WES ... BWS ...
TCC ... JDW ...
DWS ... DWL ...
RTP ... RCB ...
... SGE ...
JCL ... JLB ...
MSA ... PSO ...
GDC ... PLM ...
File ...
See file for comments. 10-12-74

STATE OF ARIZONA

ENVIRONMENTAL SERVICES NEEDS STUDY

for Pima County

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pt.8

Planning Division • Office of Economic Planning and Development

STATE OF ARIZONA

PIMA COUNTY

ENVIRONMENTAL SERVICES NEEDS STUDY

1972 - 1990

Prepared by

THE OFFICE OF THE GOVERNOR

Through the

PLANNING DIVISION

OFFICE OF ECONOMIC
PLANNING AND DEVELOPMENT

MARCH 1974

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financed in part through a comprehensive
study grant from the
U. S. Department of Agriculture
Farmers Home Administration

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FOREWORD

This study is the result of a financial assistance program administered by the Farmers Home Administration (FHA) to aid planning in small rural areas. The report was organized on a county basis with FHA regulations providing the framework for selections to study areas within the counties. The areas were not required to be incorporated municipalities, however, some semblance of community organization was required and the population could not exceed 5,500 persons.

The report is primarily concerned with the identification and evaluation of existing water systems and sewage and solid waste disposal facilities, and the projection of future needs for these services in rural areas of Pima County. In addition, the completion of the study meets the following related objectives:

> The delineation of probable areas of community growth and their concomitant need for "environmental service systems" (see definition).
>
> An appraisal of existing land use patterns and environmental services problems which may result from various types of future use.
>
> The collection and interpretation of data projecting the future needs for environmental services on a county-wide and individual community basis.

Definitions

For the purposes of this report, the following definitions shall apply.

> "ENVIRONMENT" - The aggregate of physical, social, and cultural conditions that influence the life of an individual or community.
>
> "SERVICES" - (1) Contributions to the welfare of others; (2) Facilities supplying some public demand.
>
> "COMMUNITY" - (1) A unified body of individuals; (2) People with common interests living in a particular area.
>
> "WATER SUPPLY SYSTEM" - Wells, surface water collection reservoirs, storage reservoirs and tanks, water treatment equipment, distribution pipelines, water meters and all other appurtenances which serve to supply the public within a community or built-up area with a source of water suitable for drinking.
>
> "SEWERAGE" - Pipelines and/or appurtenances which serve the public within a community or built-up area with a means of disposing sewage wastes from the properties on which they may reside. This term refers to the means by which sewage wastes are transported to some point removed from the community, or built-up area, for treatment.

"SEWAGE TREATMENT SYSTEMS" - Devices or equipment used for the expressed purpose of removing the organic and pathogenic constituents of sewage, and capable of producing an effluent safe for discharge to a water body, stream or disposal by seepage through soil to subterranean water tables.

"SOLID WASTES DISPOSAL METHODS" - Devices and/or means serving, or utilized by, the citizens of a community, or built-up area, for removal of disposal of garbage, trash, grass and brush clippings from places of residence.

"ENVIRONMENTAL SERVICES" - "Water Supply Systems," "Sewerage," "Sewage Treatment Systems" and "Solid Wastes Disposal Methods" utilized by the citizens of a community, or built-up area to serve public welfare and enhancement, enjoyment or maintenance of the environment in which they reside.

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SECTION 1

CHAPTER I. INTRODUCTION AND SUMMARY

This study is the result of a financial assistance program administered by the Farmers Home Administration to aid environmental services planning in small rural areas. The report is organized on a county basis with FHA regulations providing the framework for selection of study areas within respective counties. The areas were not required to be incorporated municipalities, however, some semblence of community organization was required and the population could not exceed 5,500 persons.

The primary emphasis of the study has been the identification and evaluation of existing water supply systems, sewage disposal and solid waste management facilities, and the projection of future needs for these facilities and/or services in the rural areas of Pima County. The projection of future needs was based on the analysis of economic conditions, present and future general land use patterns, and the existing environmental services situations found in the county. The projections have been presented on a dual basis, focusing at both the community and county level.

In reviewing the projected environmental services needs, it is intended that the report will be of value in support of further more specific planning and engineering studies, which will lead to the development of needed facilities.

The preparation of this study for Pima County primarily covered the outlying areas of the Tucson metropolitan area and sparse development surrounding the community of Ajo. The study does not cover the Papago Indian Reservation as this part of the county is covered in a separate report. Tucson is the major urban center for the county with approximately 76.3 percent of the population residing there.

Total domestic yearly water demands for the rural areas of Pima County (excluding the Papago Indian Reservation) are estimated currently at 13,326 acre feet per year. Delivery of this water to the public is carried out by 250 water utilities (TABLE II-17). Of these utilities, 88 percent are investor owned and operated systems. The locations of these existing water supply systems are noted in Plate 4, Chapter II.

Future water supply demands, for the county as a whole, are estimated to range from 63,313 to 66,075 acre feet per year by 1975; from 75,898 to 81,744 acre feet per year by 1980; and from 111,381 to 119,850 acre feet per year by 1990. These increasing demands will place corresponding pressures upon water suppliers for development of new water resources, as well as result in varied modifications and an expansion of water supply systems.

Water resources in the Tucson area of the Santa Cruz River watershed are reportedly in a critical overdraft condition which will possibly result in problems in the Green Valley, Marana and Rillito areas of the county. It should be noted that the citing of domestic water needs is not related to an effort to define or assess the water needs of agricultural or industrial (mining) interests within the county, whose water needs exceed domestic needs by a sizeable margin.

Corresponding with the increase demands for domestic water will be increased production of sewage waste waters. At present, the rural areas of the county have marginal needs for sewage treatment facilities. Green Valley has collection and wastewater treatment facilities and has the highest apparent rate of growth due to promotional land sales and inducement for retirement living. Currently sewage wastewaters are generated at an estimated level of 35,370 acre feet per year for the county. Approximately 77 percent is provided sewage treatment prior to discharge to streambeds. Practically all of the treated sewage originates in the Tucson metropolitan area.

TABLE II-20 provides an inventory of existing wastewater treatment facilities in Pima County. Sewage production levels are projected to range from 43,474 to 45,371 acre feet per year in 1975; from 51,188 to 55,122 acre feet per year in 1980; and from 71,070 to 76,437 acre feet per year in 1990. It is estimated by 1990 that 81 percent of the sewage wastes originating in the county will be provided with a minimum of secondary treatment.

The production levels of refuse, garbage and other forms of solid waste will increase as a result of population growth to be experienced in Pima County. Presently, solid waste materials are produced at an estimated rate of 318,000 tons per year. The major portion of this quantity is adequately disposed of at the regional sanitary landfills operated by the Pima County Department of Sanitation (PLATE 4). A well organized program of solid waste control exists in Pima County at this time, which will serve as a nucleus for development of new disposal sites and control of solid waste problems that occur in future years.

Solid waste production levels will range from 370,114 to 386,277 tons per year in 1975; from 469,044 to 505,224 tons per year in 1980; and 751,883 to 808,941 tons per year in 1990. The major bulk of these tonnages (76 percent) will be generated in the Tucson metropolitan area and would require about 7,000 acre-feet of sanitary landfill volume through 1990. The rural areas of the county would require another 2,300 acre-feet through 1990.

The Pima County Department of Sanitation provides a well organized program for the control of sewage and solid waste materials. The presence of this entity benefits the entire county in terms of proper planning for needed services. Continued planning activities can result in the orderly development of facilities on a schedule coinciding with occurrence of future demands.

CHAPTER II. COUNTY PROFILE

HISTORICAL INTRODUCTION

Pima County was one of the four original counties created by the First Territorial Legislature of Arizona in November, 1864. The County was named after the Pima Indians and originally consisted of all Arizona land south of the Gila River (i.e., nearly all of the land acquired from Mexico in the Gadsden Purchase). Over the years, however, the area has been reduced as Cochise, Maricopa and Pinal were formed.

Pima County's early recorded history dates back to the journeys of Father Kino in the early 1700's. He established a number of missions from Mexico City to what is now Pima County, Arizona. The northernmost of the Kino Missions, San Xavier del Bac, was built just outside the city limits of Tucson that is today a part of the Papago Indian Reservation. The mission-church still stands and is the oldest structure of its type in daily use.

Tucson was the first and only county seat of Pima County. However, until the establishment of Fort Lowell in 1863, the Community experienced serious problems from outlaws and Apache Indians. With the protection provided by the fort, Tucson began to flourish and soon became the supply depot for trade between southern Arizona and northern Mexico.

ENVIRONMENTAL CHARACTERISTICS

Physiography and Geology

Pima County is within the physiographic province known as the Basin and Range Lowlands. The province extends across southern and western Arizona covering approximately 45 percent of the State. (FIGURE II-1).

Mountain ranges with peaks between 6,000 and 10,000 feet protrude above wide alluvial plains and valleys. Mountain ranges extend north and south across the county and are composed primarily of granite, schist and quartzite deposits capped by volcanic rocks of the Tertiary to Triassic era. In some cases volcanic rock underlies deposits of sandstone, shale, limestone and conglomerate formed by erosion and faulting processes.

The Santa Cruz River flows north through the county and eventually joins the Gila River southwest of Phoenix. The San Pedro River flows across the extreme northwest corner of the county. Several major washes and intermittent streams dissect the county leading to the above water causes.

Natural Vegetation

There is a variety of vegetal cover within the boundaries of Pima County. For the most part, however, the vegetation of the area consists of plants which require small amounts of moisture for survival (FIGURE II-2). Creosote bush, salt brush, mesquite and various

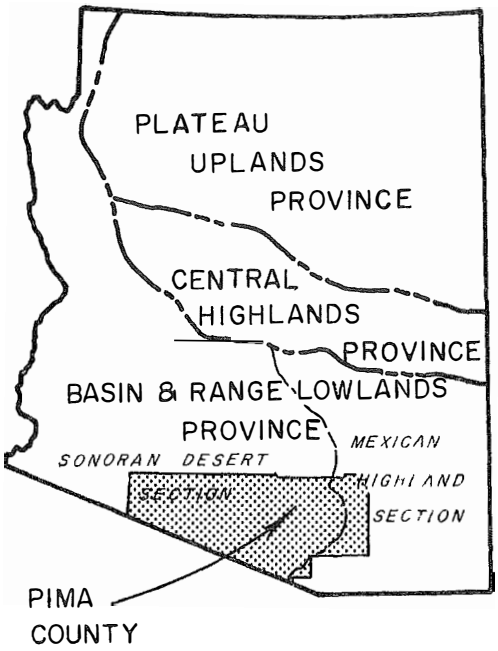


FIGURE II-1 PHYSIOGRAPHIC PROVINCES OF ARIZONA.

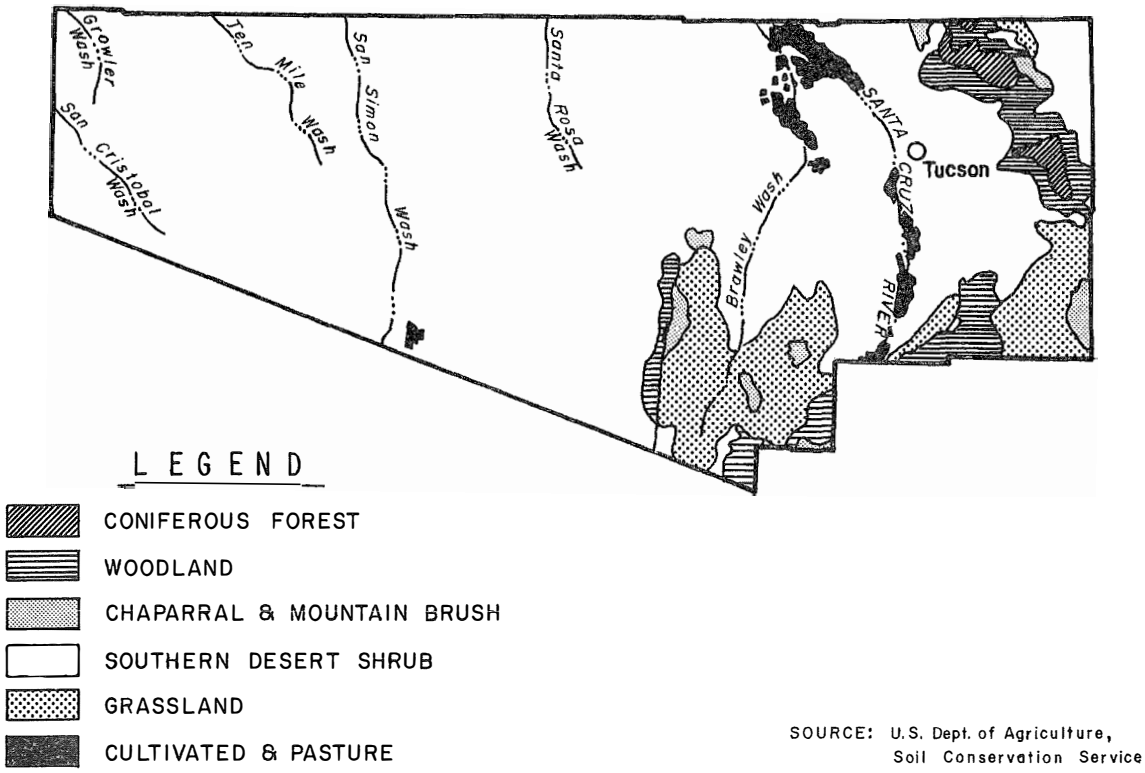


FIGURE II-2 VEGETATION OF PIMA COUNTY.

cacti such as ocotillo, cholla and yucca are common in the region. Grasses cover the lower hills and valley areas between the mountain ranges. Forested lands are found in the northeast, and southwest portions of the county. Vegetation in these areas varies from chaparral (at elevations of 4,000 to 5,000 feet) to firs and yellow pine at elevations above 6,000 feet.

Climate

In general, Pima County experiences mild winter and moderate summer temperatures. As a whole, the county averages approximately 11 inches of rain per year, most of which falls during the summer months.

The following sets of data were obtained from U. S. Weather Bureau records and are used to indicate the range of climate conditions within the county.

(1) Station: Santa Rita Experimental Range (southern Pima County)

Elevation:	4,300 feet
Average June Temperature:	47.5°F
Average July Temperature:	79.5°F
Average annual precipitation:	19.0"
Average annual snowfall:	7.6"

Comments: Over 40 percent of annual precipitation falls during July and August.

(2) Station: Ajo (western Pima County)

Elevation:	1,763 feet
Average January Temperature:	52.4°F
Average July Temperature:	90°F
Average annual precipitation:	9.10"
Snow:	Trace only
Frost-free period:	314 days/year

Comments: 50 percent of annual precipitation falls between July and September.

(3) Station: Tucson (eastern Pima County)

Elevation:	2,430 feet
Average January Temperature:	50.0°F
Average July Temperature:	86.0°F
Average annual precipitation:	10.9"
Snow:	0.9 inches per year

Comments: Temperatures exceeding 100°F are common from June through September.

(4) Station: Silverbell (northern Pima County)

Elevation:	2,740 feet
Average January Temperature:	53.2°F
Average July Temperature:	85.8°F
Average annual precipitation:	12.84"
Snow:	1.2 inches per year

Comments: semi-arid climate

NATURAL RESOURCES

Mineral Resources

Mining activity is widespread in Pima County and has always been of major economic importance to the area.

Mineral deposits of a wide variety are found throughout this portion of Arizona. Precious metals such as gold, lead, zinc, and silver are found in significant amounts, and copper production in the county is the most extensive in the State. Other metallic minerals include molybdenum, tungsten and manganese. Fluorspar, limestone, silica and marble are among the non-metallic minerals found within the county.

FIGURE II-3 shows general locations for known mineral occurrences within Pima County.

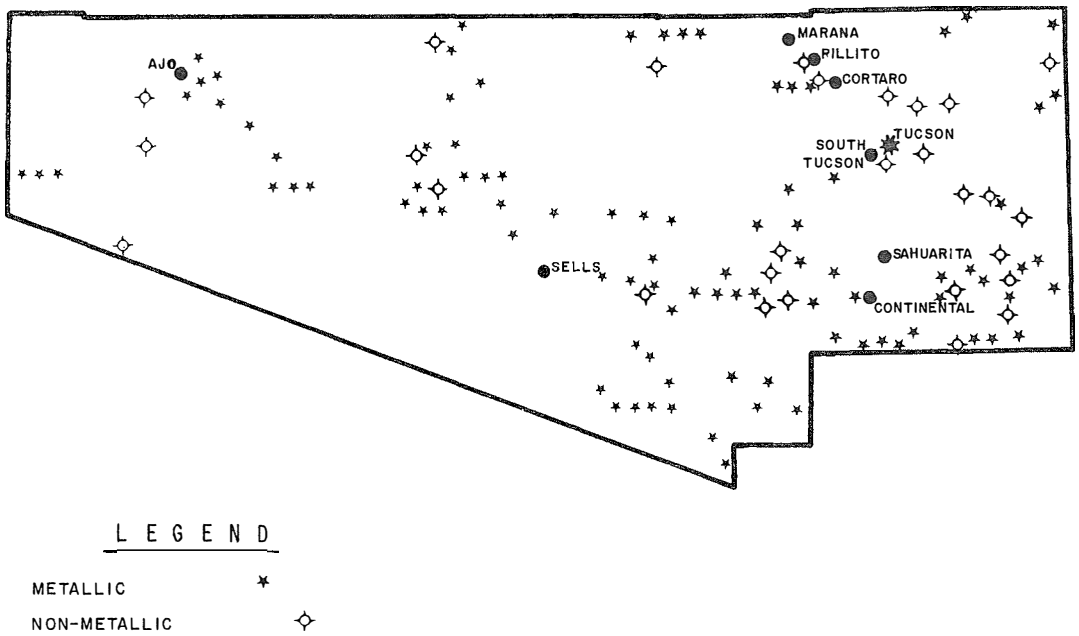


FIGURE II-3 PIMA COUNTY METALLIC AND NON-METALLIC MINERAL RESOURCES LOCATION.

Water Resources

Surface water. Arizona is divided into three general physiographic regions: the Central Highlands, the Plateau Uplands and the Basin and Range Lowlands (FIGURE II-1). In addition, and for the purpose of water resource studies, the State has been divided into several hydrologic study areas based on its interstate river basin and drainage systems. Pima County, located in the Basin and Range Lowlands, contains portions of four major drainage systems: (1) The Lower Gila River Area; (2) the Mexican Drainage Area; (3) San Pedro River Area, and (4) The Santa Cruz River Area (FIGURE II-4).

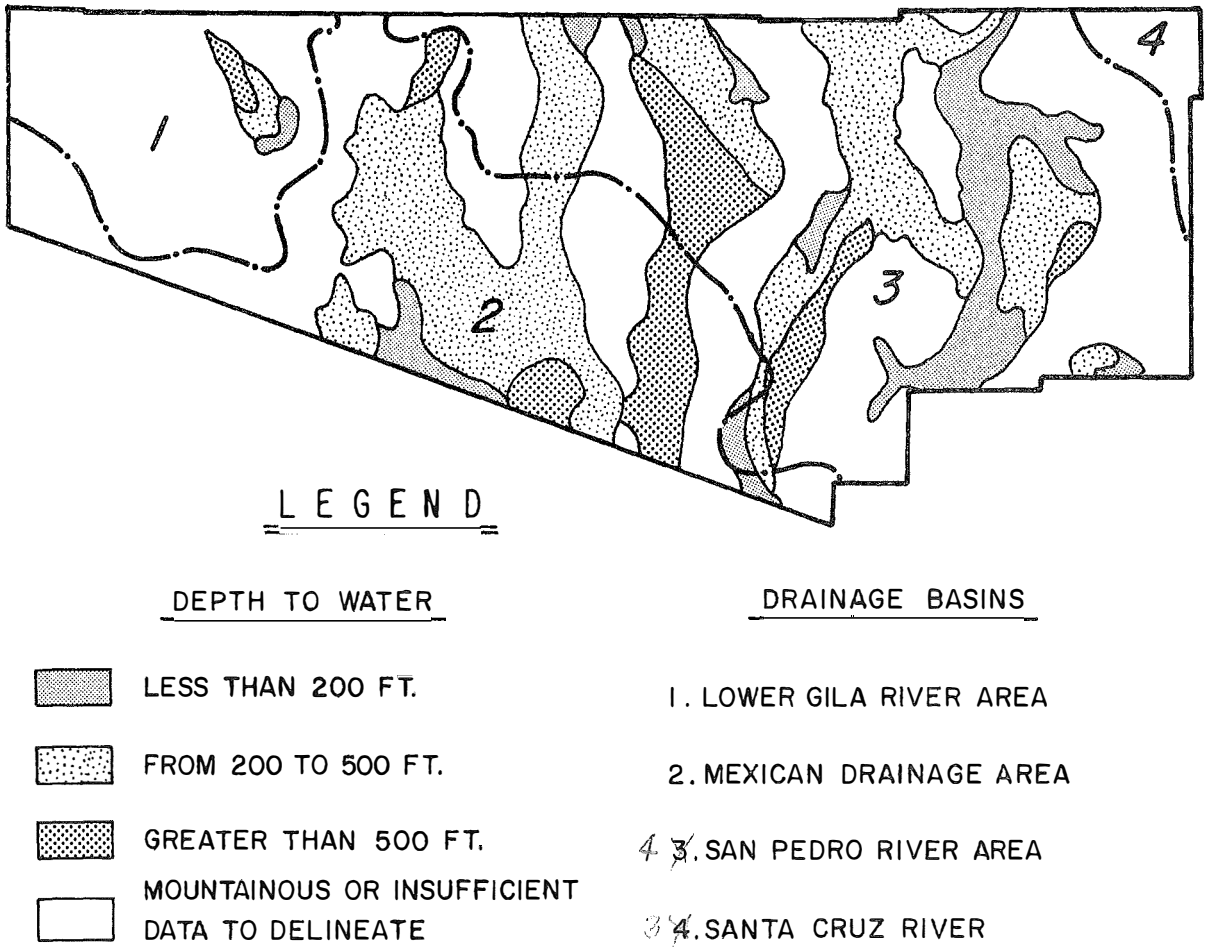


FIGURE II-4 PIMA COUNTY DRAINAGE BASINS AND ALLUVIAL DEPOSITS.

Water which is found on the surface of the earth exists either as runoff or as storage. Runoff can be defined as "that part of precipitation which appears in surface streams". 1/ Storage is defined as that water which has been artificially impounded in surface or undergound reservoirs or water which is naturally detained in a drainage basin.

Surface water made available to the county from precipitation is for the most part, small and difficult to measure. High temperatures and low humidity produce ideal conditions for high evaporation rates and enable only a small portion of the precipitation that falls to become runoff. Average annual runoff for Pima County varies with topography and climatic conditions. Generally however, runoff for the county is less than 1 inch per year,

compared to a national average of 9.4 inches. Average annual runoff for the mountain regions in the northeast, however, is generally about 10 inches. This runoff sustains stream flow in a few of the basins near the mountains for short periods of time each year. The Santa Cruz River Area, one of the four drainage areas mentioned above, covers approximately 50 percent of the county.

Streamflow throughout the area is extremely variable. The Santa Cruz River in the vicinity of Tucson (Tucson Basin) is generally dry at least 320 days per year. For a 20 year recurrence interval, the number of days of no flow in any one year for the Santa Cruz River would exceed 345 days. No flow periods exceed 350 days per year for Rillito Creek, 330 days per year for Rincon Creek and about 120 days per year for Sabino Creek. 2 /

Flood flow in the streams of Pima County is generally the result of summer thunderstorms. More than 93 percent of the flood peaks along the Santa Cruz River occurred in July, August and September of the 20 year period of record. 3 /

TABLE II-1 provides general streamflow and surface water data for the area.

TABLE II-1

PIMA COUNTY SURFACE WATER RECORDS
STREAMFLOW DATA

Gaging Station and Number	Drainage Area (sq. mi.)	Elevation of Gage (ft.)	Streamflow Average (Ac-ft.)	Streamflow Average (cfs)	Streamflow Maximum (cfs)	Streamflow Minimum (cfs)	Unit Runoff Ac. ft. per sq. mile
4820-Santa Cruz River @ Continental, AZ	1267(AZ)	2832	14,200	19.6	18,000	-0-	8
4824-Airport Wash at Tucson, AZ	22	2520	294	0.406	823	-0-	N/A
4825-Santa Cruz River @ Tucson, AZ	1827	2317	16,010	22.1	16,600	-0-	7.3
4830-Tucson Arroyo At Vine Ave, Tucson, AZ	8.2 (since '56)	2411	630	0.87	5,000	-0-	21
4831-Tanque Verde Creek near Tucson, AZ	43	2720	6,430	8.87	3,080	-0-	80
4840-Sabino Creek near Tucson, AZ	35.5	2720	8,910	12.3	7,730	-0-	249
4842-Bear Creek near Tucson, AZ	16.3	2,670	3,650	5.04	1,150	-0-	261
4846-Pantano Wash near Vail, AZ	457	3,205	5,320	7.34	9,960	N/A	13
4850-Rincon Creek near Tucson, AZ	44.8	3,120	3,580	4.94	8,250	-0-	88
4858.5-Rillito Creek near Tucson, AZ	892	2,307	11,880	16.4	24,000	-0-	13
4863-Canada del Oro near Tucson, AZ	250	2,380	1,830	2.53	13,900	-0-	N/A
4865-Santa Cruz River@ Cortaro, AZ	3,180	2,133	17,400	24	N/A	-0-	6
4866-Arivaca Wash near Arivaca, AZ	78.4	3,480	N/A	N/A	260	-0-	N/A
4868-Alter Wash near 3 Points, AZ	463	2,972	N/A	N/A	22,000	-0-	N/A

N/A= not available

Source: Water Resources Data-Surface Water Records, USGS, 1970; and, Mineral and Water Resources of Arizona, Bulletin 180, Arizona Bureau of Mines, 1967.

