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TUCSON'S TOOLS FOR DEMAND MANAGEMENT

by

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ABSTRACT

Tucson's "Beat the Peak" program implemented in the summer of 1977 effectuated a reduction in peak day water usage from 151.5 million gallons per day on July 9, 1976, to 114.0 million gallons per day on July 8, 1977. This twenty-five percent reduction, if maintained, will allow a three-year deferral of a new remote wellfield and transmission pipeline estimated to cost between $25 and $50 million. More time will be available to analyze the cost effectiveness of solutions to the region's water resources supply problems (such as imported groundwater, Central Arizona Project water, effluent reuse, and their interrelationships).

Although conservation was not promoted, the successful peak management program resulted in a 13.3 percent reduction in 1977 water use during the summer months (May through August) compared to usage during the same period in 1976. This resulted in water sales revenues less than projected, but the combination of less utility expenses and deferred capital improvements will yield lower customer rates and monthly bills than would have otherwise been necessary without the program.

INTRODUCTION

In the summer of 1974 the City of Tucson experienced one of the hottest, driest periods in its recorded history. From June 10 through July 2 temperatures exceeded 100 degrees Fahrenheit until normal monsoon thunderstorms brought needed relief from heat and drought on July 2. During this period the City's well capacity was unable to meet peak water demands created by irrigation and evaporative cooling uses. Water levels in major reservoirs continued to drop until reservoir valves had to be closed while the system sought its own level. Some areas of the City, particularly areas of high elevation, ran out of water. Fire flow requirements could not have been met had there been a major fire during the period.

To cope with the Utility's hydrological problems of declining water tables and well capacity the Water Resources Unit was expanded. An intensive program of data collection was established from which to make better decisions concerning future well location. A progressive City Council, through education by the Water Department staff, became aware of the importance of water issues such as the Central Arizona Project and basinwide water management. In July, 1974, the consulting firm of John Carollo Engineers of Phoenix was retained by the City to evaluate the capital needs of the Water Utility, develop revenue requirements to fund such improvements, and upgrade the rate structure considering cost of service and encouraging conservation. The consultant completed work in early 1976 with a recommendation for a substantial rate increase and change in the City's historical rate philosophy (John Carollo Engineers, 1976). Recommendations included equalizing the differential inside-outside rate, adopting an inverted (increasing block rate) rate structure varying with customer class, instigating a water connection charge, and applying a high lift pumping surcharge to customers living in high elevations.

With substantial analysis and delay the Mayor and Council adopted a modified version of the proposed rate structure on June 7. Water customers, not prepared for the philosophical change nor the substantial rate increase during the period of high-

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est water use, vocalized their discontent at a level never before experienced. Both the lift charge and connection charge elements of the adopted structure were challenged via class action lawsuits. The lift charge was rescinded and refunded, connection fee revenues were placed in a special fund to be held pending further study, and an advisory committee of prominent citizens was appointed by the City Manager to develop a more politically-acceptable rate methodology. All water-related questions became the dominant political and media issues such that public awareness was greatly increased.

One of the four Council members approving the rate structure resigned. The other three were soundly defeated in a recall election in January, 1977. The firm of Black and Veatch was hired to assist the Water Advisory Committee in their review of the capital improvement needs and associated rate structure (Black and Veatch, 1977). A new rate structure became effective April 1, 1977, employing the same cost-of-service approach while deferring decisions relative to lift and connection charges. The uniform winter block rate and inverted summer block rate were designed to reduce peak water use facilitating deferral of costly capital improvements otherwise required. The concept of "demand management" replaced the misunderstood notion of water conservation.

WHY DEMAND MANAGEMENT?

The City of Tucson Water Utility is in a competitive position for the groundwater sources in the Upper Santa Cruz and Avra-Altar basins with agriculture, mining, other private water companies, and private individuals. There is no regional entity with management authority over all existing groundwater sources due to lack of state enabling legislation. Such is under consideration by the Groundwater Study Commission established under Senate Bill 1391. To place municipal water use in perspective with other water users in eastern Pima County, the following table for 1975 is provided (Thuss, 1978):

TABLE 1

1975 WATER USE IN PIMA COUNTY

Use Category	Pumpage		Consumptive Use	
	Total	Percent	Total	Percent
Irrigation	288,100 A-F	65	246,800 A-F	74
Industrial	76,000	17	47,200	15
Municipal	66,600	15	24,700	7
Recreational	13,200	3	13,200	4
Total	443,900	100	331,900	100

Of the total 443,900 acre-feet pumped in 1975, an estimated sixty-five percent was for agricultural irrigation. Only fifteen percent was pumped for municipal purposes. It is estimated that seventy-five percent of total pumpage in eastern Pima County was consumptive use. Seventy-four percent of the total consumptive use was attributable to irrigation usage while only seven percent of the consumptive use was by municipal users.

