4,000 acres of this 13,300-acre service area, a relatively low pump lift would be required.

(2) Serve 28,400 acres, including all agricultural lands located south of the Santa Cruz River except those in the Three Points area.

In both systems, a 100-cubic foot per second main delivery system is proposed. This would consist of a 66-inch, 6-mile gravity pipe conduit to carry the treated waste water through the urbanized area northwest of the treatment plant, and approximately 20 miles of concrete-lined canal to reach the southern holding pond. This capacity would be sufficient to meet the waste water production through the year 1995 if diurnal fluctuations were eliminated by means of an existing holding pond. Either system would deliver water to each section of irrigated land. The delivery system would be used to augment the existing private well system the farmers are presently using.

The optimum way to use municipal waste water is in conjunction with other water of lesser nutrient value. In this sense, the enlarged project serving the 28,400 acres would be preferred over the smaller project where a higher percentage of waste water would be used.

The comparative cost data for the proposed projects presented in Tables 1 and 2 are only tentative. However, even with six percent interest charges, it appears that water can be transported

throughout the life of the project at a cost about the same as that presently incurred by the farmers for pumping well water. A formal irrigation district organization would be eligible to apply for a Small Project Reclamation Loan from the U.S. Bureau of Reclamation. Under the terms of the small project loans, the portion of the project costs properly assigned to irrigation service for lands not in excess of 160 acres in a single ownership or 320 acres held by husband and wife is free of interest charges. Thus, the estimated cost of delivering waste water to such lands is based on a "no interest" calculation. Interest charges of about 3¼ percent must be paid on all lands irrigated in excess of the 160 acres in a single ownership or 320 acres in joint holding.

The Small Project Reclamation Loan is only one of several different possibilities for financing. The proposed project is unique in that it demonstrates how a municipal water supply problem and potential pollution problem could be eliminated simultaneously. Because of this, there is a good possibility that a substantial portion of the project could be funded with an Environmental Protection Agency Demonstration grant. In order to qualify for any of these sources of outside funding, active interest in the project must be demonstrated by the principals involved: the City of Tucson, Pima County and the farmers of Avra Valley.

The proposed exchange project is compatible with the Central Arizona Project. The same distribution system built to carry treated municipal waste water could be designed to carry a mixture of CAP water and waste water to the irrigated areas to Avra Valley. The CAP water could either be replaced by waste water as the municipal demand increased, or exchanged for groundwater which, unlike CAP water, requires no additional treatment for municipal use.

THE USE OF WASTE WATER FOR IRRIGATION

Treated municipal waste water is the liquid product of bacterial action on raw sewage. Properly treated, it looks very much like ordinary water and has no objectionable odor.

The use of waste water for irrigation is an established practice. For the past 10 years, the Buckeye Irrigation District west of Phoenix has diverted an increasing amount of waste water until, at the present time, they are using 40,000 acre-feet per year--approximately half of their entire supply.

Drs. Day, Tucker, and Vavich experimented with the use of Tucson waste water for forage and grain production of barley, oats, and wheat. The waste water contained approximately 65 pounds of nitrogen, 22 pounds of phosphorus (50 pounds of P_2O_5), and 26.5 pounds of potassium (32 pounds of K_2O) per acre-foot.

Three acre-feet per acre were applied to each crop. Yields from forage and grain plots receiving waste water were equal to, and in most cases, greater than those supplied with well water and recommended amounts of commercial fertilizer or those supplied with well water plus nutrients equivalent to the nutrient content of the waste water.

Dr. Tucker advocates the use of treated municipal waste water in accordance with the nutrient requirements of the particular crop with the remainder of the water supplied from the conventional source.

No significant deterioration of the soil structure, even with the exclusive use of waste water, has been noted.

Present state regulations do not permit the use of the treated waste water on crops such as lettuce, but these could be irrigated with existing wells.

THE NEXT MOVE

Research and investigation at the University will continue, but the next step is for all the interests concerned - Agricultural, County, and City - to study the plan, identify other alternatives, and develop a cooperative approach to achieving the best possible solution to the water supply and pollution problems of the community. In the words of Bernard Baruch: "The highest and best form of efficiency is the spontaneous cooperation of a free people."

Prepared by Cooperative Extension Service, College of Agriculture, the University of Arizona

TABLE 1

*DELIVERY COSTS OF TREATED MUNICIPAL WASTE WATER

13,300-ACRE PROJECT - DOLLARS PER ACRE-FOOT

Year	Waste Water Delivered (Acre-Feet)	Percent of Irrigation Water That is Waste Water	GROSS COST			Fertilizer Value**	NET COST		
			USBR Loan Interest		6% Bond		USBR Loan Interest		6% Bond
			None	3¼%			None	3¼%	
1975	26,800	66	7.92	11.57	15.47	4.00	3.92	7.57	11.47
1985	32,300	71	6.62	9.61	12.86	4.00	2.62	5.61	8.86
1995	40,400	89	5.27	7.69	10.29	4.00	1.27	3.69	6.29

*Cost include annual pumping cost of $43,700, operation and maintenance of the proposed project @$3.50 per acre or $46,600 per year and amortization of the estimated $4,890,000 capital cost of the project over a 40-year payout period.

**Fertilizer costs are only approximate since they are dependent upon the cropping pattern and the amount and timing of applied waste water.

TABLE 2

*DELIVERY COSTS OF TREATED MUNICIPAL WASTE WATER

28,400-ACRE PROJECT - DOLLARS PER ACRE-FOOT

Year	Waste Water Delivered (Acre-Feet)	Percent of Irrigation Water That is Waste Water	GROSS COST			Fertilizer Value**	NET COST		
			USBR Loan Interest		6% Bond		USBR Loan Interest		6% Bond
			None	3¼%			None	3¼%	
1975	31,100	32	9.06	13.21	17.64	5.00	4.06	8.21	12.64
1985	38,300	40	7.36	10.72	14.33	5.00	2.36	5.72	9.33
1995	49,100	51	5.75	8.36	11.20	5.00	0.75	3.36	6.20

*Costs inlcude annual pumping cost of $21,900, operation and maintenance @$3.50 per acre or $99,400 per year and amortization of the estimated $6,440,000 capital cost of the project over a 40-year payout period.

**Fertilizer value would be higher than in the 13,300-acre project, reflecting more efficient use of the nutrient value of waste water due to reduced application rates.