Groundwater. Groundwater is a transitory phase of the hydrologic cycle wherein water percolates downward over long periods of time through consolidated and unconsolidated rock and is stored below the land surface. Several stages of erosion filled valleys in Pima County with materials which now form the major aquifers in the region. These aquifers or alluvium units cover approximately 50 percent of the county area and consist of sand, gravel, silt and clay. The major sources of the groundwater in Pima County is found in these alluvial deposits, although small amounts are sometimes found in fractures of consolidated rocks. The principal areas of alluvial deposits and groundwater storage are (1) the Upper Santa Cruz River Area; (2) the Avra Valley and (3) the Alter Valley Area. The approximate locations of these areas are shown in FIGURE II-4.

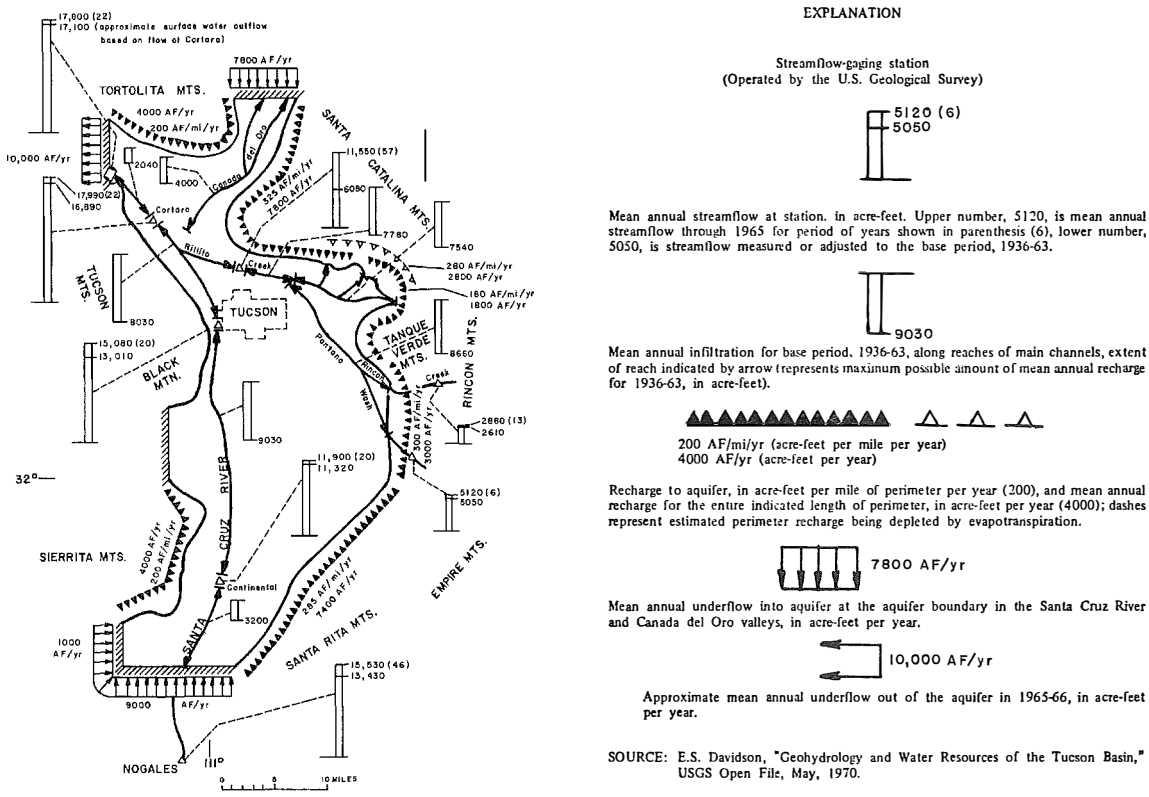


FIGURE II-5 GEO-HYDROLOGY OF THE TUCSON BASIN, UPPER SANTA CRUZ RIVER.

Groundwater reservoirs in the county receive recharge from three sources: (1) runoff from precipitation in the mountains, (2) underflow from outside the basin, and (3) direct penetration of precipitation. A significant amount of the flow from the various surface streams infiltrates through the streambeds to the groundwater reservoirs of Pima County. 4 / An explanation of this infiltration process is shown in FIGURE II-5 (Tucson Basin, Upper Santa Cruz River Area).

In many areas of Pima County, groundwater is the only dependable source of water. These large scale pumping activities remove groundwater from reservoirs at a much faster rate than it can be replaced by nature. The result has been substantial declines in the water table, especially in the most heavily developed eastern portions of the county. Declines of over 75 feet are noted for several areas of the county. Depth to water ranges from less than 50 feet to more than 500 feet below the surface in the southern reaches of the Avra Valley Area. It is estimated that since large-scale pumping began in the area in the 1940's, over 5,000,000 acre-feet of groundwater have been withdrawn from the aquifers. 5/ /Wells in Pima County vary in depth from approximately 40 feet to over 1,500 feet. Potential well production for most wells that tap the aquifer in the area exceed 1,000 gallons per minute.

Water Quality

Although the quality of water to be used for industry or agriculture may vary greatly with respect to chemical composition and physical properties, the same variance is not possible where domestic use is concerned. All water sources developed for domestic uses must comply with the 1962 U. S. Public Health Service Drinking Water Standards. These standards, which set concentration limits for chemical parameters present in the water sources are summarized in TABLE II-2.

Generally speaking, both surface and groundwater resources in Pima County are considered suitable for domestic, industrial and agricultural uses. Groundwater is rated as moderately hard to very hard throughout most of the county but it contains, on the average, less than 500 mg/l (milligrams per liter) of dissolved solids to depths of 1,000 feet or more. Streamflow generally contains less than 400 mg/l of dissolved solids and the principal ions are calcium and bicarbonate. 6 / Most flood flows carry high sediment concentrations resulting from intense storms, sparse vegetation and unconsolidated basin deposits. The costs of removing these sediments can be high, particularly if they are to be used for domestic purposes. Sediment-laden waters also decrease the serviceable depth of the storage reservoirs they enter.

TABLE II-2

WATER QUALITY STANDARDS FOR
DOMESTIC WATER SOURCES

Chemical Parameter	Limiting Concentration milligrams/liter
Arsenic	0.01
Chloride	250.0
Copper	1.0
Cyanide	0.01
Fluoride	0.6-1.7*
Iron	0.3
Manganese	0.05
Nitrate	45.0
Phenols	0.001
Sulfate	250.0
Total Dissolved Solids	500.0

*dependent upon ambient temperature.

Source: USPHS 1962 Drinking Water Standards.

POPULATION AND ECONOMIC PROFILE

In order to make projections of future water requirements and to plan for sewage and solid waste management, it is essential to have growth and locational information on both the population and industry in the county.

Data are presented in this section on pertinent demographic characteristics of the county, such as present and future centers of population density, along with projections of population through 1990. Relevant economic facts are presented for each industry in the county, including past trends in employment, labor earnings and unique factors which may affect economic development. Employment projections on a broad industry basis are made for 1990 to aid in determining future water needs.

The most significant features affecting growth and development in Pima County are the scarcity of water, and the limited amount of privately owned land.

Population Growth and Projections

Pima County, with a 1970 population of 351,667, ranks second in terms of population among the state's counties. It has a land area of 9,241 square miles and a population density of 38.0 persons per square mile compared to the state average of 15.4 persons per square mile. Over 75 percent of the population lives in the City of Tucson. The remainder is spread throughout the county in small towns, on farms and on the Papago Indian Reservation.

As seen in FIGURE II-6, the county's population grew rapidly in the 1950's. It continued this growth throughout the sixties. In addition to absolute growth, there has been a shift in relative densities among the various census tract divisions of the county. Population has been declining in the far western portion of the county and the northeast corner. While all the other divisions have been growing, the Catalina and Arivaca divisions have had the greatest amount of growth, excluding Tucson itself.

FIGURE II-6 also shows the population projections to 1990 for Pima County. The median population projection produces an estimate of 407,100 residents by 1975; 463,500 by 1980; and 600,400 by 1990. This median projection is considered the most probable. Low and high projections are also made and are based upon the long-term relationship between the county and state populations. Most of the projected population increase will be in the metropolitan Tucson area. The Avra Valley should also increase in population over the next twenty years. These two sections are the most probable areas of development for they encompass most of the privately owned land in the county. The only other potential development area would be on the Papago Indian Reservation.

Two basic industries, mining and manufacturing, are expected to expand significantly within the next twenty years. The income from these industries will support the projected 1990 population both directly and indirectly.

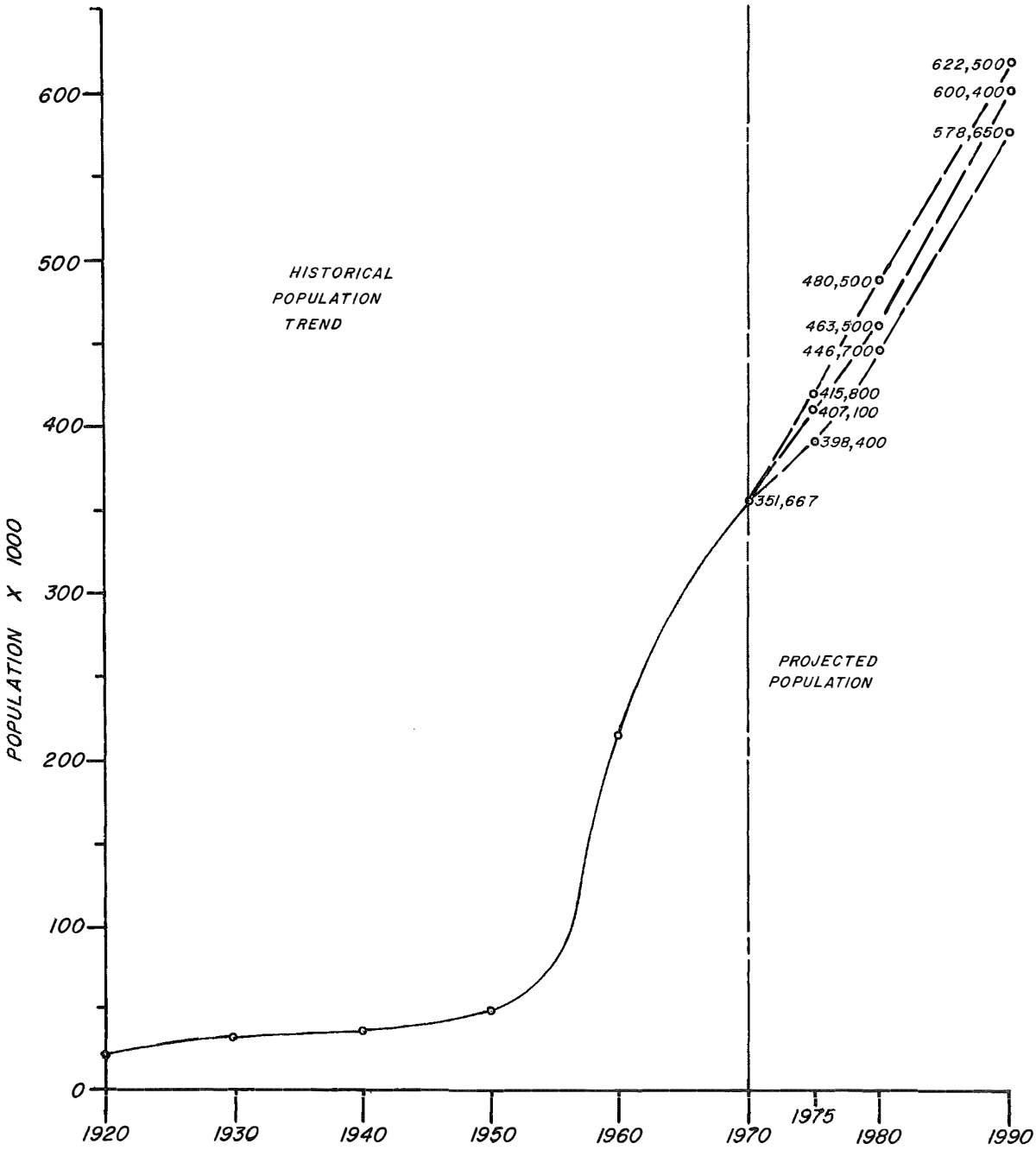


FIGURE II-6 PIMA COUNTY POPULATION PROJECTION THROUGH 1990.

Employment, Industry Analysis, Labor Earnings

Pima County had a civilian work force averaging 126,000 persons during 1970. Annual average employment was estimated to be 121,800. This results in a 3.3 percent unemployment rate, which is lower than the state rate of 4.1 percent.

Pima's labor force and employment by broad industry group for 1967 through 1970 is shown in TABLE II-3. Government is the largest employer, accounting for 21 percent of total civilian employment. It also is the largest source of labor earnings, as seen in TABLE II-4. The size of the sector is due mainly to the presence of the University of Arizona and Davis-Monthan Air Force Base in the county. Employment in retail trade and services is also quite large.

In looking at the industrial structure, the relatively limited amount of manufacturing activity is noticeable. Only 7.6 percent of total employment is in manufacturing. This industry is one of the sectors in which considerable growth is forecast. Other employment projections for 1990 are found in TABLE II-3. The increase in manufacturing, coupled with an increase in mining activity, will be a source of income from outside of the county, which will allow for the increased expansion of the local economy.

Agriculture. In 1970, farm income equaled approximately $25 million. This was fairly evenly divided between crops and livestock. In the future, however, the trend will probably be toward more crop raising with ranch livestock remaining stable. In 1970, 56,680 acres were under cultivation. While this is only slightly less than the 57,716 under cultivation in 1959, the composition of crops has changed. Cotton, alfalfa, and corn have decreased in acreage, while vegetables in general have increased. There are several pecan orchards under cultivation south of Tucson which should yield a good crop in several years. When this occurs, the base for a pecan industry in Tucson will have been created.

The future for agriculture is uncertain. Two basic factors will influence what happens in the next twenty years. First, and most important, is the scarcity of water. Water costs increase yearly in Pima County, driving out more and more marginal producers and marginal crops. The second factor which will influence agriculture in the next twenty years is the purchase of land by various development corporations. Much of this type of investment has been in the purchase of prime agriculture land near Marana and Rillito. When this land is transferred to commercial and residential use, Pima County will lose some of its best farm land. Based on these factors, and also taking into consideration the trend toward mechanization in agriculture, employment is projected to decline from 1800 in 1970 to 1106 in 1990.

Mining. Pima County lead all Arizona counties in 1969 in the value of mineral production ($251,563,000). This represents a significant expansion in mining activity in the county since 1950. From 1950 through 1968, labor earnings averaged a 10.6 percent annual rate of growth.

While copper mining dominates the county, cement, molybdemun, silver and limestone are also mined. Copper production has, however, lead in the recent expansion. Within the past three years, two new large copper mines have opened and existing mines have expanded their operations. In 1970, 910,000 short tons of copper were mined--an increase of 45 percent over 1968.

The national demand for copper is a key determinant in the further expansion of copper mining in the county. In 1970, the average price of copper per pound was $0.5807, the highest it had been in the past ten years. If prices continue at the same level, additional openings and expansions can be anticipated over the next twenty years. Employment is projected to increase by 10,930 to 17,430 by 1990. In 1970, it was 6,500, representing five percent of total employment. While not a large employer, mining is important for it does support employment in other areas of Pima's economy. The growth of copper mining has spurred an expansion of related commercial activity and residential construction. Tucson Gas and Electric attributes much of its $2.4 million revenue increase from 1969 to 1970 to increased copper mining. The copper mines represent four out of the ten largest electric customers. 9/

Construction. Contract construction has been an extremely volatile segment of Pima County's economy. There was a slump in construction activity in the mid '60's, consisting of a sharp cutback in missile base construction in 1962-65, followed by a slump in residential construction in 1966. Building permits for the county fell from a high of 5,885 in 1963 to a low of 1,222 in 1966. 7 / Since then there has been considerable activity, much of which has been centered in Tucson. This can be expected to continue as a center of building activity. Expansion in the next twenty years is also expected in the Avra Valley.

Employment in contract construction has grown from 5,800 in 1967 to 9,500 in 1970. By 1990, it is projected to reach 11,884.

Manufacturing. Compared to the state distribution of employment, manufacturing is proportionally a small segment of Pima County's employment. Thirteen percent of state employment was in manufacturing as opposed to 7.6 percent in Pima. Another significant feature of manufacturing in Pima County has been the predominance of defense oriented industries. In 1970, almost one-third of those employed in manufacturing activity worked for Hughes Aircraft. The fluctuation in labor earnings seen in TABLE II-4 can be explained by variation in defense industries.

The Development Authority for Tucson's Expansion, established in 1967, has attempted to attract a greater diversity of firms into the area. As a result, firms producing consumer products have been moving into Tucson.

The prospects for development in Pima County in terms of manufacturing are fairly optimistic. A considerable effort is being made to attract industry. The climate, tax structure, transportation situation, and the presence of the University of Arizona are all favorable points. Two large national corporations have purchased large pieces of land near Tucson in the past year for new plants. When these plants are built, there will be a significant expansion in employment in manufacturing in the county. Other new firms should also locate in the county as its advantages are more widely recognized. For these reasons, while employment is only 9,300 now; by 1990 it is projected to increase to 25,749.

Wholesale and Retail Trade. This is the second largest sector in Pima County's economy in terms of labor earnings and civilian employment. Labor earnings grew at an annual rate of 7.7 percent for 1950 through 1968 to reach $112,293,000. Employment has also grown in recent years, increasing from 18,800 in 1967 to 23,700 in 1970.

Wholesale trade employment accounts for only a small part of this total. Most of the companies engaged in wholesale activity are small. Tucson's proximity to Phoenix, the center of wholesale trade for the state, leaves it with only a secondary role to play in wholesale trade. Approximately 90 percent of employment is in retail trade establishments, the largest amount of employment being in eating and drinking places. $659,414,000 was made in retail sales in Pima County in 1969. 7 / This is almost double the amount of sales in 1959. Growth in retail trade is expected to continue over the next twenty years as the Tucson area is advertised as an ideal vacation and retirement site. Establishments to serve these retirees and visitors, as well as the local working population, will support higher employment.

Employment in both retail and wholesale trade is projected to reach 46,348 by 1990. This represents an increase of 22,648 over 1970. To achieve this total, employment must grow at an annual average rate of 3.6 percent.

Finance, Insurance and Real Estate. Employment in this sector has averaged less than four percent of total employment in Pima County in the past four years. These services are concentrated in the City of Tucson, where most of the population lives.

Although labor earnings in this sector have increased at a rate of 10.5 percent per year since 1950, they were only 4.8 percent of total labor earnings in the county during 1968. Both earnings and employment should continue to grow in the coming decades as facilities expand to meet the needs of a larger population. As shown in TABLE II-3, employment is projected to increase to approximately 8,715 by 1990, an increase of 3,915 from the 1970 employment of 4,800 in the sector.

Services. Services form an important part of Pima's economic life. They are relatively more important in Pima County than in the state in general. In 1970, about 13 percent of employment in the state was in services and miscellaneous work, while almost 16 percent of employment in Pima County, or 19,100 was in services.

The largest areas of employment are in motels, medical services, auto repairs and varied personal services, such as laundries and beauty shops.

Looking at the next two decades, the relative importance of services is expected to increase. By 1990, employment is projected to reach 37,435. The anticipated growth in tourism will make employment increases possible, as will the needs of the projected population increase.

Transportation, Communications and Public Utilities. This has not been a dominant sector in the economy of Pima County. Labor earnings have been moderate in comparison to other industries, comprising only six percent of total earnings in the county during 1968.

TABLE II-3

PIMA COUNTY EMPLOYMENT ANNUAL AVERAGE 1967-70 WITH A PROJECTION - 1990

	1967	1968	1969	1970	1990
Civilian Work Force	195,500	109,400	117,200	126,000	228,152
Unemployment	4,100	4,300	3,600	4,100	6,844
Percent Unemployment	3.9	3.9	3.1	3.3	3.0
Total Employment	101,400	104,900	113,600	121,800	221,308
(a) Non-Agricultural Wage-Salary	86,000	89,700	97,600	105,300	198,070
Manufacturing	8,800	7,800	8,200	9,300	25,749
Non-Manufacturing	77,200	81,900	89,400	96,000	172,321
Mining & Quarrying	4,300	4,700	5,500	6,500	17,430
Contract Construction	5,800	7,000	9,200	9,500	11,884
Trans., Commun., and Public Utilities	5,300	5,300	5,500	5,800	10,893
Trade	18,800	19,600	21,300	23,700	46,348
Finance, Insurance & Real Estate	3,500	3,700	4,000	4,800	8,715
Services	15,700	16,700	17,900	19,100	37,435
Government	23,800	24,900	26,000	26,700	39,614
(b) All Other Non-Agricultural Employment	13,300	13,500	14,200	14,700	22,130
(c) Agriculture	1,800	1,700	1,800	1,800	1,106

Source: Department of Economic Planning and Development

TABLE II-4

PIMA COUNTY LABOR EARNINGS BY SOURCE ($000)

	1950	1962	1966	1967	1968
Total Earnings	143,029	527,465	582,351	649,561	714,511
Farm Earnings	3,332	7,618	1,731	1,815	3,177
Total Non-Farm	139,697	519,847	580,620	647,746	711,334
Government Earnings	32,210	112,738	166,771	191,299	211,698
Total Federal	21,856	50,830	80,931	95,124	102,630
Federal Civilian	8,130	23,204	31,198	34,359	37,680
Military	13,726	27,626	49,733	60,765	64,950
State and Local	11,354	61,908	85,840	96,175	109,068
Private Non-Farm	106,487	407,109	413,849	456,447	499,636
Manufacturing	7,357	62,329	54,104	65,225	61,846
Mining	7,192	24,868	36,290	37,939	44,214
Contract Construction	15,480	89,085	53,076	56,526	67,924
Trans., Comm., and Public Utilities	16,668	32,967	38,709	41,404	44,014
Trade	29,397	84,288	95,507	103,349	112,293
Fire	5,672	23,345	28,494	30,411	34,459
Services	24,152	89,099	106,705	120,356	133,362
Other	569	1,128	964	1,237	1,524

Source: Department of Economic Planning and Development

From 1967 through 1970, employment in the industry group has remained fairly constant, increasing only in the last year. The sector is projected to maintain its relative position in relation to total employment in the county through 1990. In 1970, employment totaled 5,800 or five percent of total civilian employment. By 1990, this figure is projected to increase to 10,893; five percent of the 1990 projected total employment.

Government. The government sector has played an important role in the economic life of Pima County. Total government labor earnings in 1968 were $211,698,000, making government the largest source of labor earnings. This represented a 10.8 percent annual rate of growth, one of the highest of all sectors.

The actual number employed by the government is also significant. Over the past four years, civilian workers have averaged approximately 22 percent of the total civilian labor force. Approximately 10,000 military and civilian personnel are employed at Davis-Monthan Air Force Base. The University of Arizona is a large employer and will continue to be over the next twenty years. The Tucson Economic Base Analysis projects an increase in staff employment of 4,546 by 1985. Total government employment by 1990 is projected to increase to 39,614, an increase of 12,914 from its present level.

LAND OWNERSHIP AND LAND USE

Patterns of land use are the collective product of many influences, purposes and ideas as expressed by man in his development of the land. The land use and ownership information assembled in this study provides a broad picture of the general development patterns for the county as a whole. Particular interest is expressed for the rural areas where projected land use categories can give insight into needs for water supply, wastewater disposal and solid waste management systems.

Land Ownership

Land ownership is an essential part of any land use study in that it is a major determinant of where various types of land use appear. The more intensive types of land use, i.e., urban uses, occur exclusively on private lands, while public domain lands differ in character of land use.

Pima County has a total land area of approximately 9,241 square miles or 5,914,240 acres (TABLE II-5). The Papago Indian Tribe owns the largest part of this land area with 2,509,760 acres.