From the aforementioned it can be readily deduced that the City's efforts towards effectuating conservation would have minimal impact on the region's total groundwater reserves and declining water tables. If the City were successful enough to achieve a twenty percent reduction in its total water pumpage through primarily a reduction in outdoor irrigation use, an annual savings of 13,320 acre-feet of consumptive use would result. This amounts to a regional savings of only four percent in the total annual consumptive use. If the City's program focused on indoor water conservation devices such as flow restrictors and low-flush toilets, sewage volumes would be reduced but the effect on consumptive use would be minimal. While potentially beneficial to individual water users via lower monthly bills, water conservation as such is in vain under today's conditions and will have little impact on the City's future revenue requirements and water rates. Without a mechanism for management of the entire resource, the City cannot be assured that what it conserves won't only prolong the life of short-term competitive uses.

Historically, water usage in the Tucson metropolitan area has been very seasonal with peak uses occurring in the hot, dry summer months. With the exception of few years with large total pumpage, the ratio of peak day pumpage to average day pumpage is about two as can be seen in Table 2.

TABLE 2

HISTORICAL AVERAGE AND PEAK DAY PUMPAGE

Fiscal Year	Average Day Pumpage	Peak Day Pumpage	Peak/Average
1969-70	51.2 mg	99.1 mg	1.94
1970-71	54.1	110.2	2.04
1971-72	57.8	112.3	1.94
1972-73	60.1	118.8	1.98
1973-74	75.4	130.4	1.73
1974-75	67.6	115.2	1.70
1975-76	70.0	117.6	1.68
1976-77	60.5	131.1	2.17
1977-78	57.2[1]	112.1[2]	1.96

(1) Extrapolated based on first nine months

(2) Summer 1977

The historical ratio of peak day pumpage to average winter pumpage has been three and in some years was greater than five.

Water systems must be designed to handle peak conditions or risk low delivery pressures and possible water outages. Supply and transmission systems are often designed to meet peak day demands while storage and distribution elements meet fire flow and peak hour requirements. Characteristics of water demand are directly translatable into sizing requirements. Inasmuch as peak demands can be reduced, facility sizes can be reduced, and construction of certain facilities can be postponed. This results in lower immediate revenue requirements and lower water rates.

Realizing this relationship, Black and Veatch (1977), in conjunction with Water Utility Staff, developed alternative capital improvement programs using two demand projections. Well capacity requirements to meet peak day demand with an allowance of five percent for reserve were projected to be 200 million gallons per day by 1983 with no reduction in peak period demand. With a twenty-five percent reduction in water used for lawn and garden irrigation, 1983 well capacity requirements could be reduced to 166 million gallons per day. These two alternatives are plotted in Figure 1 with an additional well capacity projection curve assuming twenty-five percent reduction in total peak day water usage and the Utility's estimate of well capacity change with time based on recent experience with existing wellfields. With no reduction in peak day usage, it was projected that the City would need additional well capacity by 1979. Since this additional supply must be imported from the Avra Valley at great cost, the six-year construction program cost through 1983 was estimated by Black and Veatch at $140 million. With curtailment of twenty-five percent peak irrigation use the six-year program cost was estimated to be $100 million. With a $40 million incentive, the Mayor and Council undertook a public information program in the summer of 1977 under the slogan of "Beat the Peak."

SUCCESSFUL DEMAND MANAGEMENT

On June 1, 1977, the "Beat the Peak" program was launched with a Press Conference and television appearances by the Mayor and members of the Council. The initial goal of the program was to reduce the peak day water use from the 151.5 million gallons used on July 9, 1976, to 125 million gallons. Elements of the program were a voluntary alternate day outdoor watering program utilizing customer address and date and a voluntary limitation of outdoor watering between four and eight in the afternoon, the Utility's hours of highest demand. Program monitoring was accomplished through media announcement and newspaper publication of daily reservoir volumes. Full reservoirs indicated that demand was within the capability of wellfields to supply peak needs. Monthly reports were prepared for June, July, and August comparing 1976 summer