The National Forests and Bureau of Land Management make up 22.52 and 19.63 percent of the 1,548,608 acres of Federal lands, respectively. Federal lands are utilized to the highest and best uses as determined by the public needs and the physical resources of the land. The U. S. Department of Defense owns the majority of lands classified as "Other federal lands" with 446,208 acres or 22.81 percent.

The land ownership patterns for the county are presented in PLATE 1. The privately owned land accounts for 12.18 percent of the land area. A substantial portion of the privately held land is controlled by the copper mining interests.

TABLE II-5

EXISTING LAND OWNERSHIP DATA FOR
PIMA COUNTY - 1972

Ownership Classification		Acres	Percent of Total Land Area
Federal Lands		1,548,608	26.18
National Forests	348,800		
Bureau of Land Mgmt.	304,000		
Other Federal Lands	896,608		
State of Arizona		1,033,600	17,48
Papago Indian Reservation		2,509,760	42.43
Private		720,384	12.18
Municipalities and other		101,888	1.73
TOTAL		5,914,240	100.00

Source: Pima County Planning Department.

Present Land Use Characteristics

Existing land use patterns influence and largely determine future land use patterns. There is a relationship between the amount of land used for various purposes and the amount which will be required for future urban development. This relationship also has a direct bearing on the present and future needs for water supply, waste water disposal and solid waste management systems.

Urban land uses are defined as those areas which have been classified for residential, commercial, and industrial purposes in contra-distinction to those lands which are either undevelopable (topograhically unuseable) or rurally classified, i.e., agricultural and grazing lands. Urban land uses account for 15 percent of the developed land in Pima County (TABLE II-6).

TABLE II-6

EXISTING LAND USE - PIMA COUNTY - 1972

Land Use Classification*		Acres	Percent of Total Area
Rural and Indian Reservations		5,111,559	86.44
Urban		93,713	1.59
Residential	19,368		
Commercial	7,949		
Industrial	1,711		
Public and Quasi-Public	64,685		
Agricultural		380,456	6.43
Grazing & Ranching**		243,609	4.13
Mining		55,655	0.94
Mountainous Lands ***		29,248	0.05
TOTAL		5,914,240	100.00

* Land Use classifications used by State Department of Property Valuation

** Estimated from State Department of Property Valuation, BLM, State Land Department and U.S. Forest Service Records

*** Topographically unusable (Engineering Science, Inc., Marum & Marum, Inc.). Technically, these lands could possibly be utilized for mining purposes.

Source: Bureau of Land Management, Coronado National Forest, Department of Property Valuation, State Land Department.

The land areas under urban classification noted in TABLE II-6 are predominantly found in the Tucson metropolitan area (PLATE 2). The primary source of land use data in eastern Pima County were derived from a 1967 study by the Tucson Area Transportation Agency, which included 18.0 percent of the total county area. Almost all prior development has occurred in this portion of the county and it is expected that most future development will take place here also.

Major public reserves in eastern Pima County are tabulated in TABLE II-7. Of the approximately one million acres analyzed in the 1967 study, public reserves accounted for approximately 16 percent. Although these areas are unavailable for future land development, they will provide open space for the Tucson area of the future.

PLATE 2 shows those areas of eastern Pima County which are used for agriculture and mining. Major institutional and industrial areas are also indicated.

TABLE II-7

MAJOR PUBLIC RESERVES IN EASTERN PIMA COUNTY

Reserve Jursidiction	Acres	Year Established
National Forests	21,280	--
Catalina Forest Reserve		1902
National Monuments	18,080	--
Saguaro National Monument		1933
Military Reservations		--
Davis-Monthan AFB	11,045	1940
Sahuarita Bombing Range	18,440	1941
Indian Reservations		
San Xavier Indian Reservation	78,960	1874
County Park		
Tucson Mountain Park	13,320	1929
TOTAL	161,125	

Source: Land Status in Eastern Pima County, Tucson Area Transportation Planning Agency

The Pima mining district, located immediately south of the San Xavier Indian Reservation, has developed as a major copper-producing area within the last twenty years. Due to the expansion of many of the country's leading mining corporations in the area, the extent of lands required for the future will be difficult to predict. This industry is extremely important to the economy of Arizona and, of course, more important to the Tucson economy (TABLE II-8). Other major mining areas include the Silverbell mine and the cement-producing area north of Tucson Mountain Park.

TABLE II-8

LEADING COPPER PRODUCING MINES IN ARIZONA
1970

Rank	Mine	County	Operator
1	Morenci	Greenlee	Phelps Dodge
2	Ray	Pinal	Kennecott Copper
3	San Manuel	Pinal	Magma Copper
4	Twin Buttes	Pima	Anaconda
5	Pima	Pima	Pima Mining
6	New Cornelia	Pima	Phelps Dodge
7	Copper Queen Lavender Pit	Cochise	Phelps Dodge
8	Inspiration	Gila	Inspiration Consolidated Copper
9	Mission	Pima	American Smelting and Refining
10	Sierrita	Pima	Duval Sierrita
11	Mineral Park	Mohave	Duval
12	Copper Cities	Gila	Cities Service
13	Esperanza	Pima	Duval
14	Silverbell	Pima	American Smelting and Refining
15	Magma	Pinal	Magma Copper

Source: Arizona Statistical Review, Valley National Bank, 1971.

Irrigated lands are found in close association with the major rivers and washes. TABLE II-9 presents the distribution of agricultural land in Pima County by crop for the last seven years. Land used for cotton has decreased from 25,610 acres in 1964 to 16,110 acres in 1970. However, the land used for grain production has increased from 17,190 acres in 1964 to 29,600 in 1970. The number of acres used for vegetable production has also increased substantially. For those major crops shown, it is interesting to note that the total acreage in production increased from 46,640 in 1964 to 55,500 in 1970. It is anticipated that a major portion of this land will be inadequate for future urban use due to its location within major flood plains.

TABLE II-9

DISTRIBUTION OF CROP ACREAGE IN PIMA COUNTY

Year	Alfalfa	Cotton	Citrus	Grains	Vegetables	Total
1964	1,000	25,610	50	17,180	500	46,640
1965	1,000	23,385	50	22,700	500	49,715
1966	1,300	16,900	50	22,670	1,200	44,770
1967	1,800	16,140	50	31,700	2,030	52,460
1968	2,000	18,800	50	27,220	1,690	51,550
1969	1,900	17,500	50	28,850	2,100	56,680
1970	2,100	16,110	50	29,600	2,390	55,500

Source: "Arizona Agriculture", University of Arizona.

A summary of the land status analysis made by the Tucson Area Transportation Planning Agency in 1967 is presented in TABLE II-10. Within the area studied, federal and state land amounts to 48.6 percent. As of that date, 6.5 percent of the land was planted and 37.8 percent remained privately owned and unplanted. It is anticipated that these 401,975 will provide a base for future urban development where the land is topographically suitable.

TABLE II-10

STATUS OF LAND IN EASTERN PIMA COUNTY

Land Use	Acres	Percent of Total
National Forest	21,280	2.0
National Monument	18,080	1.7
Military Reservations	29,485	2.8
Indian Reservations	78,960	7.4
Bureau of Land Management	85,840	8.1
State of Arizona	283,255	26.6
County Park Reserve	13,320	1.2
Irrigated Land	62,550	5.9
Planted Land	69,050	6.5
Remaining Private Land	401,975	37.8
TOTAL	1,063,795	100.0

Source: Land Status in Eastern Pima County, Tucson Area Transportation Planning Agency.

Due to an abundance of land available both within and surrounding the City of Tucson, residential land development has progressed at a rapid rate in response to the tremendous population increase. Recent construction trends are presented in TABLE II-11, showing residential building permit data for Pima County since 1961. A period of increased multiple unit construction occurred between 1961 and 1966 but more recently, a boom in single unit construction has been experienced. Annual dwelling construction starts declined in Pima County from almost 6,000 units in 1963 to only 1,200 units in 1966. Annual residential construction has since increased to 5,620 units in 1970.

TABLE II-11

SUMMARY OF RESIDENTIAL BUILDING PERMIT DATA
IN PIMA COUNTY

	Single Family		Multiple Family		
Year	Number	Percent	Number	Percent	Total
1961	2523	68.4	1168	31.6	3691
1962	2596	51.8	2414	48.2	5011
1963	2388	40.6	3497	59.4	5885
1964	1849	59.3	1271	40.7	3120
1965	1193	61.0	763	39.0	1956
1966	781	63.9	441	36.1	1222
1967	1300	82.2	282	17.8	1582
1968	2024	84.4	375	15.6	2399
1969	2896	66.1	1486	33.9	4382
1970	3946	70.2	1674	29.8	5620
TOTAL	21,497	61.7	13,371	38.3	34,868

Sources: City of Tucson, Building Inspector, Pima County, Zoning Inspector.

Much of the housing in the Study Area is single family, located on large elots in the Southwest tradition, providing for informal outdoor living. In 1950, all constructed housing consisted of 84.5 percent single family (TABLE II-12). By 1960, this proportion had increased to 90 percent single family housing in the Study Area to approximately 79 percent in 1970. Of the existing 108,220 residential units (mobile homes excluded) 23,000 are multiple family.

TABLE II-12

CHANGES IN PIMA COUNTY HOUSING INVENTORY

Year	Units	Percent of Total	Units	Percent of Total	Total Units
1950[a]	38,142	84.5	6,990	15.5	45,132
1960	72,349	90.0	8,065	10.0	80,414
1961[b]	74,585	89.3	8,960	10.7	83.545
1962	76,119	88.0	10,358	12.0	86,477
1963	77,698	85.4	13,248	14.6	90,946
1964	79,150	81.9	17,434	18.1	96,584
1965	80,274	80.9	18,955	19.1	99,229
1966	80,999	80.3	19,868	19.7	100,867
1967	81,474	80.0	20,396	20.0	101.870
1968	82,264	79.9	20,734	20.1	102,998
1969	83,495	79.8	21,183	20.2	104,678
1970	85,258	78.8	22,962	21.2	108,220

(a) Census data for 1950, 1960 and 1970

(b) Estimates for 1961-1969 based on building permit data

Sources: City of Tucson, Building Inspector; Pima County, Zoning Inspector

TABLE II-13 gives the proportion of single family, multiple family and mobile home units in Pima County for census years from 1950. The percent of single family units decreased from 80.6 in 1950 to 72.0 in 1970. During the same period, multiple family units increased from 14.8 percent to 19.4 percent, and mobile home units increased from 4.6 to 8.6 percent of all residential units in Pima County.

TABLE II-13

DWELLING UNIT PROPORTIONS IN PIMA COUNTY

Year	Single Family	Multiple Family	Mobile Home
1950	80.6%	14.8%	4.6%
1960	84.9	9.4	5.7
1970	72.0	19.4	8.6

Source: United States Department of Commerce, Bureau of the Census.

The western part of Pima County is federally owned or within the boundaries of the Papago Indian Reservation. The land area has been zoned primarily suburban ranch and general rural which have minimum lot requirements of 144,000 and 36,000 square feet respectively. This zoning produces a housing density of 0.25 and 1.0 units per acre.

Ajo is the only major community in western Pima County. The community is an unincorporated mining town with Phelps Dodge Corporation being the largest private land owner (TABLE II-14). Pima County has adopted a 34,560 acre area plan for Ajo. The basic configuration of the plan is noted in PLATE 2. The present commercial zones are along this highway, and the plan maintains the trend in addition to neighborhood shopping districts which are located at the major street intersections. Future development will be closely related to the interests of the largest land owner in the area.

TABLE II-14

LAND OWNERSHIP WITHIN AJO PLANNING AREA

Owner	Acreage	Percent of Total
Phelps Dodge	5,816	16.9
Federal Government	23,148	66.9
Patented	3,068	8.8
Pima County	2,320	6.8
Other State or Federal	208	.6
TOTAL	34,560	100.0

Source: Ajo Area Plan, Pima County Planning Department, October 1966.

Generalized Future Land Use

Future land uses in Pima County will presumably be characterized by the "General Land Use Plan for Pima County" adopted by the Pima County Planning and Zoning Department. The major part of this plan concerns the eastern sector of the county. The western sector has had an overall plan developed also. The land uses noted in the plan are presented in PLATE 3.

Urban growth in the Tucson metropolitan area will characterize the land use patterns in the peripheral "rural" areas. These areas are included in the development guide prepared by the consortium Engineering Science Inc., Marum and Marum Inc. Rate of growth in the western sector of the county is anticipated to be slow and as a consequence major shifts in land utilization are not expected.

Legislation to permit long-term leasing of Indian Reservation land has been approved by Congress which will no doubt stimulate development activity along State Highway 85 which passes from the eastern to western sectors of the county through the reservation. (See Environmental Services Needs Study - Papago Indian Reservation - Department of Economic Planning and Development). This growth could conceivably be evident within the next ten years.

There is a potential for large scale subdividing activity in Pima County. Empire Ranch properties comprise on the order of 60,000 acres of land most of which is situated in northeastern Pima County. Future development though in this area will be dependent upon adequate sources of water to supply the planned community. A conflict exists at this time as to availability of water in the Santa Cruz water shed to adequately supply the new development and the metropolitan area of Tucson.

The water issue will also effect the rate of growth of agricultural activity south and north of the City of Tucson. Urban growth of the Tucson area will compete for the use of water as a domestic source rather than irrigation supply.

Continuing exploration will possibly lead to expanded mineral extraction activities in both the eastern and western sectors of the County. This would result in increasing acreage under the land use classification of "mining". The Ajo area will experience increasing development in accordance with the Ajo Plan.

SUMMARY - COUNTY NEEDS FOR ENVIRONMENTAL SERVICES

This section provides a compendium of existing and projected environmental services needs for Pima County. Opinions related to existing needs were based upon field surveys and information provided by community and county representatives. Future needs were based upon methodologies discussed in Section III of this report and qualitative judgments as to life expectancies of existing facilities, if any, and modifications or expansion requirements indicated by respective rates of growth. The vast majority of population and development within Pima County is in the vicinity of the Tucson metropolitan area. Needs for environmental services in this area have been formulated and presented in the study titled "A Regional Plan for Water, Sewage and Solid Waste Management".

TABLE II-15

EXISTING AND FUTURE* WATER SUPPLY AND DISTRIBUTION NEEDS IN RURAL AREAS OF PIMA COUNTY

Community On Developed Area	Existing Needs**					Future Needs**														
						1975					1980					1990				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Green Valley						●					●					●	●			
Marana			●	●			●	●							●					
Tucson	●			●		●	●		●		●					●				●
Rillito			●						●				●			●				

*Based on high population projection levels.

**Needs classifications:

1. Replacement and/or modifications (expansion) within distribution system.
2. Water storage or additional storage facilities.
3. Combining of water systems for more economical delivery of services or consideration of municipal ownership and operation of water supply systems.
4. Water supply augmentation.
5. Modification and expansion of equipment utilized in supplying water to distribution work (well motors, booster pumps, etc.).

Source: Staff estimates

(Engineering Service, Inc. - Marum and Marum, Inc.). In addition, 42.4 percent of the county land area is a part of the Papago Indian Reservation. Environmental Services needs for this part of Pima County are covered under a separate report prepared for the reservation.

The following summary would augment projections and existing recommended needs presented in other reports covering Pima County.

Water Supply and Distribution Systems

Existing and future water supply and distribution needs for communities surveyed in Pima County are outlined in TABLE II-15. The needs expressed are categorized in terms of varied system modifications and/or expansions, water supply augmentation or additional engineering evaluation of the existing facilities or needed systems.

TABLE II-15 illustrates the need for water supply augmentation in two areas due to increasing land development activities.

Future water supply demands for the rural area and metropolitan center of Pima County are presented in TABLE II-16. The total demand data includes estimates for Tucson and South Tucson collectively.

TABLE II-16

PIMA COUNTY SUMMARY OF PROJECTED ANNUAL WATER SUPPLY DEMANDS IN 1975, 1980 AND 1990
(Acre-feet)

Developed Area	Projection Year	Domestic Water Demands Projection Levels* Low	Median	High
Green Valley	1975	573	602	631
	1980	668	737	813
	1990	885	1,077	1,310
Marana	1975	47	51	57
	1980	53	64	79
	1990	64	96	128
Tucson	1975	54,423	55,605	56,787
	1980	64,753	67,265	69,739
	1990	93,865	97,388	100,982
Rillito	1975	175	195	214
	1980	195	245	287
	1990	237	348	473
Papago Indian Reservation	1975	393	402	410
	1980	501	520	537
	1990	804	831	858
All Other Areas of Development**	1975	7,703	7,840	7,976
	1980	9,728	10,014	10,289
	1990	15,526	15,835	16,099
County Total	1975	63,313	64,695	66,075
	1980	75,898	70,845	81,744
	1990	111,381	115,575	119,850

* Based on respective population projection levels.
** Includes the areas of Ajo and Lukeville.
Source: Staff estimates.

The demands noted in TABLE II-16 will be felt by the 250 public and semi-public water purveyors presently found in the county (TABLE II-17). Of the 250 systems 113 or 45 percent are in a sixteen mile radius of the City of Tucson. Also, 88 percent or 219 of these 250 systems are investor owned operations. The type of consumers are noted in TABLE II-18. The five municipal facilities are owned and operated by the City of Tucson.

The relative locations of water supply systems are found in PLATE 4. Although detailed data was not developed for this report, there may be water resources shortages in future years in reference to the estimated demands which could conceivably reach 119,850 acre-feet per year by 1990 for domestic uses. (TABLE II-16). Present domestic demands are estimated at 38,000 acre-feet per year. If agricultural and industrial needs are considered, a drastic supply situation could develop. This is seemingly evident at this time by the continued depression of groundwater tables in the Tucson area.

TABLE II-17

PIMA COUNTY PUBLIC AND SEMI-PUBLIC
WATER UTILITIES CLASSIFICATION
October 1972

Class of Owner	Number of Systems
Investor	219
Municipal	5
Co-Op	5
State	7
County	3
Federal	11
Total	250

Source: Arizona State Department of Health, Water Supply Division (Tucson Office)

TABLE II-18

PIMA COUNTY DOMESTIC WATER
SUPPLY CONSUMER CLASSIFICATIONS
1972

Type of Consumer	Number of Systems
Trailer Park	41
Community	83
Motel	33
Subdivision	26
Industrial	14
Camp	5
Recreation	11
Miscellaneous*	37
	250

Source: Arizona State Department of Health, Water Supply Division (Tucson Office)

Sewerage and Wastewater Treatment

Existing and future needs for sewage collection and treatment facilities are presented in TABLE II-19. Needs in the Marana, Lukeville and Rillito areas are minimal as population densities are such that collection networks are basically unfeasible. The Green Valley is a planned community with all high density and commercially zoned areas provided with sewage collection facilities. The rate of growth projected for Green Valley will result in a continuing program of collection network expansion and treatment capability. An inventory of wastewater collection and treatment mechanisms is provided in TABLE II-20. The facilities noted in TABLE II-20 are shown on PLATE 4.

TABLE II-19

EXISTING AND FUTURE* SEWERAGE AND WASTEWATER TREATMENT FACILITIES NEEDS IN RURAL AREAS OF PIMA COUNTY

Community Or Developed Area	Existing Needs**					Future Needs*														
						1975					1980					1990				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Green Valley		●						●				●					●	●		
Marana					●				●	●	●							●		
Tucson				●			●	●				●		●			●	●		
Rillito					●	●						●						●		

*Based on high population projection levels.

**Needs classification:

1. Detailed engineering design study for future development of sewerage and treatment facilities leading to construction of needed systems.
2. Expansion and/or additions to sewage collection network.
3. Expansion and/or modification of treatment facilities.
4. a. Areas with centralized sewage treatment systems: Consideration of wastewater reclamation for agricultural or industrial uses should be reviewed.
5 b. Areas utilizing septic tank disposal systems: Septic tanks and urban densities are compatible for time frames noted.

Source: Staff estimates

TABLE II-20

WASTEWATER COLLECTION AND TREATMENT
FACILITIES INVENTORY FOR
PIMA COUNTY - 1972

units? kumquats?

Location	Facility	Capacity	Area	Connections
La Puenta Del Norte	Package Plant	20,000	--	29
Branding Iron Park	Package Plant	5,000	--	135
Corona De Tucson	Oxidation Pond(2)	--	1.88	79
Tucson National	Package Plant	25,000	--	19
Highland	Package Plant	5,000	--	146
49ers' Country Club	Storage Tank	--	--	53
Avra Valley	Oxidation Ponds(2)	--	7.34	--
Green Valley	a) Oxidation Ponds(2)	--	9.18	--
	b) Package Plant	40,000	--	--
Kinsley Ranch	Oxidation Pond	--	0.66	--
Santo Tomas	Oxidation Pond	--	1.41	--
Desert Museum	Oxidation Ponds(2)	--	1.12	--
Rabies Control Center	Oxidation Ponds(2)	--	0.36	--
Asthmatic School	Oxidation Pond	--	1.25	--
New Tucson	Oxidation Ponds(2)	--	6.30	--
Helton Addition	Oxidation Pond	--	1.43	--
Palo Verde Park	Oxidation Pond	--	0.31	--

Source: Pima County Department of Sanitation

Oxidation ponds provide the basic form of wastewater treatment found in the county. The septic tank concept of sewage treatment used extensively in the remaining rural areas.

Wastewater production levels within the county are presently estimated at 30,476 acre-feet per year. The major portion of this production is generated in the Tucson metropolitan area (94 percent). Projected future levels of sewage production that may be generated by the year 1990 are noted in TABLE II-21.

By 1990 it is estimated that 82 percent of the sewage generated in Pima County will undergo treatment other than by septic tank systems. There is potential for using reclaimed wastewaters in the Tucson metropolitan area for industrial or agricultural purposes.

TABLE II-21

PIMA COUNTY SUMMARY OF PROJECTED
ANNUAL SEWAGE PRODUCTION LEVELS
IN 1975, 1980 AND 1990
(Acre-feet)

Developed Area	Projection Year	Sewage Production Projection Levels* Low	Median	High
Green Valley	1975	475	501	526
	1980	534	590	650
	1990	664	808	983
Marana	1975	39	42	47
	1980	42	50	62
	1990	47	71	95
Tucson	1975	35,715	36,491	37,267
	1980	41,899	43,525	45,126
	1990	56,808	58,945	61,121
Rillito	1975	144	161	176
	1980	154	193	227
	1990	175	257	350
Papago Indian Reservation	1975	315	321	328
	1980	383	398	410
	1990	574	593	613
All Other Areas of Development**	1975	6,786	6,907	7,027
	1980	8,176	8,417	8,647
	1990	12,802	13,057	13,275
County Total	1975	43,474	44,423	45,371
	1980	51,188	53,173	55,122
	1990	71,070	73,731	76,437

* Based on respective population projection levels
** Includes the areas of Ajo and Lukeville
Source: Staff estimates.

Solid Waste Disposal Practices and Techniques

Problems related to the adequate disposal of refuse, garbage and other forms of solid waste materials become more evident within an area as population densities increase. At present solid waste disposal problems in rural areas of Pima County are minimal. This is primarily as a result of an efficient program of management carried out by the Pima County Department of Sanitation. A few isolated dumpsites exist however, the sanitary landfill concept of disposal is used extensively as a form of solid wastes disposal. An inventory of sites and maintenance scheduling for Pima County is found in TABLE II-22 (PLATE 5).

The existing county landfill handles an estimated 318,060 tons per year (1972) of waste materials. Future annual production levels for solid wastes are noted in TABLE II-23.

TABLE II-22

PIMA COUNTY SOLID WASTE DISPOSAL
SITES INVENTORY AND MAINTENANCE SCHEDULING
1971

Site Name	Equipment	Manpower	Maintenance Days Per Week
Ina Road	2 Dozers 1 Water Truck 1 Scraper	2 Men	7
Rita Road	1 Dozer	1 Man	5
Sahuarita	1 Dozer	1 Man	5
Catalina	1 Dozer		3
Marana	1 Dozer		2
Why	1 Dozer		(once a month)

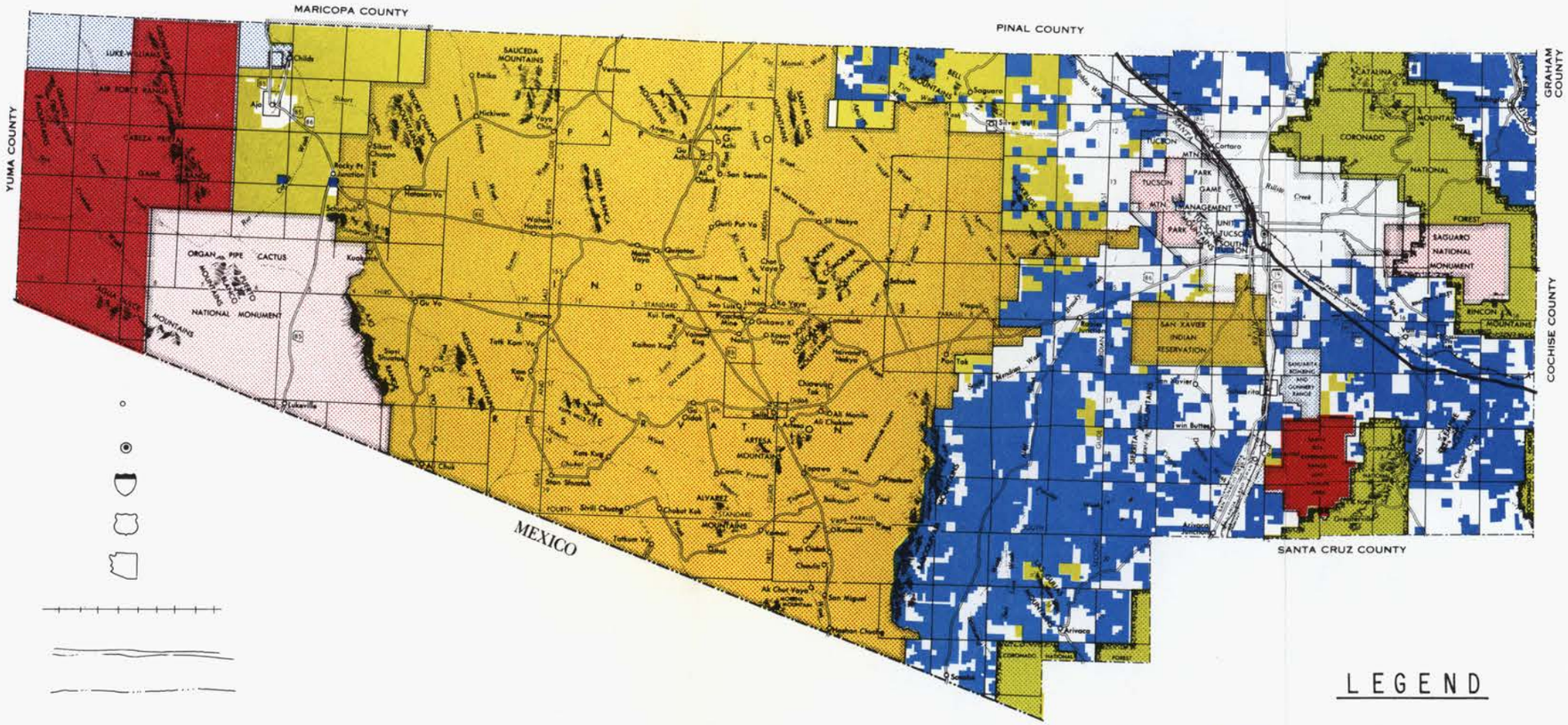
Source: Pima County Department of Sanitation

TABLE II-23

PIMA COUNTY SUMMARY OF PROJECTED
ANNUAL SOLID WASTES PRODUCTION LEVELS
IN 1975, 1980 AND 1990
(Tons per year)

Developed Area of Community	Projection Year	Solid Wastes Production Projection Levels* Low	Median	High
Green Valley	1975	5,272	5,539	5,815
	1980	6,269	6,918	7,628
	1990	8,559	10,425	12,672
Marana	1975	463	502	557
	1980	523	631	778
	1990	647	971	1,294
Tucson**	1975	282,230	288,362	294,493
	1980	357,618	371,494	385,160
	1990	573,295	594,865	616,825
Rillito	1975	1,707	1,904	2,090
	1980	1,931	2,418	2,838
	1990	2,387	3,508	4,774
Papago Indian Reservation	1975	4,352	4,443	4,534
	1980	5,530	5,743	5,927
	1990	8,883	9,183	9,483
All Other Areas of Development	1975	76,090	77,446	78,788
	1980	97,173	100,027	102,770
	1990	158,062	161,207	163,893
County Total	1975	370,114	378,196	386,277
	1980	469,044	487,411	505,224
	1990	751,833	780,159	808,941

* Based on respective population projection levels
** Includes the areas of Ajo and Lukeville
Source: Staff estimates.



SYMBOLS

- City, Town, Settlement
- County Seat
- Interstate Highway
- U.S. Highway
- State Highway
- Railroad
- River
- Wash
- Township Line
- County Line
- State Line

SCALE–MILES

10 5 0 10 20

LEGEND

- BUREAU OF LAND MANAGEMENT
- INDIAN RESERVATIONS
- NATIONAL FOREST
- PARKS & MONUMENTS
- WILDLIFE REFUGE
- MILITARY RESERVATIONS
- STATE TRUST LANDS
- PRIVATE

ENVIRONMENTAL SERVICES NEEDS STUDY

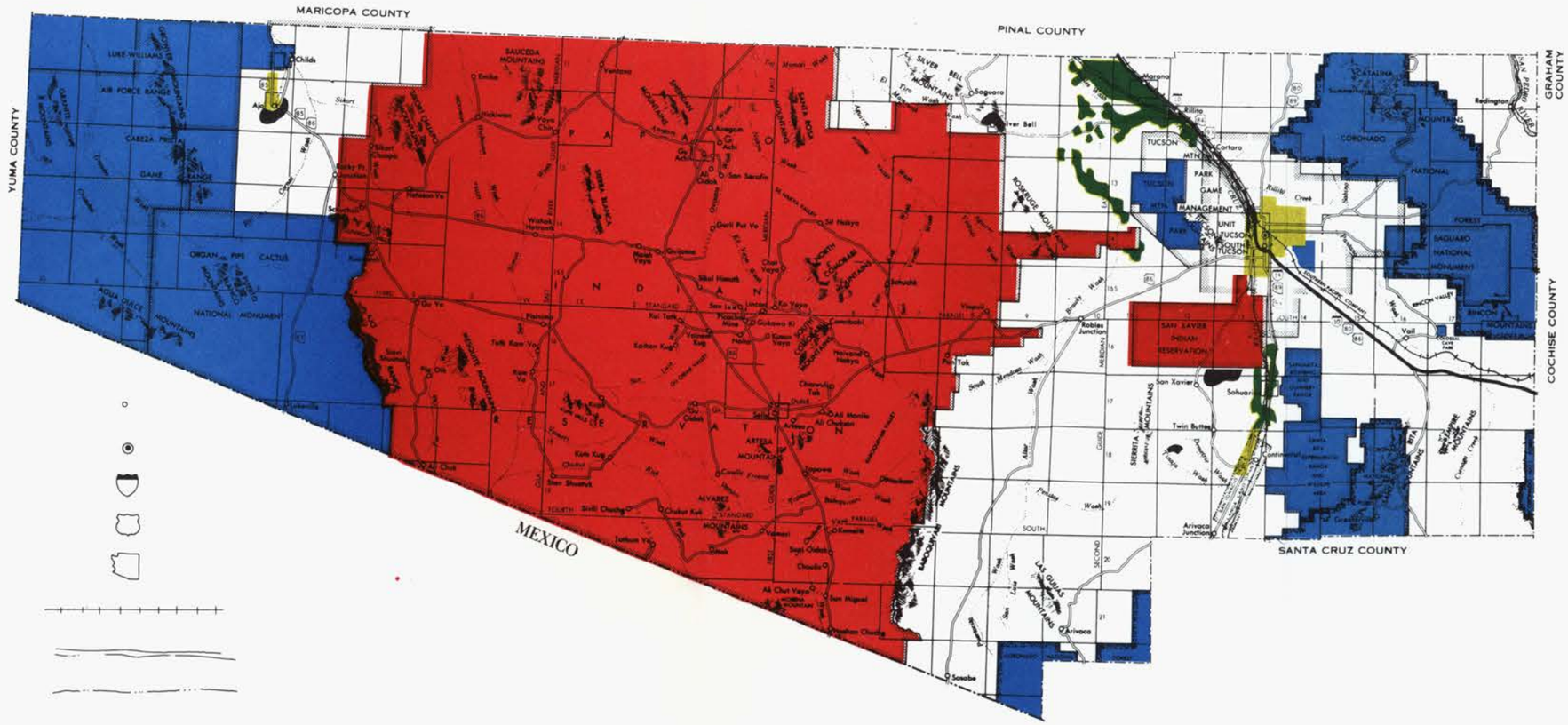
PREPARED BY
DEPARTMENT OF ECONOMIC
PLANNING AND DEVELOPMENT

PIMA COUNTY, ARIZONA
LAND OWNERSHIP

N

PLATE I

Copyrighted Base Map
Courtesy of
ARIZONA HIGHWAY DEPARTMENT



SYMBOLS

- City, Town, Settlement
- County Seat
- Interstate Highway
- U.S. Highway
- State Highway
- Railroad
- River
- Wash
- Township Line
- County Line
- State Line

SCALE–MILES

10 5 0 10 20

LEGEND

- URBAN
- PUBLIC/QUASI-PUBLIC
- INDUSTRIAL
- AGRICULTURAL
- INDIAN RESERVATION

ENVIRONMENTAL SERVICES NEEDS STUDY

PREPARED BY

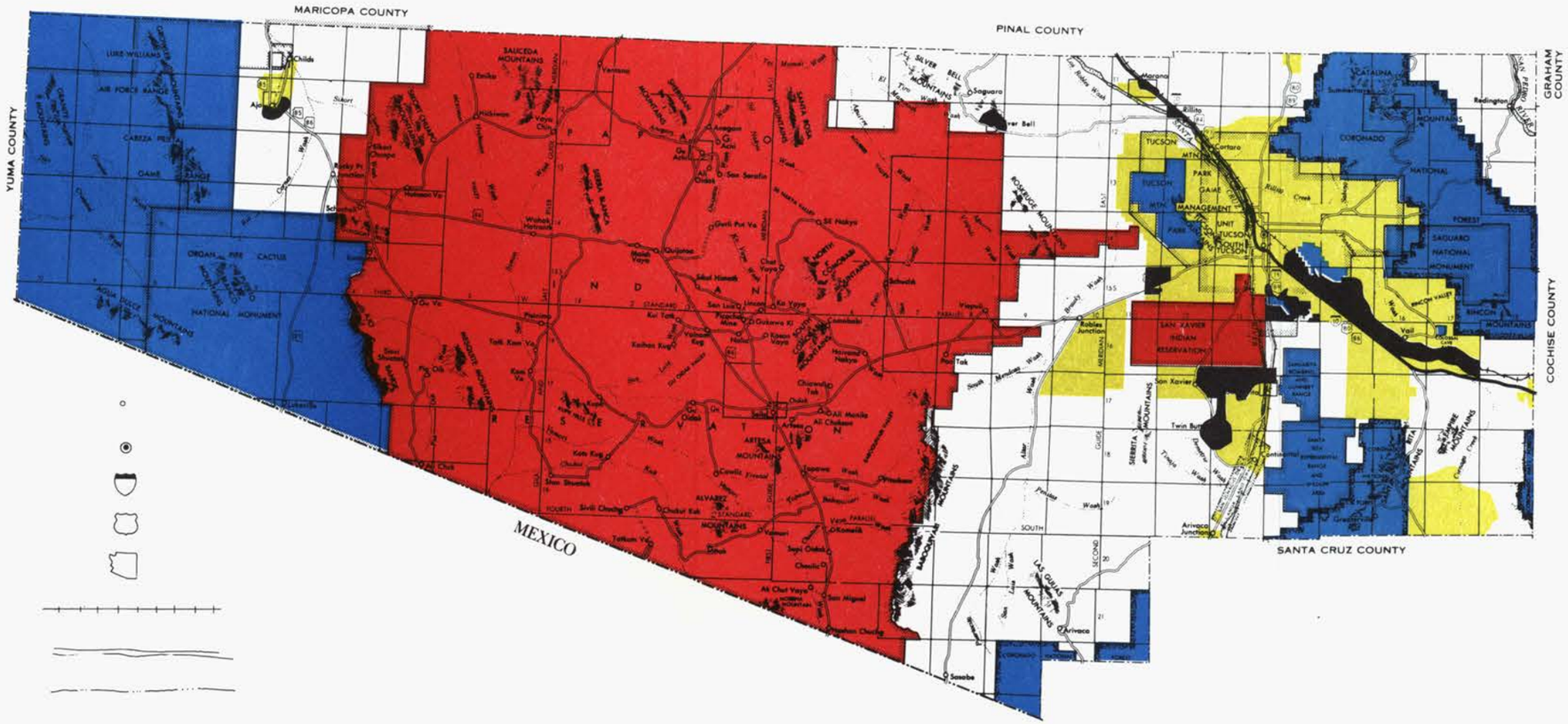
DEPARTMENT OF ECONOMIC PLANNING AND DEVELOPMENT

PIMA COUNTY, ARIZONA

LAND USE

PLATE 2

Copyrighted Base Map
Courtesy of
ARIZONA HIGHWAY DEPARTMENT



SYMBOLS

- City, Town, Settlement
- County Seat
- Interstate Highway
- U.S. Highway
- State Highway
- Railroad
- River
- Wash
- Township Line
- County Line
- State Line

SCALE–MILES

10 5 0 10 20

LEGEND

- URBAN/SUBURBAN
- PUBLIC/QUASI-PUBLIC
- INDUSTRIAL
- INDIAN RESERVATION

ENVIRONMENTAL SERVICES NEEDS STUDY

PREPARED BY
DEPARTMENT OF ECONOMIC
PLANNING AND DEVELOPMENT

PIMA COUNTY, ARIZONA
PROJECTED LAND USE

PLATE 3

Copyrighted Base Map
Courtesy of
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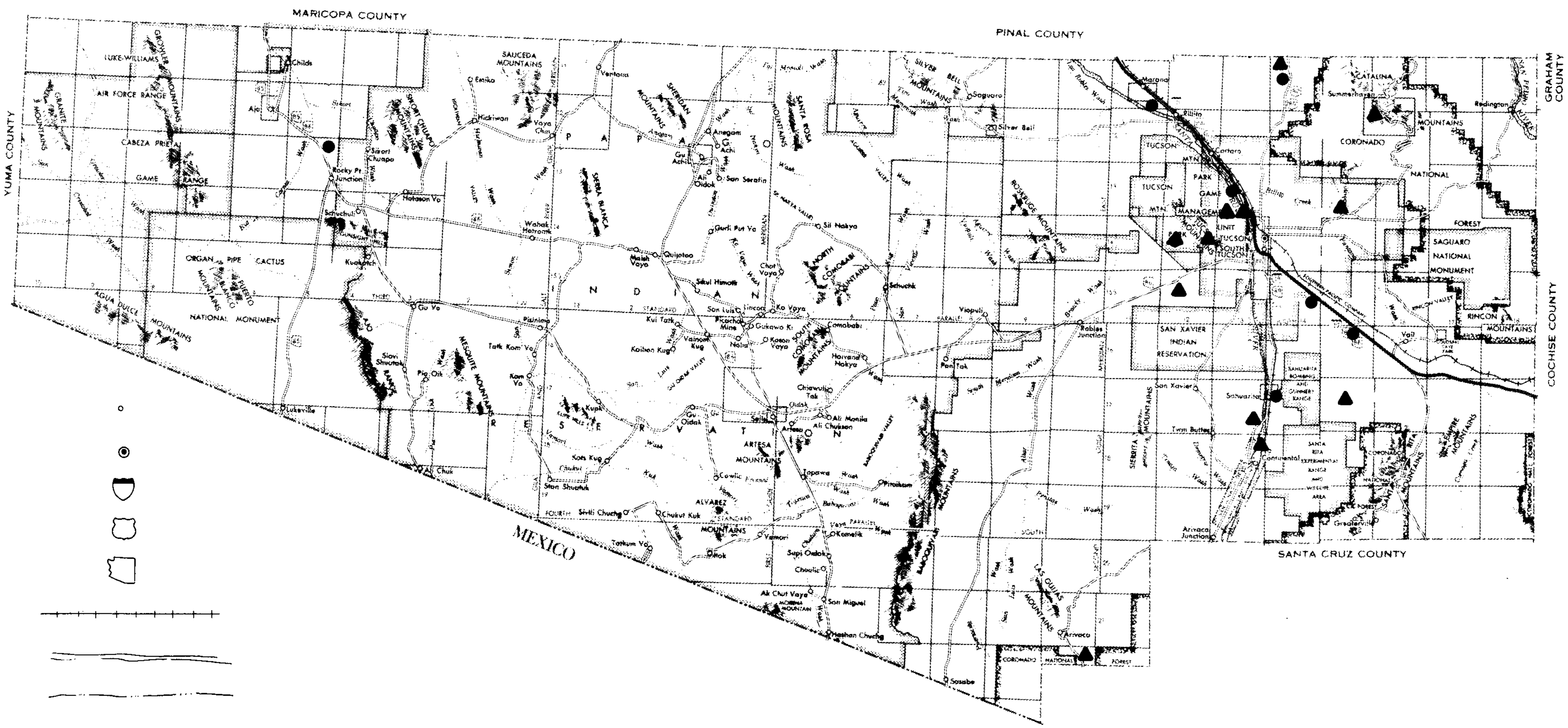


SYMBOLS

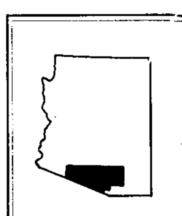
Symbol	
City, Town, Settlement	○
County Seat	◉
Interstate Highway	
U.S. Highway	
State Highway	
Railroad	
River	
Wash	
Township Line	
County Line	
State Line	

Sewage Treatment Facilities ▲

Solid Wastes Dumpsites ●

SCALE–MILES

10 5 0 10 20



ENVIRONMENTAL SERVICES NEEDS STUDY

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PIMA COUNTY, ARIZONA

LOCATION OF FACILITIES

N

PLATE 4

Copyrighted Base Map
Courtesy of
ARIZONA HIGHWAY DEPARTMENT

CHAPTER III. COMMUNITY PROFILES

This chapter presents profiles and analyses, as far as feasible, for several rural areas of Pima County. It should be noted that the major portion of the population found in Pima County is in the Tucson Metropolitan area. A detailed environmental services needs study for this area has been prepared under another program by Engineering Science Inc.--Marum and Marum, Inc., a consortium. As a consequence this section of this report will not attempt to discuss the environmental services needs delineated in outlying areas of the Tucson metropolitan complex. The remaining land area of Pima County, excluding the Papago Indian Reservation, is characteristically rural and includes the unincorporated areas of Ajo, Why, Lukeville, Marana, Rillito and Green Valley.

COMMUNITY OF GREEN VALLEY

Physiography

Green Valley was established in March 1964 as a planned community on 2,900 acres of land which was part of the original San Ignacio de la Canoa land grant. The area is situated in the fertile Santa Cruz River Valley at an elevation of 2,900 feet approximately 25 miles south of Tucson and nine miles north of the Pima County southern boundary.

To the east of the valley lie the White Stone Mountains (a part of the Santa Rita Range), which rise to elevations in excess of 5,000 feet some 18 miles distant. The developed area comprising Green Valley lies on the western bank of the Santa Cruz River. The topography slopes down to the river with a gently rolling character from the Sierrita Mountains which exceed 5,000 feet elevations about six miles west (PLATE 5).

Vegetation of the area is characterized by saguaro cactus and creosote bush in the non-irrigated areas. Many other types of cactus also are indigenous to the area. Moving away from the river course up into the mountains, the vegetation changes to a chaparral and oak woodland horizon.

Soils are deeply alluvial in nature. The soils found in and adjacent to the Santa Cruz water source are not restricted in depth by cemented layers or bedrock and have a very sandy (fine), profile. Moving away from the river the alluvials become more course with evidence of cementatious character. Five to six miles to the west, granitic deposits appear in the higher elevations. 8/

SOCIOECONOMIC PROFILE AND COMMUNITY SERVICES

Economy and Historical Background

Green Valley is primarily a retirement community where much of the income to the town takes the form of transfer payment, social security payments, private retirement benefits, stock dividends, and withdrawals from savings. The Santa Cruz Valley in which the community is located has two important industries. Agriculture, first begun by Jesuit priests in the 18th century, is still extensive in the valley. Cotton, chili, alfalfa, and small grains are the major crops cultivated. Adjacent to Green Valley is a large pecan orchard, one of the largest in the state. Sheep and cattle are grazed in open pastures and in feed lots. The second key industry is copper mining, pursued both in the Santa Rita Mountains to the east and in the rich Sierrita Mountains to the west.

The county surrounding Green Valley abounds with historic attractions--early Spanish missions, frontier outposts, and old mines. Most prominant are San Xavier del Bac and Tumacacori; Spanish missions built by Jesuit priests in the early 1700's, both located about 20 miles away. Tubac, the oldest Spanish settlement in the Southwest, has been a frontier town, an army post, and is now an active artist colony.

Scenic drives and recreational opportunities are also plentiful near Green Valley. Madera Canyon in the Santa Rita Mountains is directly east, and Pena Blanca and Parker Canyon Lakes are in the high desert hills to the south. Ambos Nogales is an international city stretching across the border from the United States into Mexico; interesting to visit itself, it is also the gateway to Mexico's interior.

Population

The 1970 population of the town is estimated to be 5,400. This includes an allowance for a number of winter visitors who live at Green Valley for part of the year. By 1990 the median population projection is for a population of ~~7,257~~ 8073 for Green Valley. FIGURE III-1 also gives a high projection of 9,752 and a low projection of 6,587.

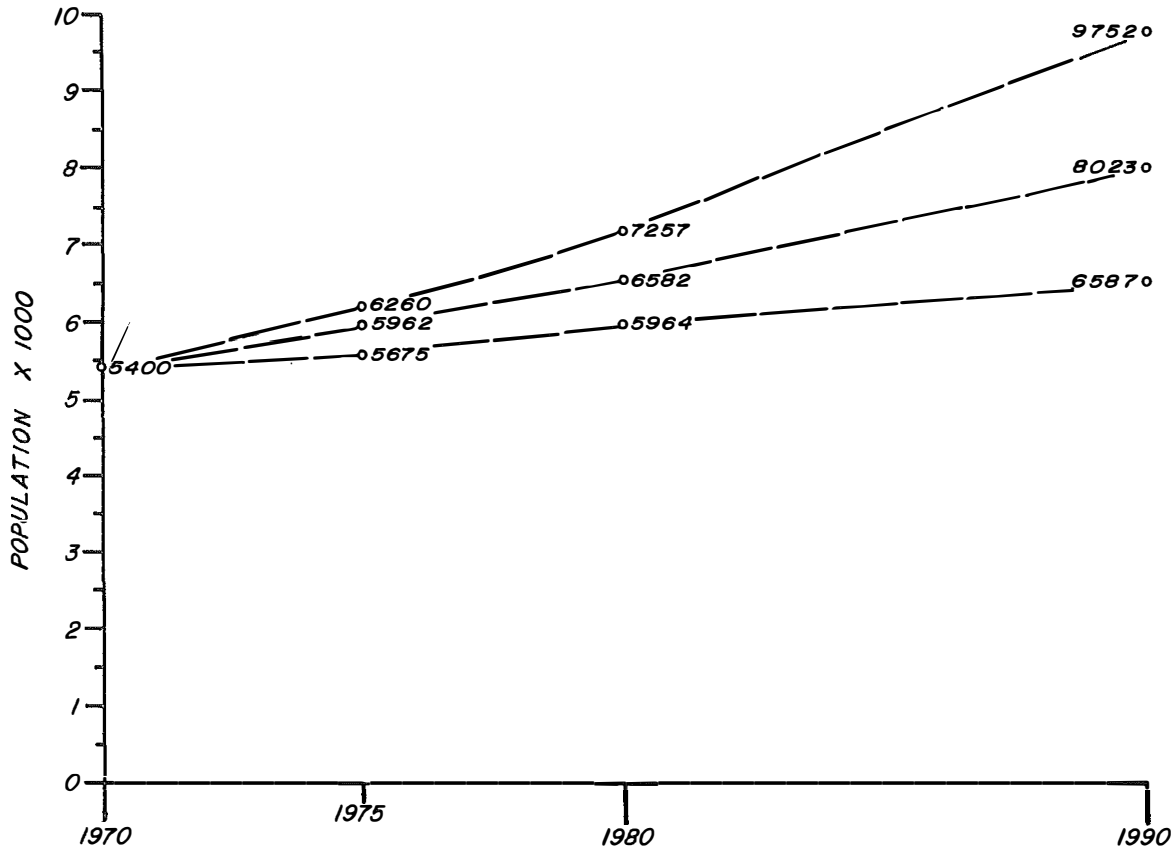


FIGURE III-1. POPULATION PROJECTION FOR GREEN VALLEY TO 1990.

Community Services

Recreational Facilities

Pools:	7 - heated
Recreation Center:	arts & crafts, club meeting rooms
Golf Courses:	1 public - 18 hole 1 private - 9 hole
Athletic Facilities:	shuffleboard, putting green, driving range
Greyhound Dog Racing Track:	located in Tubac

Community Facilities

1 Catholic Church
1 Protestant Church
Several denominations hold services in the Green Valley Recreation Center.

Government Facilities

Sheriff Substation:	7 deputies
Fire Department:	Rural Fire Protection, one station
Underwriters Rating:	Rural area - no grade

Communications

Newspapers:	1 weekly, state-wide dailies
Television:	5 stations from Tucson

Medical Facilities

A medical clinic is operated by Southern Pacific Hospitals and currently provides full-time physicians, a dentist, a physical therapist, dental technician, and also x-ray, EKG and laboratory facilities.