PROJECTED WELL CAPABILITY COMPARED WITH PROJECTED PEAK DELIVERY REQUIREMENTS

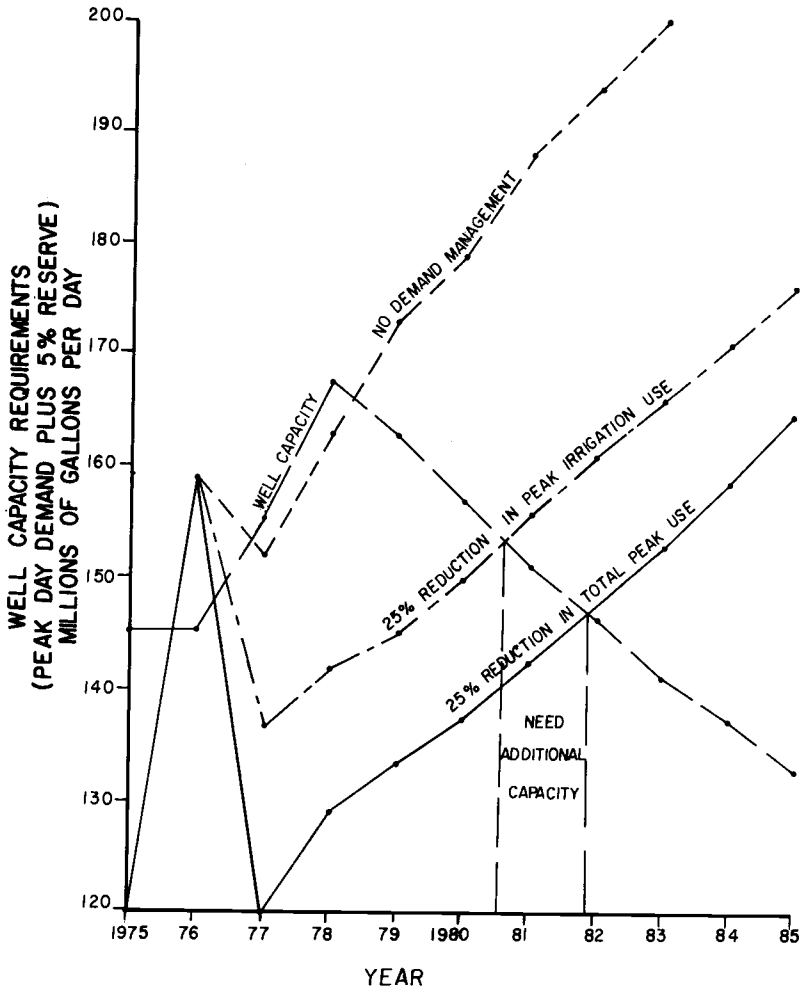

FIGURE 1

pumpage, total usage, and per capita usage with the same parameters for 1977. Local newspapers and radio and television stations contributed free space and time for public water education and "Beat the Peak" status announcements.

The success of the program is illustrated in Figure 2 comparing 1974, 1976, and 1977 metered water usage for the single family customer class alone and all customers combined. In 1974 single family metered water usage amounted to sixty-six percent of the total use. In 1976 and 1977 single family use was sixty percent of the total. Since the majority of water used is by single family customers, their attitudes and water use habits greatly affect the total utility water requirements. Since 1974 the average daily water use during the peak month has declined from 100 million gallons to 78 million gallons, primarily due to a reduction in peak day use by the single family customer class. Whereas usage characteristics during the months of October through March have not changed significantly, there has been a substantial reduction in total usage comparing the summer of 1976 with the summer of 1977. Summer usage by the single family class has declined by twenty-five percent since 1974 and thirteen percent since 1976. The peak day demand of only 114 million gallons occurred on July 8, 1977, indicating a thirty-seven percent reduction in peak outdoor irrigation use and a twenty-five percent reduction in total peak day use. This success was considerably greater than originally anticipated by both consultant and staff.

Although water conservation per se was not promoted, the peak management program resulted in a total summer savings of 13.3 percent and annual savings of 11 percent over 1976 usage. This is more significant when utility growth of three percent per year is considered. Per capita usage has steadily declined from 205 gallons per person per day in 1974 to 150 gallons per person per day in 1977. Present figures are less than the published national average per capita use. Recent information shows even further reductions as indicated in Table 2.

Whereas the Utility can benefit through reductions in peak use by reducing the need for some capital expenditures, water conservation results in revenue reductions. Water sales revenues were ten percent less than anticipated in 1976-77. In Tucson's case, decreased revenues were substantially offset with decreased power costs. The combination of less utility expenses and deferred capital improvements will yield lower customer rates and monthly bills than would have otherwise been necessary without the program.