Educational Facilities

	No.	Faculty	Enrolled
Public Elementary	1	9	149
Public High School	1	22	396

Utilities

Electric:	Tucson Gas and Electric
Natural Gas:	Tucson Gas and Electric
Telephone:	Mountain Bell
Water:	Arizona Water Company
Sewer:	Pima County Sanitation Department

Finance

Arizona Bank:	1 branch
Valley National Bank:	1 branch
Pima Savings and Loan:	1 branch

LAND USE

Present and generalized projected land use patterns for Green Valley are presented in PLATES 6 and 7. The community is primarily residential in character with a low percentage of commercial categorized land use.

The future land use patterns will be extension of that existing primarily in the north and south directions along Interstate 19.

WATER SUPPLY AND DISTRIBUTION SYSTEM

Existing Facilities

Water for domestic use and fire protection is provided by the Arizona Water Company who purchased the then existing water supply system from the Maxon Construction Company in 1965. In negotiating the sale, a very favorable contract was entered into whereby costs to the developer are nominal. Expanding the systems to serve new subdivisions can be done with relative ease and the developer has only to pay for fire hydrants and the trunk mains between subdivisions. Trunk main costs are later recovered when customers connect to the system. (PLATE 8)

The distribution network (approximately 60,000 feet of pipeline) is supplied by a series of four wells which have a total delivery capacity of about 3,000 gallons per minute. Peak daily demands (summer) approach 1,300,000 gallons for approximately 1,000 service connections. Other equipment in the system consists of three centrifigul booster pumps (5, 10 and 20 horsepower), two steel pressure tanks (2,000 and 10,000 gallons), and a 1,000,000 gallon storage reservoir. Well depths are 491,500 and 500,228 with power ratings of 60, 100, 75 and 100 horsepower respectively.

Water quality data for the system are noted in TABLE III-1.

Well #1, 2 and 3 are 16 inches in diameter and have approximate depths of 500 feet with static water levels of 195 feet. Well #3 has a delivery capacity rated at 500 gallons per minute. Well #4 is the newest well in the system and has a delivery capacity of 840 gallons per minute. This well has a cased depth of 228 feet, is 20 inches in diameter, and has a static water level of 150 feet.

Future Needs

The rate of annual growth exhibited in the Green Valley area indicates that there can be expected a continual program of water distribution network expansion. Also there will be needs for additional storage facilities and booster stations. Future water demands expected in the area are noted in TABLE III-2.

TABLE III-1

WATER QUALITY DATA FOR GREEN VALLEY
(ARIZONA WATER COMPANY)

Chemical Constituent	Concentration mg/litter			
Well	#1	#2	#3	#4
Total Dissolved Solids	325.0	234.0	210.0	450.0
Total Hardness	186.0	136.0	114.0	280.0
Calcium	59.0	40.0	35.0	74.0
Magnesium	9.0	9.0	6.0	23.0
Sodium	28.0	25.0	22.0	37.0
Alkalinity	170.0	158.0	136.0	198.0
Chlorides	24.0	9.0	7.0	22.0
Fluorides	0.3	0.3	0.4	0.4
Nitrates	14.0	2.0	6.0	26.0
Sulphates	46.0	11.0	19.0	124.0

Source: Arizona State Department of Health.

TABLE III-2

PROJECTED AVERAGE DAILY AND YEARLY
WATER DEMANDS FOR GREEN VALLEY
IN 1975, 1980 AND 1990

1972 usage
1050 acre

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		ACRE-FEET PER YEAR
Summer	845,000		1,090,000		1,755,000		
HIGH		631		813		1,310	
Winter	470,000		581,000		975,000		
Summer	805,000		988,000		1,444,000		
MEDIAN		602		737		1,077	
Winter	447,000		527,000		802,000		
Summer	766,000		895,000		1,186,000		
LOW		572		668		885	
Winter	426,000		477,000		660,000		

Source: Staff estimates.

SEWERAGE AND WASTEWATER TREATMENT

Existing Facilities

Green Valley is within the Pima County Sanitation District which requires sanitary sewers in subdivisions whose lots are smaller than one acre in size. The policies of the District require developers to install, at the developers costs, all lines eight inches and smaller; then donate these to the District. On lines ten inches and over, the District absorbs the costs over what equivalent lengths of eight inches would cost. (PLATE 9).

The treatment facilities are located east of the Santa Cruz River, just north of the property, and with an existing trunk interceptor sewer along the river, all of the undeveloped properties can be readily served.

Sewage treatment is provided by an extended aeration class of facility with a daily capacity of 40,000 gallons.

Future Needs

Increasing development activity of the area will generate the need for extending the collection network and expansion of the treatment facility to handle the greater sewage flows. (TABLE III-3).

SOLID WASTE DISPOSAL PRACTICES AND TECHNIQUES

Existing Facilities

Residents of Green Valley are not provided with a public garbage collection service. A private franchise contract service is available but is primarily subscribed to by the commercial sectors of the community. Collected wastes are disposed of at a sanitary landfill operated by the Pima County Department of Sanitation.

Future Needs

A community garbage collection service will be needed in Green Valley in the near future. Future production levels of solid waste materials for the community are noted in TABLE III-4.

The sanitary landfill serving the area will need sufficient capacity to adequately dispose of accumulated solid waste on the order of 156,000 tons through 1990. This quantity of material would have an equivalent volume of 132 acre-feet.

TABLE III-3

PROJECTED AVERAGE DAILY AND YEARLY SEWAGE FLOWS FOR GREEN VALLEY IN 1975,1980 AND 1990

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		ACRE-FEET PER YEAR
Summer	639,000		871,000		1,317,000		
HIGH		526		650		983	
Winter	376,000		472,000		731,000		
Summer	608,000		790,000		1,083,000		
MEDIAN		501		590		808	
Winter	358,000		429,000		602,000		
Summer	579,000		716,000		889,000		
LOW		475		534		604	
Winter	341,000		388,000		494,000		

Source: Staff estimates.

TABLE III-4

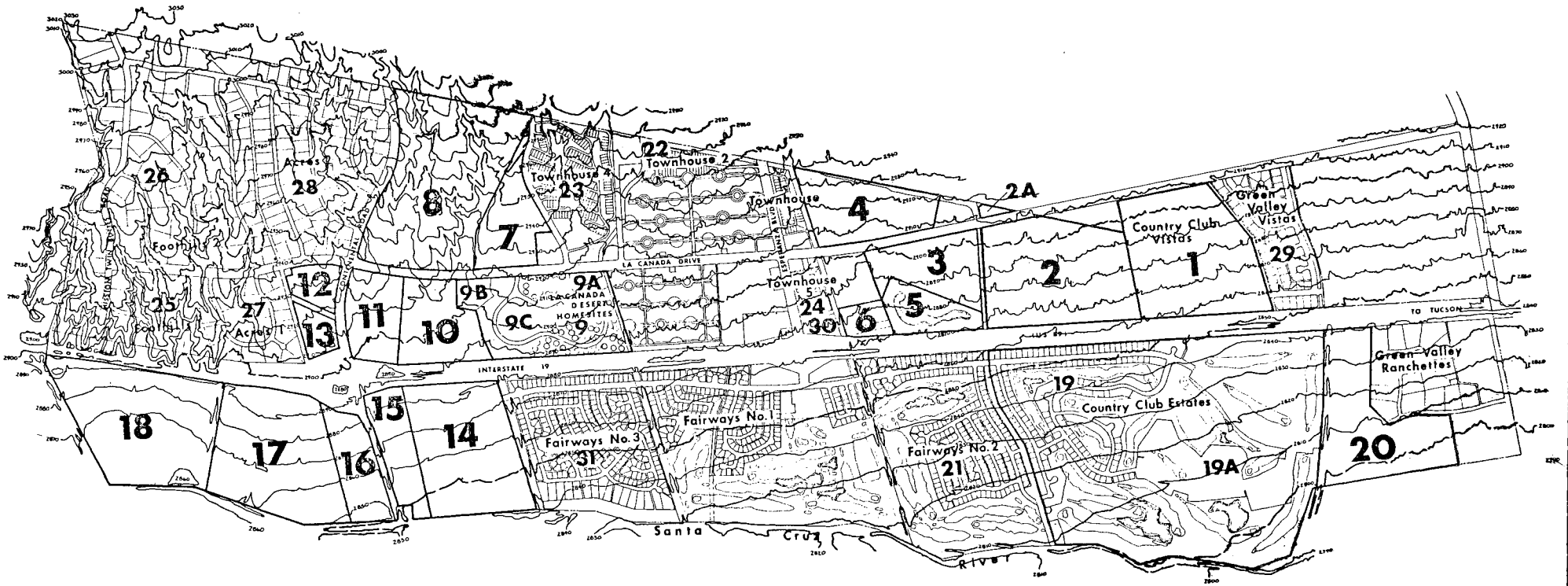
PROJECTED AVERAGE YEARLY SOLID WASTES PRODUCTION LEVELS FOR GREEN VALLEY IN 1975, 1980 AND 1990
(tons per year)

PROJECTION YEAR	SOLID WASTE PRODUCTION LEVELS LOW	MEDIAN	HIGH
1975	5,272	5,539	5,815
1980	6,269	6,918	7,628
1990	8,559	10,452	12,672

OTHER RURAL AREAS IN PIMA COUNTY

This section discusses very small areas of rurally characterized development found in Pima County. These areas hold an unincorporated status, have populations less than 500 people, lack a post office and are generally without a framework for community leadership.

Environmental services are basically provided by private interest groups, particularly with respect to water supply systems. Sewage treatment is provided by the septic tank concept of treatment and solid waste collection services are nonexistent. These areas are provided with a regional sanitary landfill operated and maintained by the county, however, transport of waste materials to a landfill site is an individual responsibility.



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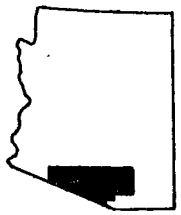
SOURCE: Tucson Green Valley Development Corp.
January, 1971



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TOPOGRAPHY

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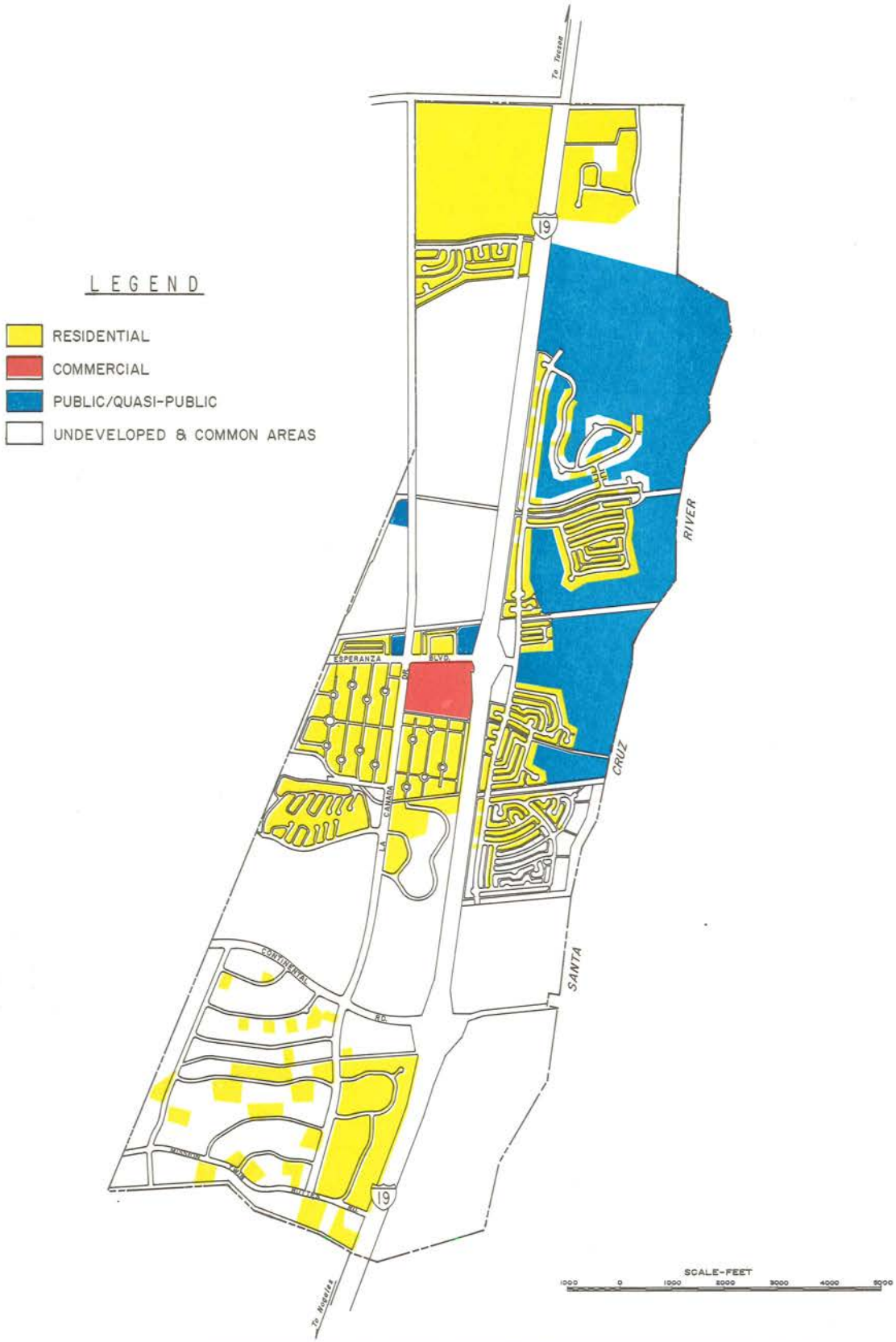
PLATE 5



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GREEN VALLEY, ARIZONA

LAND USE

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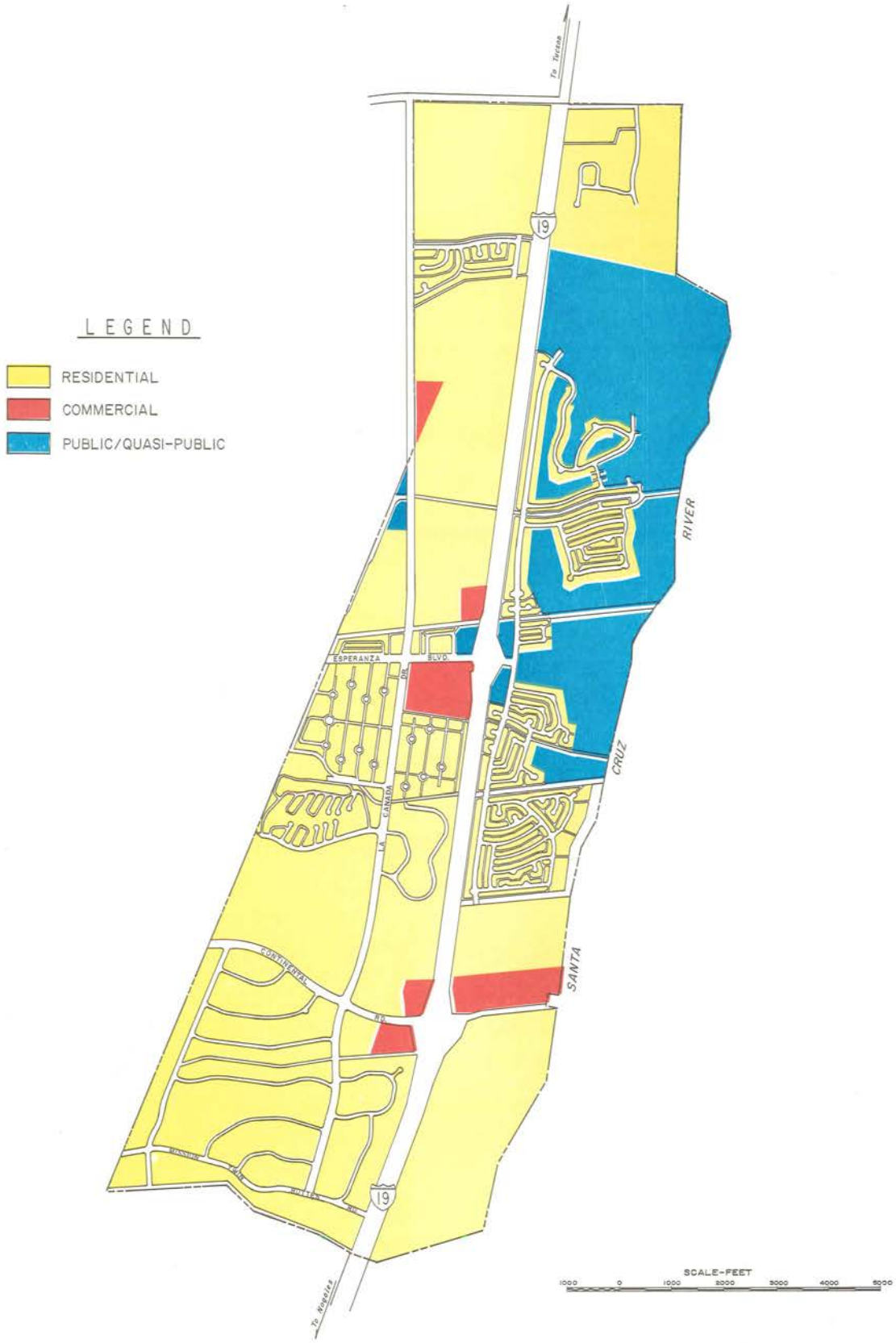
PLATE 6



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GREEN VALLEY, ARIZONA

PROJECTED LAND USE

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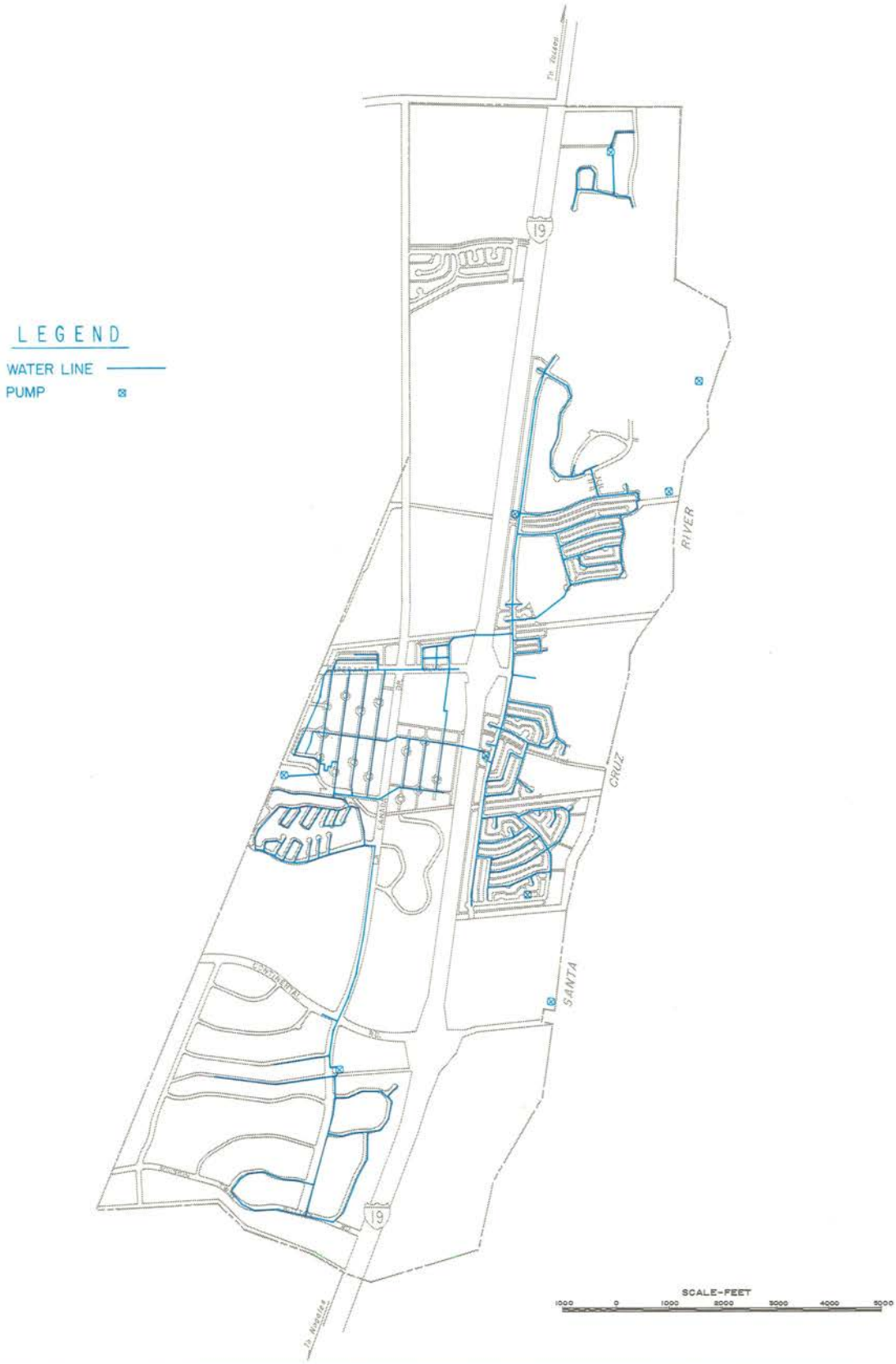
PLATE 7



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GREEN VALLEY, ARIZONA

WATER SYSTEM

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PLATE 8

ENVIRONMENTAL SERVICES NEEDS STUDY

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GREEN VALLEY, ARIZONA

SEWER SYSTEM

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PLATE 9

COMMUNITY OF MARANA

Physiography

The developed area of Marana is located at an elevation of about 2,000 feet in the desert country of south-central Arizona approximately 21 miles northwest of Tucson (PLATE 10). The area lies near the northern (lower) end of the Avra Valley. The Santa Cruz River follows a normally dry course northward about 4.5 southwest of the community. Terrain in the immediate vicinity is practically flat with exception of a few washes which dissect the topography.

The native vegetation consists almost entirely of creosote bush and salt brush. Much of the natural vegetation has been replaced by irrigated farm land. The soils which are alluvial in origin carry a silty-sand horizon with a dark colored surface layer. Cotton crops grow extremely well in this class of soil.

Precipitation is extremely light, less than ten inches per year, and at best an undependable source of moisture. The most consistent rains occur in summer, particularly in July and August when deep currents of moist air flow into Southern Arizona from the Gulf of Mexico. The summers are warm with afternoon temperatures from June through September near or above 100 degrees. During Autum, winter and early spring the climate is considered ideal, warm days following cool nights. In mid-winter temperatures vary from the upper thirties to middle or upper sixties. Maximum temperatures above 80 degrees have been recorded in all months. Readings below freezing occur frequently at night from about the last week in November until the second week in March.

Economy and Population Profile

The economy of this small town has its base in agriculture. The surrounding area is a rich farming area used for cotton and grains. Industry in the town consists of two cotton gins, and varied retail trade establishments to meet the needs of the local population.

The town is situated on Interstate 10 which puts it in a good position to share in any industrial growth spreading up from Tucson. It also is at the edge of Avra Valley, which is judged to have a good development potential over the next twenty years. Eventually, Marana should share in the growth of the valley. Several development corporations have purchased land near the town which will eventually be put to commercial or residential use.

According to the 1970 Census of the Population, the present population of Marana is 498. By 1990, the median population projection is for the town to reach 747. A low projection of 498 and high projection of 996 are also shown in FIGURE III-2. These projections assume the continuation of Marana as primarily a farm service center during the projection period. Any significant urban development is excluded from the projection.

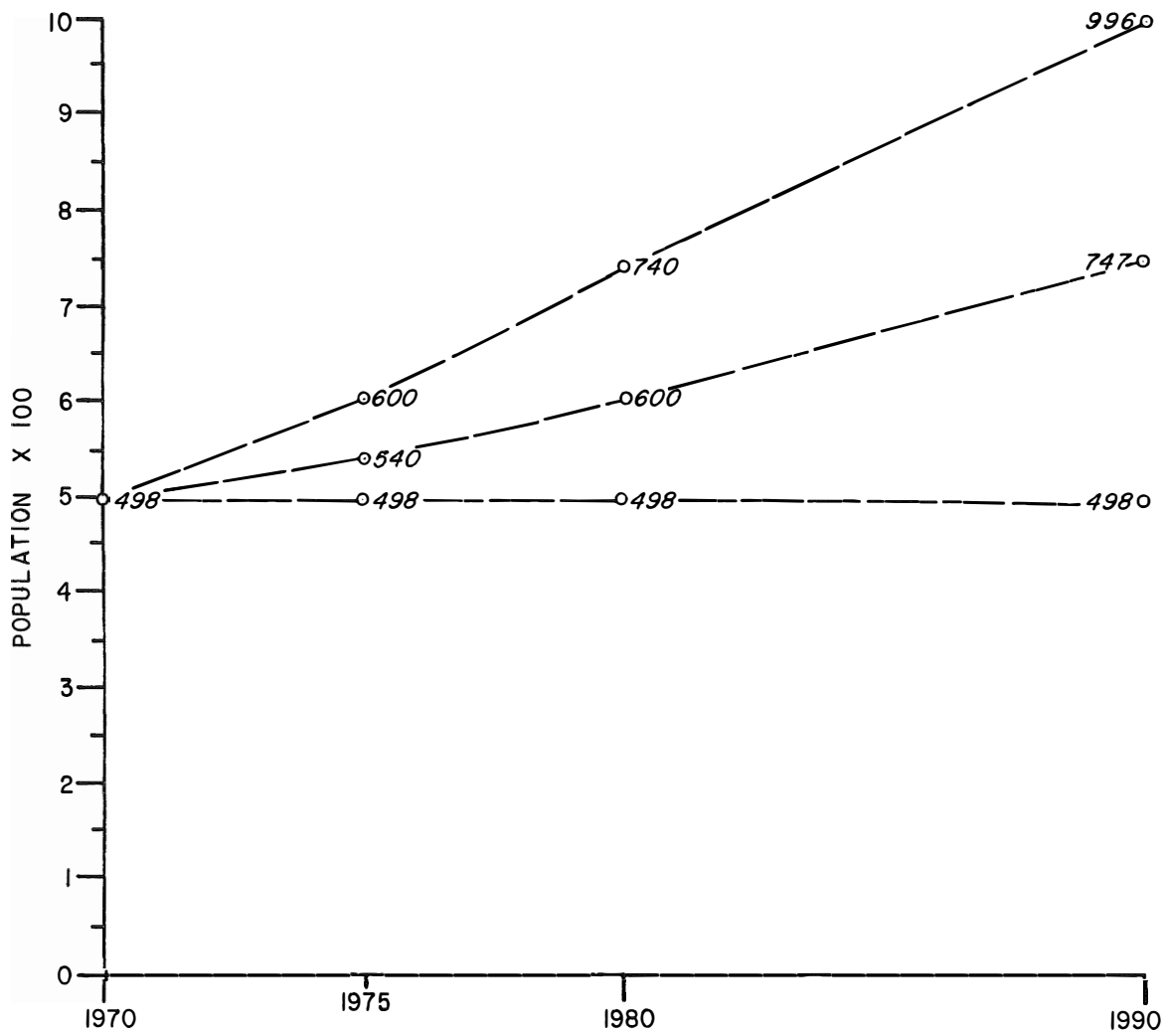


FIGURE III-2. POPULATION PROJECTION FOR MARANA THROUGH 1990.

Existing Facilities

Domestic water services for the community are provided by two private franchised utilities; Village Water Company and Marana Water Company. Distribution networks are small with water supply derived from well systems. Water quality data for these systems are noted in TABLE III-5.

TABLE III-5

WATER QUALITY DATA FOR
VILLAGE WATER COMPANY AND MARANA WATER COMPANY
MARANA, ARIZONA

Chemical Constituent	Concentration, mg/liter Village	Marana
Total Dissolved Solids	400.0	340.0
Total Hardness	220.0	168.0
Calcium	70.0	54.0
Magnesium	10.0	8.0
Sodium	34.0	45.0
Alkalinity	130.0	140.0
Chlorides	38.0	40.0
Fluorides	0.3	0.5
Nitrates	42.0	10.0
Sulphates	100.0	72.0

Source: Arizona State Department of Health.

The Marana Water Company has the larger of the two systems. It is supplied by three wells with a total delivery capacity of 560 gallons per minute. Static water level for these wells is about 300 feet. This system currently has about 200 service connections which in 1971 utilized 27,830,600 gallons of water. 85 AF = .427 AF/conn.

Two additional water companies are found in the Marana area which serve small subdivisions. Berry Acres Water Company is situated about four miles west and Honea Water Company is found one mile south of Marana.

Future Needs

Land subdividing activity in the area will result in the formation of new water companies and/or expansion of the existing systems. In the event rapid development activity should become evident in the area a detailed planning analysis should be implemented towards the consolidation of the existing water supply systems. When viewed from a county

standpoint, better water resources management would be a possible outcome resulting from such a study. Future water supply demands are presented in TABLE III-6.

TABLE III-6

PROJECTED AVERAGE DAILY AND YEARLY WATER DEMANDS FOR MARANA IN 1975, 1980 AND 1990

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		ACRE-FEET PER YEAR
Summer	76,000		106,000		172,000		
HIGH		57		79		128	
Winter	45,000		63,000		95,000		
Summer	69,000		86,000		129,000		
MEDIAN		51		64		96	
Winter	41,000		51,000		71,000		
Summer	64,000		71,000		86,000		
LOW		47		53		64	
Winter	37,000		42,000		47,000		

SEWERAGE AND WASTEWATER TREATMENT

Existing Facilities

Marana is without a centralized sewage collection and disposal system. Sewage wastes generated in the area are treated by individual septic tank leach pit or bed type of disposal systems. Soils are alluvial in character and are suitable for low density utilization of septic tank systems.

Future Needs

Subdivisions are required by the Pima County Department of Sanitation to have centralized sewage collection systems where lots are one acre or less in area.

Should land development activity occur, responsibility for development of sewage treatment facilities will be upon the Department of Sanitation. Projected sewage flows for Marana are noted in TABLE III-7.

TABLE III-7

PROJECTED AVERAGE DAILY AND YEARLY
SEWAGE FLOWS FOR MARANA IN 1975, 1980 AND 1990

Projection Levels	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day	ACRE-FEET PER YEAR
Summer	63,000		83,000		127,000	
HIGH		47		62		95
Winter	36,000		52,000		80,000	
Summer	57,000		68,000		95,000	
MEDIAN		42		50		71
Winter	32,000		42,000		60,000	
Summer	53,000		56,000		64,000	
LOW		39		42		47
Winter	30,000		35,000		40,000	

SOLID WASTE DISPOSAL PRACTICES AND TECHNIQUES

Existing Facilities

Residents in the Marana area are without a garbage collection service. Responsibility for removal and transportation of solid wastes to a sanitary landfill operated by the county falls on the individual property owners.

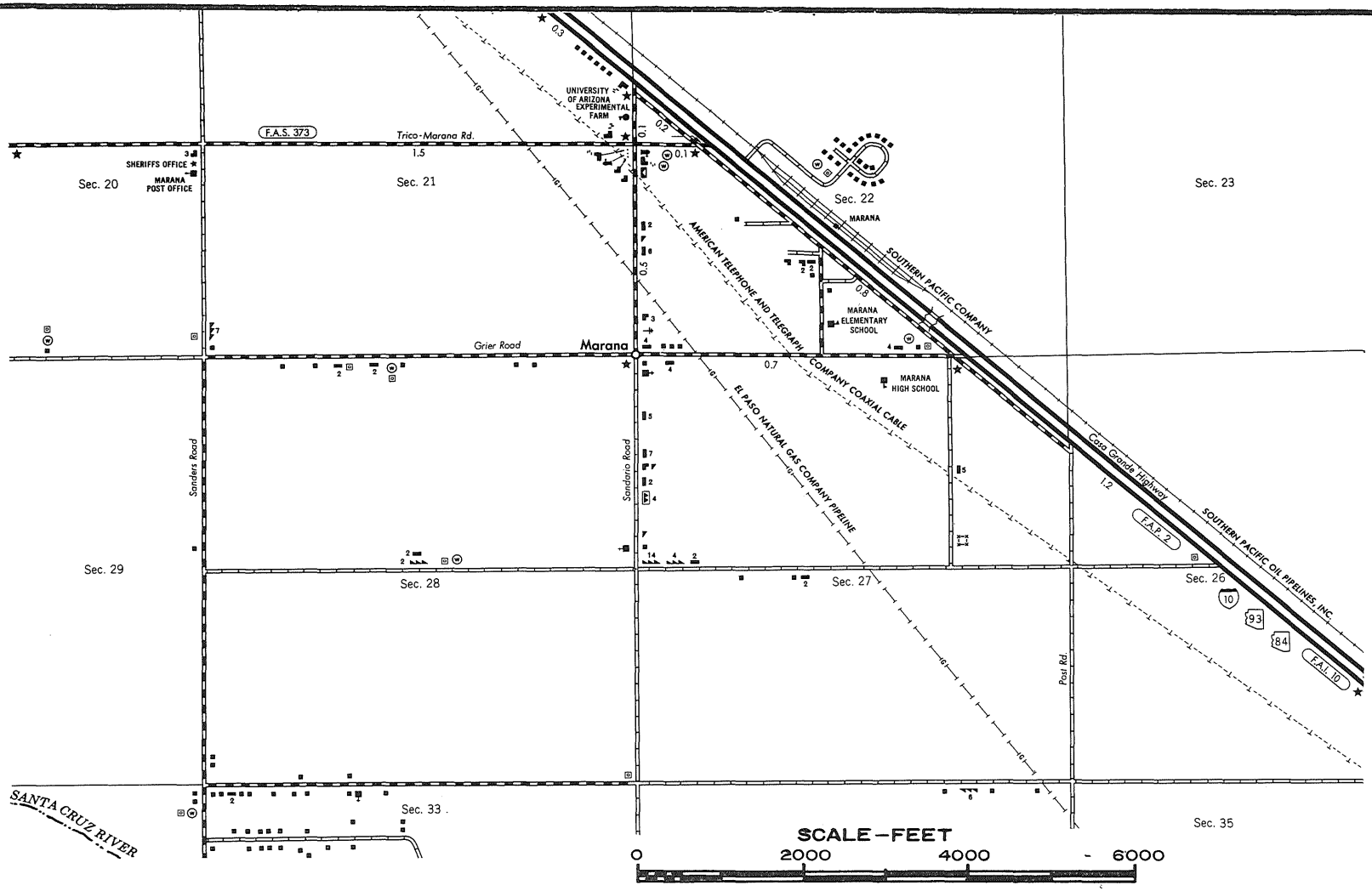
Future Needs

In the event land development in the Marana area becomes centralized and of greater density, a municipally operated garbage collection service would benefit the area. Population projections, however, suggest that such a service may not be feasible for a number of years. Average yearly levels of solid waste production are estimated for the Marana area in TABLE III-8.

TABLE III-8

PROJECTED AVERAGE YEARLY SOLID WASTES
PRODUCTION LEVELS FOR MARANA IN 1975, 1980 AND 1990
(ton per year)

PROJECTION YEAR	SOLID WASTE PROJECTION LEVELS LOW	MEDIAN	HIGH
1975	463	502	557
1980	523	631	778
1990	647	971	1294



SOURCE: Pima County General Highway Map

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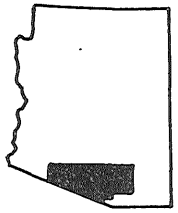

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MARANA, ARIZONA

GENERAL FEATURES

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PLATE 10

COMMUNITY OF RILLITO

Physiography

Rillito is located approximately 16.5 miles northwest of Tucson at the northern most tip of Tucson Mountains. The Santa Cruz River lies roughly three-quarters of a mile south and to the west of the community. The elevation is about 2,100 feet above mean sea level in a geologic area underlain with deposits of limestone, sandstone and shale (PLATE 11). Several washes leading from the Tucson Mountains to the Santa Cruz River dissect the topography of the area giving it a dendridtic character.

The native vegetation consists primarily of creosote bush and salt brush which dominates along the normally dry Santa Cruz River water course. Mesquite becomes prevalent in the Tucson Mountains at higher elevations. Precipitation is light usually less than eleven inches per year. The most consistent rains occur in the late summer and early spring.

Temperatures are relatively high, often eclipsing the century mark from June through mid-September. Winter climate is considered ideal with moderately warm days following cool nights almost without interruption. Temperature readings below freezing occur frequently at night from about the week in November until mid-March.

Soils in the immediate vicinity of Rillito are alluvial in nature having primarily a sandy silty horizon. The soils also have a tendency to exhibit higher concentrations of carbonates with appreciable contents of limestone and calcareous sandstone fragments.

Economy and Population

The dominant feature of Rillito's economy is the Arizona Portland Cement Company which has a plant in the town. There is little else in the town besides the cement plant. Farm lands surround the town and are a source of employment for inhabitants.

Rillito is located on Interstate 10, the same as Marana, and may someday also experience some development as a result of Tucson's outgrowth. Whether this will have a significant impact on the town within the next 20 years is uncertain. Its present population is 1,837. By 1990 the population is projected at a maximum to double. The low projection is for the population to remain the same, while the median projection is for a population of 2,755 (FIGURE III-3).

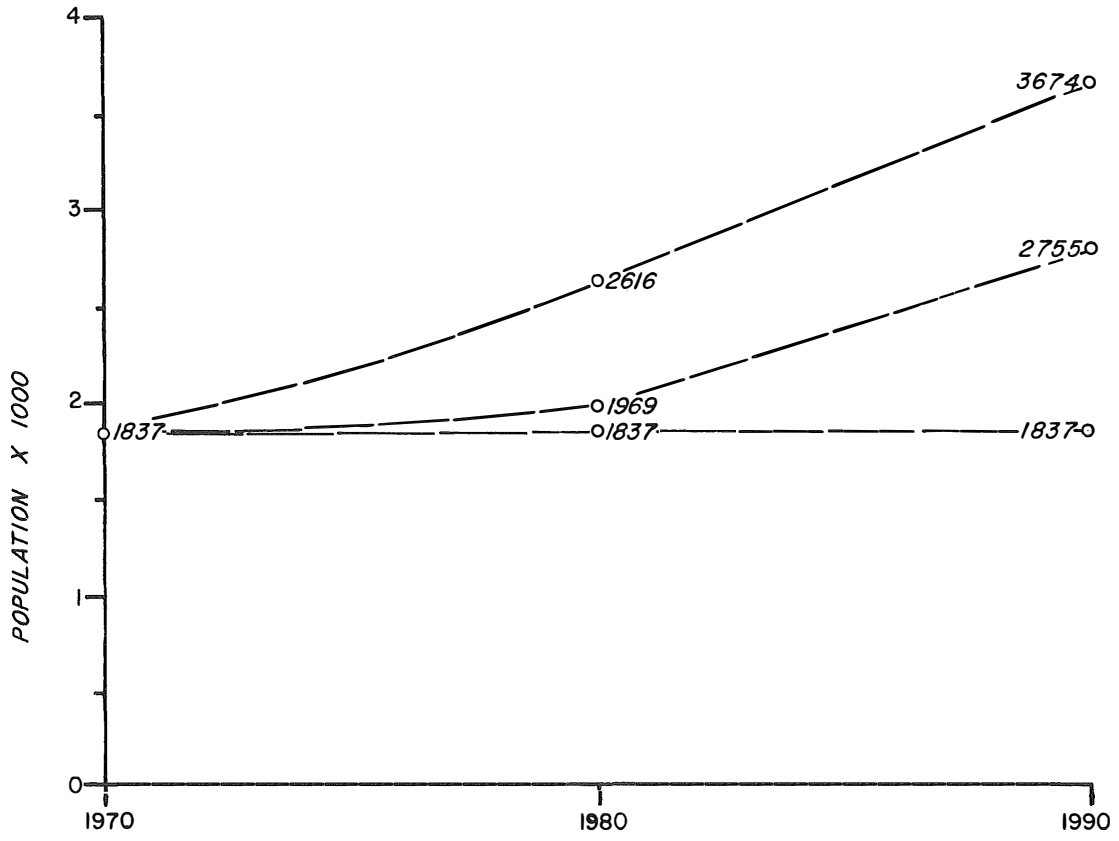


FIGURE III-3. POPULATION PROJECTION FOR RILLITO THROUGH 1990.

WATER SUPPLY AND DISTRIBUTION SYSTEMS

Existing Facilities

Domestic water is provided by the Rillito Water Users Association. In 1971 there were 54 water connections which has a demand of about 4,300,000 gallons. The supply is drawn from one well with a depth of 500 feet and static water level of 175 feet. The rated delivery capacity 100 gallons per minute. Water quality is presented in TALBE III-9.

TABLE III-9

WATER QUALITY DATA
RILLITO WATER USERS ASSOCIATION
RILLITO, ARIZONA

Chemical Constituent	Concentration, mg/liter
Total Dissolved Solids	370.0
Total Hardness	238.0
Calcium	76.0
Magnesium	11.0
Sodium	39.0
Alkalinity	168.0
Chlorides	104.0
Fluorides	0.6
Nitrates	19.0
Sulphates	76.0

Source: Arizona State Department of Health.

Future Needs

Urban growth in the Tucson Metropolitan area will have a corresponding influence on the Rillito area. Although the rate of growth will be less than the Tucson water system, expansion and consolidation will be necessary within the next five-year period. In this respect a detailed engineering study should be implemented by 1977. The water supply situation will also be in need of evaluation as the source is derived from the ground water reservoirs of the Santa Cruz River. Greater demands by the City of Tucson could possibly generate a shortage situation in the Rillito area of the Santa Cruz watershed. Future water demands are noted in TABLE III-10.

TABLE III-10

PROJECTED AVERAGE DAILY AND YEARLY WATER DEMANDS FOR RILLITO IN 1975, 1980 AND 1990

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		ACRE-FEET PER YEAR
Summer	287,000		385,000		634,000		
HIGH		214		287		473	
Winter	180,000		230,000		386,000		
Summer	261,000		328,000		416,000		
MEDIAN		195		245		348	
Winter	164,000		196,000		284,000		
Summer	234,000		262,000		317,000		
LOW		175		195		237	
Winter	147,000		156,000		193,000		

SEWERAGE AND WASTEWATER TREATMENT

Existing Facilities

The septic tank is utilized predominantely in the Rillito area as a form of sewage treatment. Soils are alluvial in origin and as a consequence minimal problems have occurred with this concept of treatment.

Future Needs

Rillito has a population base which is sufficient to justify consideration of community incorporation. The community is also taking on an urbanized character which suggests the development of centralized sewage collection and treatment tied to water reclamation. The cement plant comprising the basic economy of the community could augment its future water supplies by utilizing reclaimed waste waters. In addition, the construction of a centralized collection network could serve as an asset in coordinating land development activity in the area. Expected sewage flows are found in TABLE III-11.

TABLE III-11

PROJECTED AVERAGE DAILY AND YEARLY
SEWAGE FLOWS FOR RILLITO IN 1975, 1980 AND 1990

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		ACRE-FEET PER YEAR
Summer	236,000		304,000		468,000		
HIGH		176		227		350	
Winter	135,000		176,000		276,000		
Summer	215,000		259,000		344,000		
MEDIAN		161		193		257	
Winter	123,000		150,000		203,000		
Summer	193,000		206,000		234,000		
LOW		144		154		175	
Winter	110,000		119,000		138,000		

SOLID WASTES DISPOSAL PRACTICES AND TECHNIQUES

Existing Facilities

Public services in the Rillito area do not include garbage collection and disposal. Responsibility for solid waste disposal falls on individual property owners. The Pima County Department of Sanitation operates a sanitary landfill near the community for disposal of waste materials transported to the site.

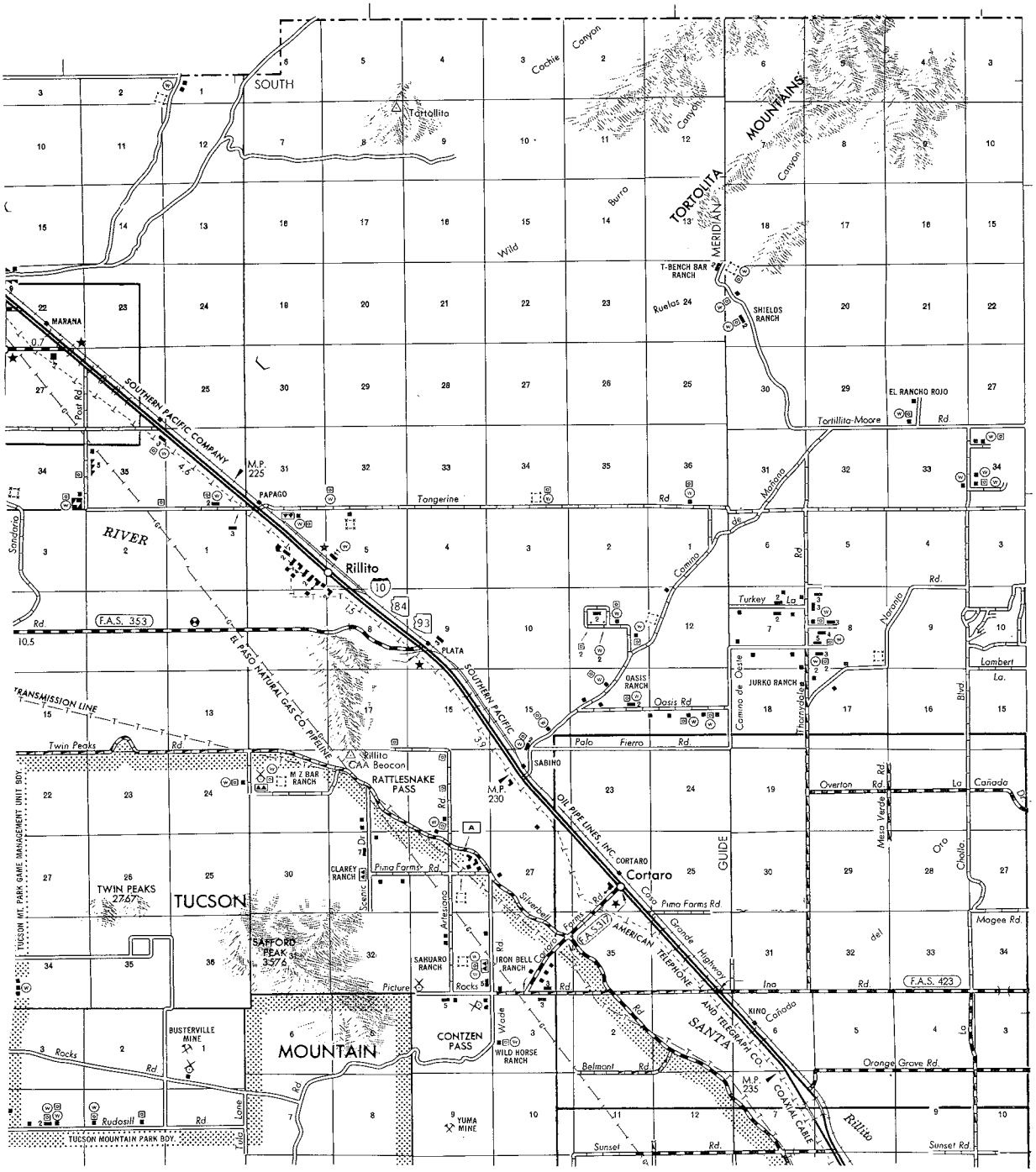
Future Needs

The population of Rillito is sufficient to make it feasible for the implementation of community garbage collection service. However, such service could only be effectively operated if it were under the jurisdiction of a municipality type of management. Solid wastes production levels in future years are noted in TABLE III-12.

TABLE III-12

PROJECTED AVERAGE YEARLY SOLID WASTES PRODUCTION LEVELS FOR RILLITO IN 1975, 1980 AND 1990 (ton per year)

Projection Year	SOLID WASTE PROJECTION LEVELS LOW	MEDIAN	HIGH
1975	1707	1904	2090
1980	1931	2418	2838
1990	2387	3508	4774



SOURCE: Pima County General Highway Map

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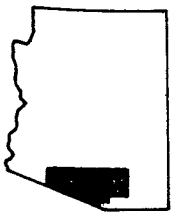

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RILLITO, ARIZONA

GENERAL FEATURES

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PLATE 11

COMMUNITIES OF SUMMERHAVEN, AVRA, LUKEVILLE, WHY AND ARIVACA

The above community developments are areas with estimated permanent populations that range from 50 to 400 resident (PLATES 12, 13, 14, 15 and 16). These areas are the smallest levels of rural development in Pima County which are provided with public water supply facilities.

WATER SUPPLY AND DISTRIBUTION SYSTEMS

Existing Facilities

Domestic water supply services are provided by privately classed purveyors. These companies are outlined briefly in the following paragraphs.

The distribution network consists of approximately 24,300 feet of water mains, 450,000 gallons of total storage capacity and chlorination equipment.

The Summerhaven recreation area located in the Santa Catalina Mountains is served by a small service system that presently has 220 service connections (PLATE 12). The water supply is derived from a series of three springs in Carter Canyon. Water quality data is noted in TABLE III-13.

TABLE III-13

WATER QUALITY DATA
MT. LEMMON WATER COOPERATIVE

Chemical Constituent	Concentration, mg/liter
Total Dissolved Solids	135.0
Total Hardness	98.0
Calcium	36.0
Magnesium	2.0
Sodium	3.0
Alkalinity	90.0
Chlorides	2.0
Fluorides	0.5
Nitrates	1.0
Sulphates	7.0

Source: Arizona State Department of Health.

The water company presently has an application submitted to the FHA for $130,000 to upgrade the entire system. The request covers the installation of water meters, additional storage capacity, new transmission mains, and improving the catchment basins used at the water supply source. The modification of catchment basins will increase the production and delivery capability of the system.