The peak management program success cannot be fully attributed to the one-time publicity campaign of the summer of 1977. Public awareness and response grew since 1976 with increased governmental and news media awareness and response. Changes in water rate philosophies and structures coupled with higher unit rates have also increased public consciousness. Perhaps fear of even higher future rates is a contributing motivator. All of the above factors give the City hope for managing its limited resources of money and water in the future.

LOOKING AHEAD

Water Utility Staff are confident that customer response can be perpetuated in the near future and peak use will grow proportional to growth in number of water customers between the two lower curves in Figure 1. If the success of 1977 is extrapolated, additional well capacity will be required by 1982. If some use backsliding occurs such that the original peak management goal of twenty-five percent reduction in peak irrigation use is achieved, additional well capacity will be required between 1980 and 1981. The government and Utility want to defer large costs of new source development as long as possible. Major policy and technical questions remain unanswered, including the following:

1. What legislative changes are forthcoming to change the City's role in regional groundwater management?

2. What is the future of the Central Arizona Project and the Tucson Aqueduct?

3. When will the CAP deliver water to Tucson, and at what cost?

4. What will be the effects of the Farmers Investment Company court decision and the Papago Indian lawsuit on the City's authority to pump groundwater?

5. Should the City be expanding its groundwater sources now at large cost with long-term rate implications and pay again if Central Arizona Project water comes in 1987?

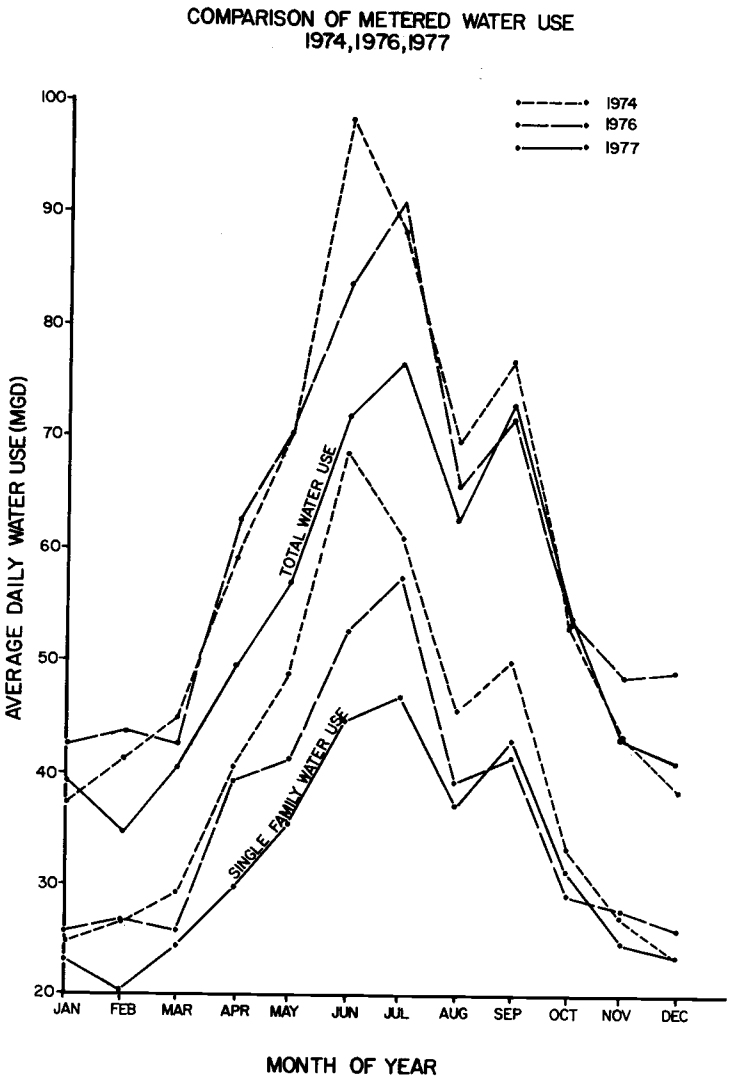
COMPARISON OF METERED WATER USE
1974,1976,1977
1974
1976
1977
TOTAL WATER USE
SINGLE FAMILY WATER USE
AVERAGE DAILY WATER USE (MGD)
100
90
80
70
60
50
40
30
20
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH OF YEAR

FIGURE 2

These and other questions relative to demand management, hydrological parameters, wastewater effluent reuse, and political climate make water utility planning difficult, complicated, and often impossible. It is hoped that both political and public awareness can be maintained long enough to generate solutions to some of these immediate problems. Peak management must continue to play an important role in the provision of municipal water service, particularly in a desert climate with seasonal use characteristics and limited resources.

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