TABLE III-14

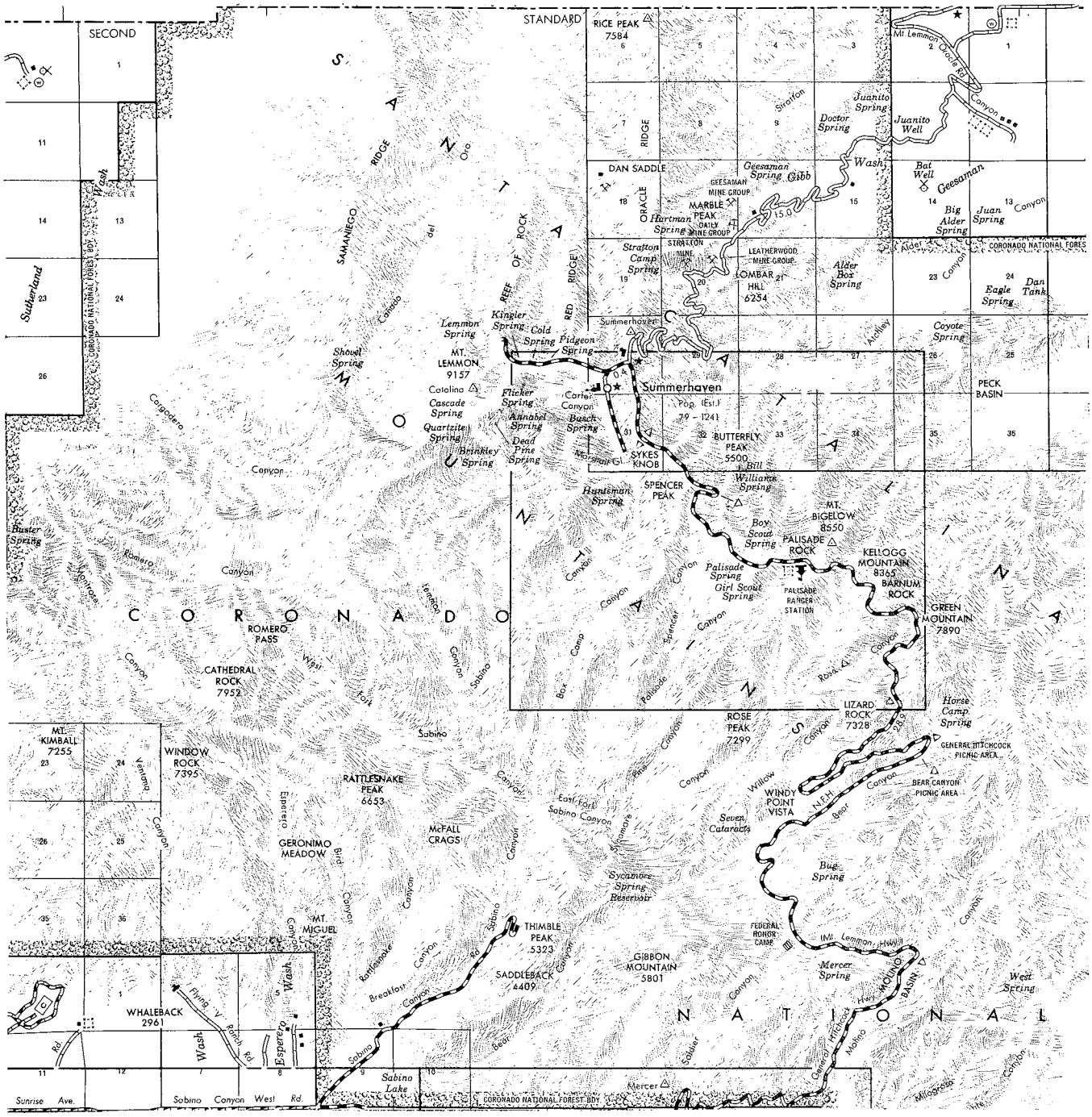
WATER QUALITY DATA
WHY UTILITY CORPORATION

Chemical Constituent	Concentration, mg/liter
Total Dissolved Solids	535.0
Total Hardness	92.0
Calcium	20.0
Magnesium	10.0
Sodium	132.0
Alkalinity	92.0
Chloride	148.0
Fluorides	0.2
Nitrate	9.0
Sulphates	102.0

Source: Arizona State Department of Health.

The developed area of Why is located at the intersection of Arizona Highway 85 and 86 ten miles southeast of Ajo, adjacent to the westernmost boundary of the Papago Indian Reservation (PLATE 13). Water serving the area is drawn from a well 1,120 feet in depth with a static water level of 805 feet. The well has a delivery capacity of about 60 gallons per minute. Water quality for the area is typified by the data noted in TABLE III-14. In addition to the data noted the groundwaters in this region of Arizona have been found to exhibit arsenic levels above U. S. Public Health Service limiting concentrations of 0.05 milligrams per liter. In the vicinity of Why levels of 0.11 mg/liter are found which has necessitated the use of special filters for removal of arsenic before use.

Lukeville is located at the International Boundary 27 miles south of Ajo (PLATE 14). The community is primarily a border crossing and public facilities are minimal. Water quality data for the area is noted in TABLE III-15.



SOURCE: Pima County General Highway Map

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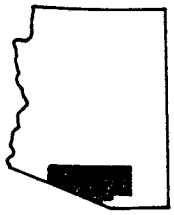

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SUMMERHAVEN, ARIZONA

GENERAL FEATURES

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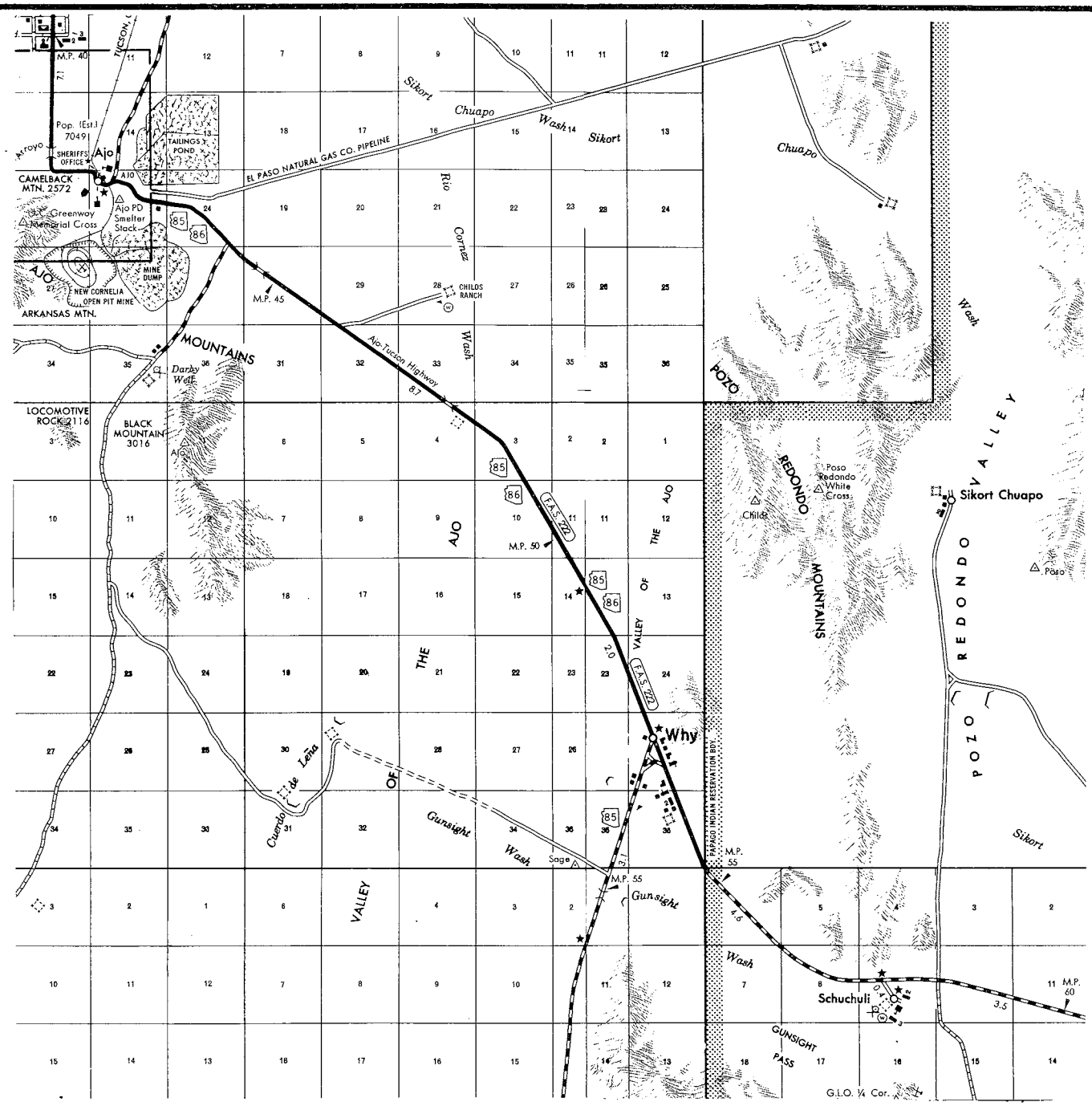
PLATE 12



SOURCE: Pima County General Highway Map

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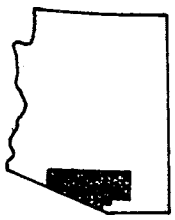

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WHY, ARIZONA

GENERAL FEATURES

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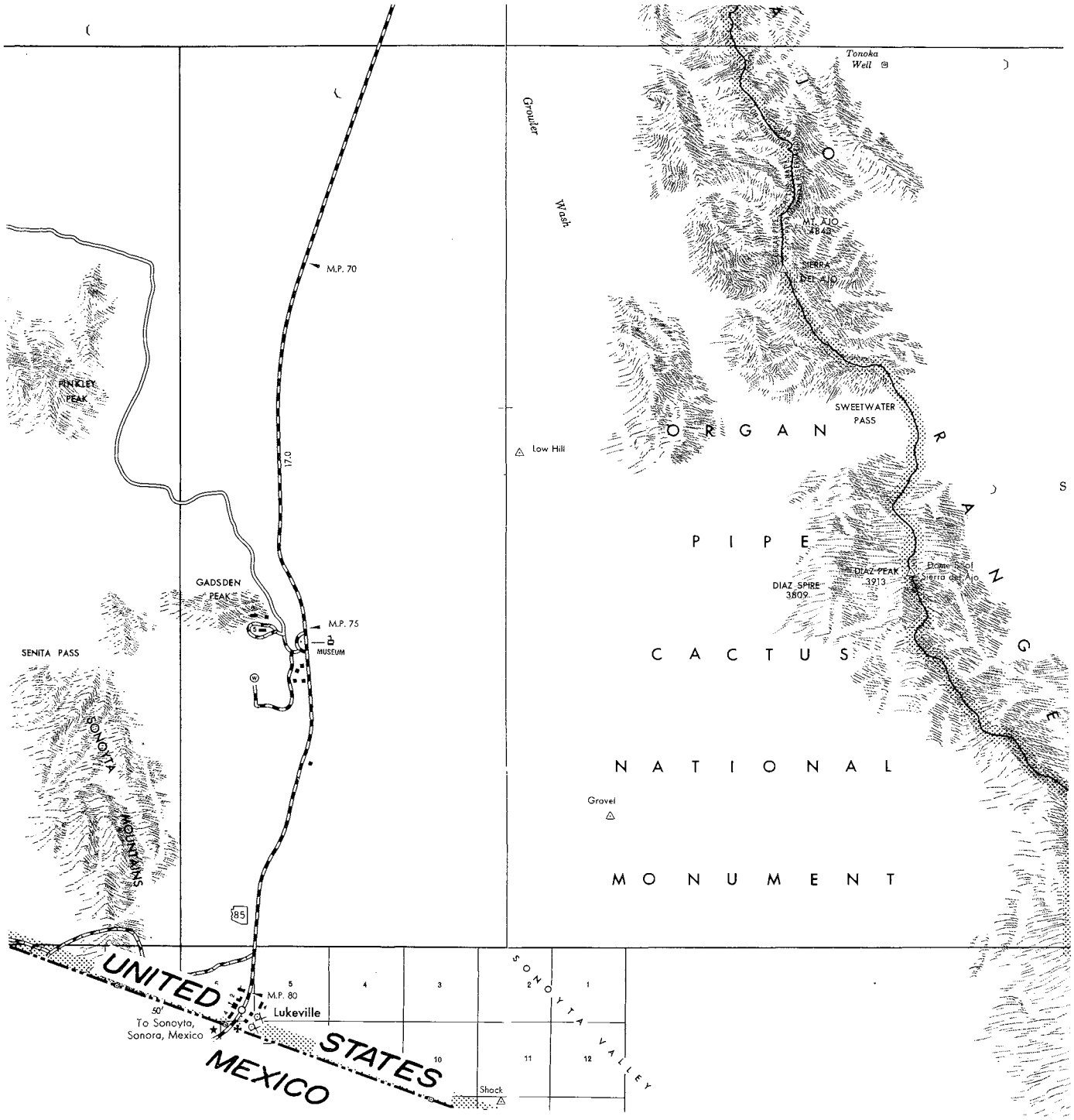
PLATE 13



SOURCE: Pima County General Highway Map
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LUKEVILLE, ARIZONA

GENERAL FEATURES

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PLATE 14

TABLE III-15

WATER QUALITY DATA
GAYS' GRINGO PASS - LUKEVILLE, ARIZONA

Chemical Constituent	Concentration mg/liter
Total Dissolved Solids	547.0
Total Hardness	63.0
Calcium	16.0
Magnesium	5.0
Sodium	153.0
Alkalinity (M.O./P.)	6.0/162.0
Chlorides	112.0
Fluorides	4.8
Nitrates	12.0
Sulphates	72.0

Source: Arizona State Department of Health.

The water quality data above is for water pumped from a well 210 feet in depth with a static water level of 80 feet and delivery capacity of 200 gallons per minute.

The small community of Avra is located at the northern end of Avra Valley west of Marana (PLATE 15). Domestic water for the area is provided primarily by the Central Water Company via an eight inch well with a submersible pump. The well is 620 feet in depth and has a static water level of 340 feet. Delivery capacity is about 550 gallons per minute with a resulting drawdown of eight feet. Other facilities include a 1,000 gallon storage tank. Water quality data is noted in TABLE III-16.

The community of Arivaca is located at the Pima-Santa Cruz county line approximately 35 miles south of Tucson (PLATE 16). Water is taken from springs by the Arivaca Water Cooperative and delivered through a small distribution network (42 connections) which has a 20,000 gallon storage facility and approximately 4,500 feet of water main.

Water quality for the supply is noted in TABLE III-17.

TABLE III-16

WATER QUALITY DATA
CENTRAL WATER COMPANY
AVRA, ARIZONA

Chemical Constituent	Concentration, mg/liter
Total Dissolved Solids	355.0
Total Hardness	120.0
Calcium	34.0
Magnesium	9.0
Sodium	82.0
Alkalinity	106.0
Chlorides	47.0
Fluorides	0.8
Nitrates	2.0
Sulphates	91.0

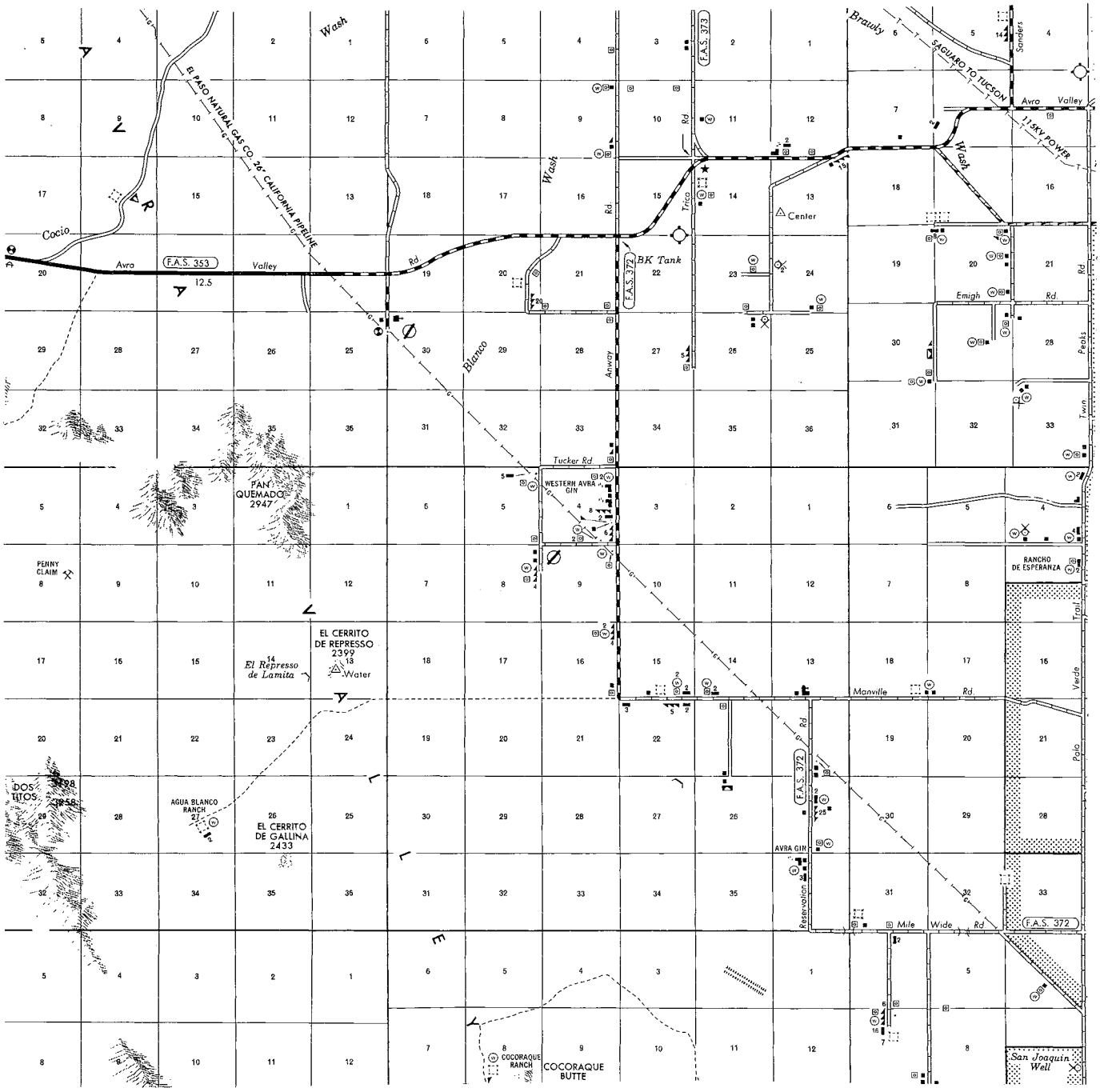
Source: Arizona State Department of Health.

TABLE III-17

WATER QUALITY DATA
ARIVACA TOWNSITE COOPERATIVE WATER COMPANY
ARIVACA, ARIZONA

Chemical Constituent	Concentration, mg/liter
Total Dissolved Solids	255.0
Total Hardness	152.0
Calcium	48.0
Magnesium	8.0
Sodium	18.0
Alkalinity	160.0
Chlorides	11.0
Fluorides	0.2
Nitrates	6.0
Sulphates	7.0

Source: Arizona State Department of Health.

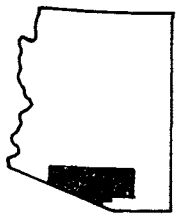


SOURCE: Pima County General Highway Map

© Arizona Highway Department

SCALE-MILES

0 1 2 3 4 5 6



ENVIRONMENTAL SERVICES NEEDS STUDY

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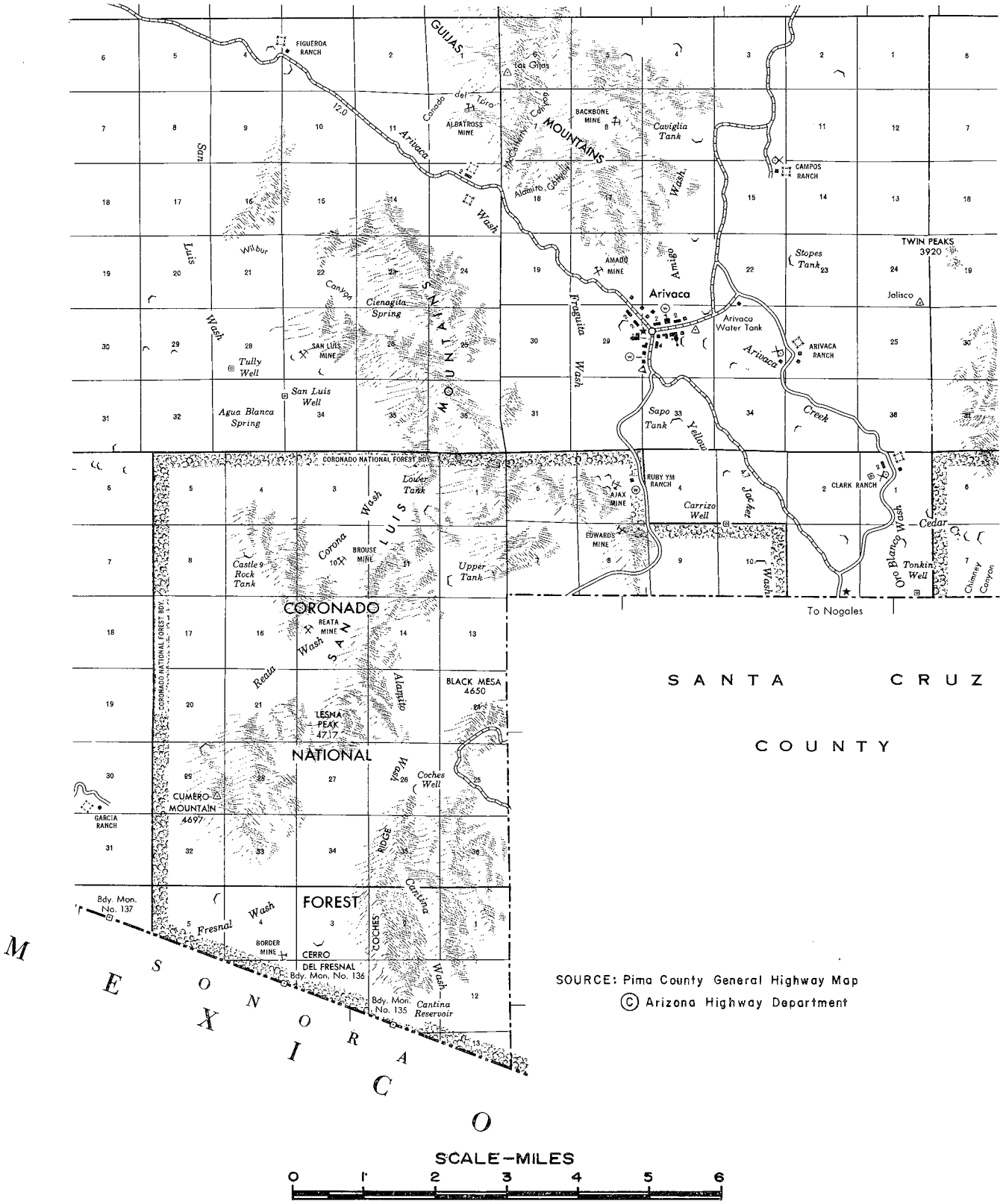
AVRA, ARIZONA

GENERAL FEATURES

N

PLATE 15



SOURCE: Pima County General Highway Map
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ARIVACA, ARIZONA

GENERAL FEATURES

N

PLATE 16

Future Needs

All the systems discussed above are small in terms of the number of service connections and extensiveness of distribution networks. Water supplies for these systems appear adequate with respect to the rates of growth expected for such areas. Those areas where water quality is marginal there is a need for new sources of better quality water.

It is difficult to assess which of the systems will feel the greatest pressure for expansion or modification in the next 20 year period. Population growth for the county as a whole would seem to indicate the possibility of growth in all rural areas presented as well as those areas which have not been fully delineated.

SEWERAGE AND WASTEWATER TREATMENT

Existing Facilities

The rural areas discussed herein depend primarily on the septic tank system for the sanitary disposal of sewage wastes. The use of septic tanks for areas of low density is an economical means of sewage disposal. Except in areas where soils are incompatible with septic tank systems this form of disposal is adequate. No overt disposal problems exist in these areas.

Future Needs

The septic tank systems will continue to be the major form of sewage disposal practiced in rural areas. County ordinances require that major land subdividing be accompanied by centralized collection and disposal facilities. A collection system may be needed in the recreation area of Summerhaven.

SOLID WASTE DISPOSAL PRACTICES AND TECHNIQUES

Existing Facilities

All areas of development discussed are without services for collection of solid wastes and transporting to disposal sites. Individual responsibility prevails for transfer of collected materials to sanitary landfills operated and maintained by the county.

Future Needs

The rates of growth for the rural areas are such that future needs are difficult to project. Should any of the areas discussed witness rapid growth, detailed feasibility studies should be implemented.

REFERENCES SECTION I

1. Definitions from K.T. Loer, and W. B. Langbein, USGS Water Supply Paper 1541-A, 1960, P. 17-18.

2. E. S. Davidson, "Geohydrology and Water Resources of the Tucson Basin," USGA Open File Report, May 1970.

3. Ibid, P. 164.

4. "Mineral and Water Resources of Arizona," Arizona Bureau of Mines, Tucson, 1969.

5. "Water and Mineral Resources of Arizona," Bulletin 180, Arizona Bureau of Mines, 1969.

6. E. S. Davidson, "Geohydrology and Water Resources of Tucson Basin," USGS Open File Report, 1970.

7. Forecast Reviews and Data Inventories June 1970, Tucson Area Transportation Planning Agency.

8. Geologic Map of Pima and Santa Cruz Counties, Arizona, Prepared by the Arizona Bureau of Mines, University of Arizona, Tucson, Arizona.

9. Tucson Gas and Electric Company Annual Report, 1970, Financial and Statistical Review, 1960-1970.

SECTION II

CHAPTER I. ENVIRONMENTAL SERVICES ESTIMATED COSTS

It is the responsibility of municipal officials faced with the need for environmental services to know how much suggested installations should cost. Actual project costs do not become available until plans and specifications have been completed and approved, bids for construction work, materials and equipment received, and contracts let. Yet there is need for preliminary concepts of what the eventual cost will be long before finalization steps have been taken. In short, there is need for valid "measuring sticks" or guidelines which will supply preliminary cost estimates for projects.

There is no substitute for actual cost information, but costs estimates play an important role in the preliminary stages of environmental services planning, despite the fact that decisions often must be based on needs within a community or the availability of funds. While the size of a project may be firmly established by the population to be served or regulatory requirements, knowledge of what the project may cost will be of great value:

--Cost estimates may dictate whether construction should be phased out in stages rather than on a single project basis.

--Cost estimates may ascertain the future period for which capacity will be provided or for which actual construction will be scheduled on a long-range plan.

--Cost estimates can help municipal and county officials develop planning for rational long-range financing.

--Cost estimates can serve as a guide in judging the validity of competitive bids.

--Cost estimates can help guide bond issue referenda and assure investors in such bonds of the stability of the offerings.

These examples of the serviceability of construction cost estimates point up the responsibility in establishing guidelines. They demonstrate the need for using cost statistics of known validity in offering cost estimating guidelines and for clear interpretation of such data in terms of their limitations as well as their proven values. It should be noted the above examples can also serve as warnings in that estimates are no more than estimates; that the estimates must be used by persons versed in their application; that estimates are no substitute for actual cost experiences by public officials; and that estimates cannot and do not reflect total project costs.

The cost data found in the succeeding sections do not cover certain important items in the overall cost of the actual completion of a constructed project. Non-covered items include administrative, engineering, financing and other services, and land costs. These factors should be kept in mind during review of the following costs data.

SEWERAGE AND SEWAGE TREATMENT PROJECTS

The difference between sewerage and sewage treatment plant projects is best illustrated by a comparison of the percentage breakdown of their four major components of construction – material, labor, contractor's plant, and overhead and profit – as shown in TABLE I-1.

TABLE I-1

MAJOR COMPONENTS OF CONSTRUCTION FOR SEWAGE TREATMENT PLANTS AND SEWERS (1970)

Item	Material	Labor	Contractors Plants	and Profit
Sewage Treatment Plants	54.49	25.33	6.45	13.73
Sewers	35.42	18.48	31.30	14.70

Source : U. S. Department of Interior, Federal Water Pollution Control Administration.

The costs estimates for sewer lines installed in trenches (TABLE I-2) includes (a) excavation, (b) cost of pipe, (c) placing and joining of the pipe, and (d) backfilling of the trench. Sheeting and shoring, gravel foundation cradle or encasement of pipe and surface restoration are excluded. The ranges of costs depicted are based on construction cost indexes for July, 1972. It should be understood that the range of prices indicated here are influenced further by the size of the project and the inplace soil characteristics. Definite economics of scale result with larger sewer projects.

TABLE I-2

ESTIMATED AVERAGE UNIT COSTS FOR CONSTRUCTION OF SEWAGE COLLECTION LINES - 1970 (For Illustrative Purposes)

Vitrified Clay Pipe		Asbestos Cement Pipe	
Diameter, inches	Cost/foot	Diameter, inches	Cost/foot
8	$3.87 - $4.82	8	$3.98 - $4.86
10	$6.36 - $7.95	10	$5.23 - $6.54
12	$8.49 - $10.63	12	$6.66 - $8.32
15	$12.78 - $16.02	15	$9.83 - $12.31

Source: Project Staff Estimates.

Consideration should also be given to the type of pipe to be used in a project. Factors such as life expectancy, durability, unit weight, strength and ease of assembly, and inclusion of service connections all influence final cost figures in sewerage projects.

Costs for wastewater treatment facilities are primarily based on the degree of treatment which may be required by regulatory agencies. As the degree of treatment moves from primary to secondary to tertiary, the costs increase correspondingly (FIGURE I-1). 1,8/

Generalized costs for basic wastewater treatment processes are presented in TABLE I-3. The costs for wastewater treatment facilities are also influenced by economies of scale. The possibilities of areas joining together in regionally organized waste treatment projects can be advantageous for communities in proximity to each other. Economies of scale through consolidation of waste sources and the resulting cost advantages are exemplified in FIGURE I-2. 2/

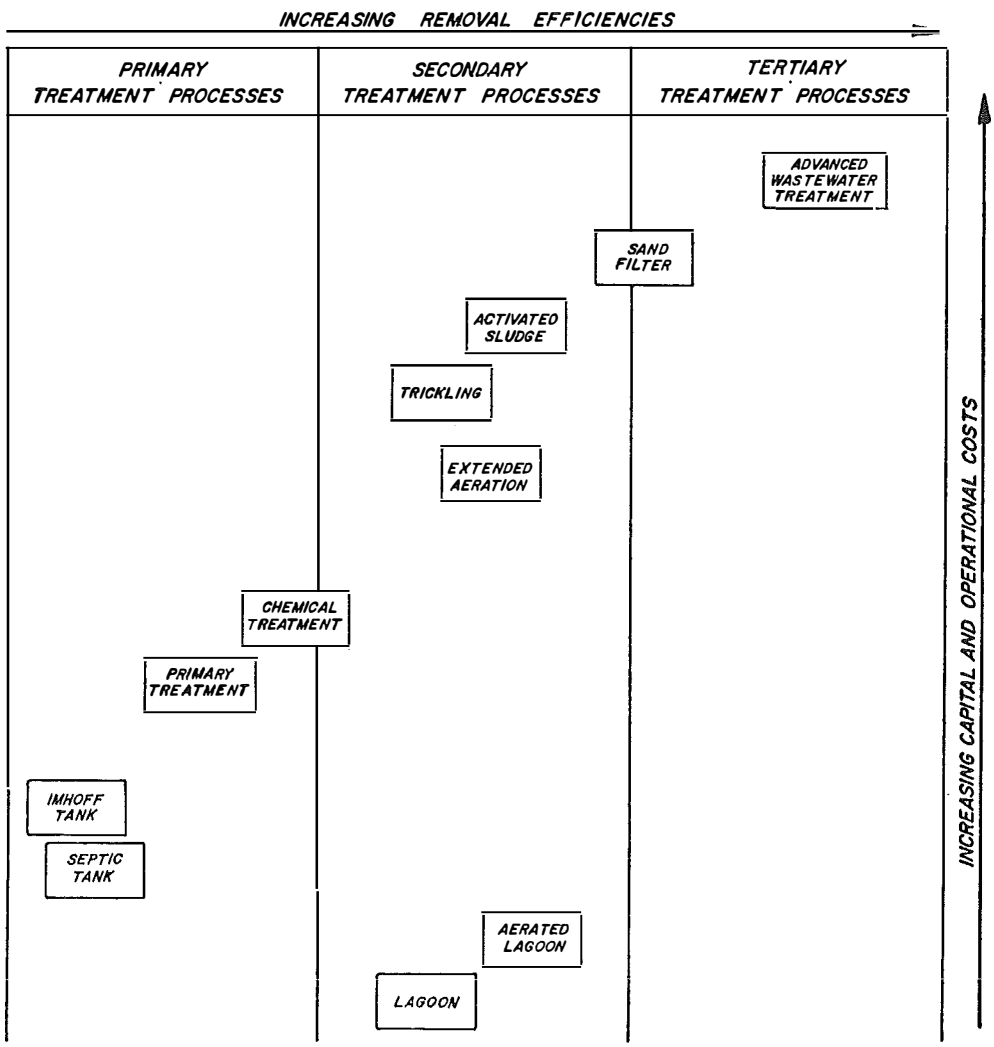

FIGURE I-1. GENERALIZED RANKING OF UNIT COST AND REMOVAL EFFICIENCIES OF CONVENTIONAL WASTE TREATMENT PROCESS.

TABLE I-3

GENERALIZED COST TO SIZE RELATIONSHIPS OF BASIC WASTE TREATMENT PROCESSES

	Million Gallons Per Day Capacity				
	.01	.10	1.0	10.0	100.0
	Construction Cost, $1000*				
Primary		58.7	308.6	1,247.7	6,559.0
Primary, Separate Sludge Digestion		85.2	305.1	1,092.2	3,084.0
Activated Sludge	11.7	70.8	417.3	2,458.9	14,487.6
Trickling Filter		101.8	288.9	1,374.4	5,045.2
Lagoons	6.2	23.4	88.0	330.3	1,080.0
	Annual Operating and Maintenance Charges, $1000's**				
Primary		4.5	19.7		
Primary, Separate Sludge Digestion		5.5	20.6		
Activated Sludge		6.3	31.3	172.3	
Trickling Filter		5.1	18.3	83.3	
Lagoons	0.1	0.6	3.0		

*Source: ~~Modern Sewage Treatment Plants, How Much Do They Cost and Sewage Treatment Plant Cost Index~~ for June 1969.

**Source: R. L. Michels, et al "Operation and Maintenance of Municipal Waste Treatment Plants," Journal of the Water Pollution Control Federation, March 1969. 1962-64 dollars raised to 1968-1969 conditions by use of BLS Craftsmen's median earning, 1968 ÷ craftsmen's median earnings, 1963 x table value.

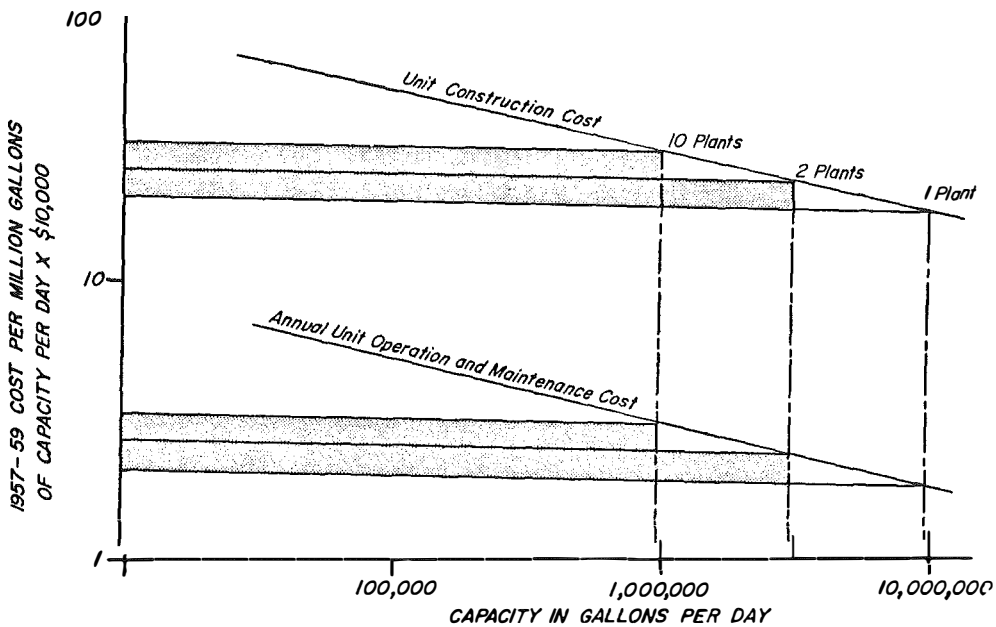

FIGURE I-2. APPLICATION OF ECONOMIES OF SCALE THROUGH CONSOLIDATION OF WASTE SOURCES PRODUCING 10 MILLION GALLONS PER DAY OF SEWAGE'.

WATER SUPPLY AND DISTRIBUTION SYSTEMS

Predicting costs for capital improvements in water systems is difficult, in part because of the variety of equipment and techniques utilized in providing domestic water. Water chemistry and bacteriologic quality of a raw water source also influence total costs related to development of a water supply. Bacteriologic quality of a public water system must adhere to rigid criteria for the public welfare.

The means by which water quality standards are approached is dependent upon the initial characteristics of the water to be used in a water distribution system. These inherent characteristics establish the basic capital costs for water treatment facilities. For well water meeting chemical criteria, captial outlay generally involves pumping equipment, pressure tanks and reservoirs, etc., with provisions for protection against bacteriologic contamination in the system. The larger the distribution system, the more sophisticated chlorination equipment becomes as well as the construction cost.

Well systems have basic operational costs in power consumption for pumps utilized in the system. FIGURE I-3 gives a generalized presentation of pumping costs versus depth to water on the supply end of a system. 3/

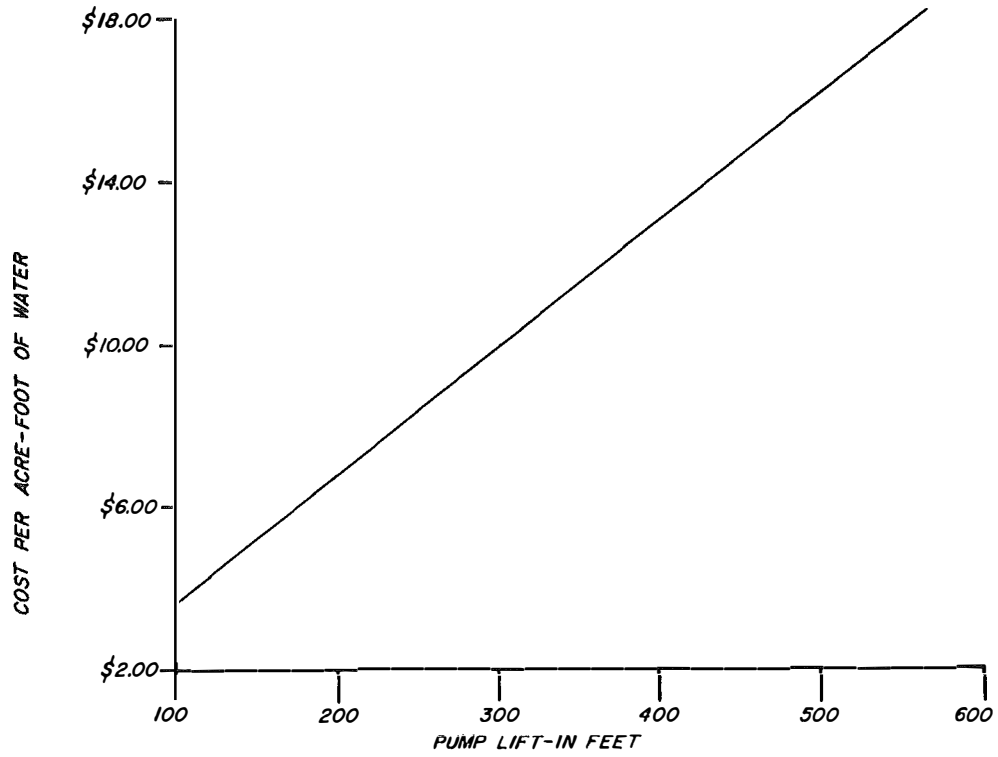

FIGURE I-3. RELATIONSHIP BETWEEN LIFT AND COST PER ACRE-FOOT OF GROUNDWATER PUMPED.

Another major consideration for costs in water systems development is the amortization of equipment to be used. These costs will be reflected in water service rates, particularly if a community is served by a private utility corporation.

The cost of water treatment by coagulation and sedimentation followed by rapid sand filtration for thirty water treatment plants across the country are noted in TABLES I-4 & 5. 9/The costs presented are the result of comparative cost engineering audits made in 1965. (The term "cost engineering audit" means a detailed investigation and analysis of the physical characteristics, the operating data, and the costs of a plant or other operating installation and the presentation of these in a standardized manner so that internal and external comparisons can be made.)

TABLE I-4

WATER TREATMENT PLANT DESIGN FACTORS

Plant No.	Design Capability (Qd) mgd	Year Of Last Major Addition To Plant	Mixing Basin Detention min	Flocculation Basin Detention min	Sedimentation Basin or Clarifier: Detention min	Surface Loading gpm/sq ft	Average Transport Rate fpm	Clarifier Loading gpm/sq ft	Basins Housed or Covered **	Filters Rate gpm/sq ft	Filters Housed or Covered **	Design Manpower man-hr/mg	Days 32° and Below days/year
1	6.00	1959	1.3	30	391	0.651	0.102		o	1.70	o	3.1	11
2	9.00	1953	5.0	30	240	0.313	0.430		o	1.65	½o	9.8	17
3	8.00	1950	0.6	40	283	0.333	0.588		o	1.85	½o	6.6	48
4	6.00	1952	-	65	288	0.366	0.327		o	2.00	h	10.0	33
5	0.500	1953	MI‡	51	305	0.329	0.199		o	1.93	h	48.0	81
6	0.500	1951	MI‡	52	346	0.386	0.221		o	1.93	h	48.0	63
7	0.500	1950	10.0	43	315	0.273	0.144		o	1.72	h	48.0	63
8	0.500	1939	with floc	20	240	0.345	0.184		o	1.93	h	48.0	80
9	6.00	1957	-	57	447	0.225	0.278		o		h	4.0	37
10	0.300	1962	with floc	18	220	0.284	0.251		o	1.64	h	15.0	85
12	12.00	1958	-	17†	206† 81†#	0.290#	0.580		o	3.31	h	2.53	94
13	4.00	1946	MI‡	10	212	0.495	1.16		o	1.96	h	7.5	100
14	0.432	1947	†	†	67†	†		1.59	h	1.85	h	23.1	148
15	12.00	1960	†	†	102†	†	0.161†	1.10	h	1.87	h	5.1	144
17	12.00	1961	with floc‡	23	202	0.778	0.448		c	1.54	h	9.6	144
18	0.300	1948	†	†	47†	†	0.262† 0.262	2.19	h	0.075	c	12.0 7.9	144 144
19	8.00	1946	1.6	33	125	0.702	0.925		o	1.93	½c		
21	7.50	1955	0.7	51	335	0.321	0.127		o	1.94	o	6.8	11
22	6.81*	1955	†	†	102†	†	0.800†	1.18	o	2.00*	c	5.0	65
23	0.576	1938	-	7	327	0.177	0.566		o	1.94	h	42.0	65
24	0.504	1930	MI	22	249	0.326	0.352		o	1.82	h	47.0	83
25	0.504	1937	MI	20	283	0.298	0.340		o	1.82	h	48.0	73
26	0.500	1965	†	†	229†	†	0.092†	0.491	o	1.62	h	28.0	70
27	0.486	1948	1.1	142	6960	0.011	0.033		o	3.00*	h	18.0	70
28	1.00	1964	†	†	280†	†	0.161† 0.427	0.354	o	1.49	o	26.6	66
29	8.00	1958	2.4	39	261	0.457			o	1.95	o	7.9	59
30	6.81*	1955	0.18		102		0.80		o	2.00*	c	5.0	65

*Based on an arbitrary design filter rate as shown.
†Suspended solids contact clarifer.
‡MI signifies mixing basins detention could not be computed because mixing is done in the line. "With floc" indicates mixing basin not separated from floculation basin and floculation detention includes both.
#This plant operates sedimentation basins and a clarifer in parallel. Data applicable to the clarifier are shown in the right hand column. Certain dimensions of the Clarifier were not available.
**Housed, covered, open.
SOURCE: After 9/

The data illustrated in TABLE I-5 can give a general idea of the costs associated with the different operational functions of a water treatment facility.

TABLE I-5

WATER TREATMENT PLANT COSTS

	Investment, ¢/gpd of Qd		Labor			Energy			Chemicals, ¢/lb							
									Coag.		Alkali		Dis-infect.	Taste and Odor		
Plant No.	Adjusted to 1964	Deregion-alized and Adjusted to 1964	Super-visor, $/hr	Operator and Maint. $/hr	General Labor, $/hr	Elec. ¢/KWH	Oil (for heat) ¢/gal	Gas (for heat ¢/Kcf	Alum	Iron Sulfate	Hy-drated Lime Equiv.	Type	Cl	Carbon	$KMnO_4$	$NaClO_2$
1	15.1	16.6	3.64	2.05	1.54	0.92	-	-	2.76	2.60	0.88	h	4.9	9.6	36	
2	-	-	3.99	2.01	1.17	0.77	-	-	2.61	1.81	1.20	h	6.5	-		
3	16.0	17.3	3.72	1.79	1.19	1.71	-	33.3	2.51	-	0.78	q	6.5	-		
4	34.5*	37.3	3.14	2.05	1.24	1.00	-	-	2.43	-	1.19	h	9.6	12.5		
5	-	-	1.91	1.62	-	1.40	-	-	3.40	-	2.90	s	8.7	-		
6	32.2*	32.2	-	1.24	-	1.40	-	-	3.78	-	0.33	h	9.0	-		
7	48.6	48.6	-	1.63	-	1.00	-	-	3.55	-	1.50	h	9.0	-		
8	39.0	42.2	-	1.55	-	2.00	-	-	4.92	-	1.65	h	12.7	-		
9	-	-	2.31	2.26	-	1.04	-	-	2.48	-	1.50	h	4.7	-		
10	65.3	63.7	-	2.03	-	2.00	-	-	4.10	-	3.33	s	13.0	12.0		
12	5.6	5.5	5.50	3.38	-	1.00	-	-	4.79	-	4.55	c	3.7	-	32	
13	10.4	10.1	3.03	2.84	-	1.30	-	-	2.58	-	1.10	h	7.0	10.0		
14	54.9	47.0	2.70	1.83	-	1.90	15	-				none	17.5	-		
15	18.0*	17.7	11.10‡	3.19	-	0.77	9.6	705#	2.56	-	-	none	5.4	-		
17			4.70	2.84	2.23	0.69	10.5		2.68	-	-	none	7.9	-		70
18	30.1	29.5	3.08	2.62	2.15	2.00	16.9		4.1	-	-	none	12.5	-		
19	14.0	13.7	3.32	3.05		0.91	9.9		2.37	-	-	none	5.6	11.6		70
21	12.5	24.6	4.47 =	3.14	2.07	0.89		76		2.60	0.54	q	4.9	7.5	40	
22	12.5	13.7	1.91	1.70	-	0.70	-		2.92	-	1.27	h	8.2	14.7		
23	-	-	1.93	1.93	-	1.33	-	-	3.25	-	1.70	h	13.5	12.2		
24	21.8	23.8	1.51	1.38	-	-	-	-	4.10	-	3.80	s	12.5	-		
25	29.0	30.0	-	1.55	-	-	-	-			-	h		-		
26	28.4	31.0	-	1.72	-	1.20	-	-	4.00	-	3.50	h	13.5	-		
27	37.6	41.2	-	1.72	-	1.20	-	-	4.00	-	3.50	h	13.5	-		
28	24.8	27.1	1.93	1.70	1.54	1.04	-	30	3.35	-	0.80	h	13.5	-		
29	20.7	22.6	3.74	2.18	1.92	0.91		47	2.34	-	1.23	h	4.8	13.6		
30			1.91	1.70	-	0.70	-	-	2.92	-	1.27	h	8.2	14.7		

*The cost of a pipeline of length to constitute and appreciable fraction of plant plus pipeline cost was estimated from author's data and removed from total cost.

†A raw water pump station exists but costs for it were not obtainable. Quantity shown is for cost of plant plus pump station estimated.

‡Plant at present operating without a supervisor, but this role is filled by a consultant. The rate shown is the consultant's rate.

#Plant uses LPG and price is per liquid cubic foot.

SOURCE: After 91

SOLID WASTE MANAGEMENT

One of the most popular means for control of solid wastes is the sanitary landfill. Other forms of processing or disposal are, incineration, composting, salvage and reclamation and open burning. Land filling and salvage operations appear the best suited operations for environmental control and service to small communities.

Sanitary landfills have the advantages of being inexpensive and applicable to a wide variety of terrain. Land requirements are the only limiting factor for use of this form of disposal. Sanitary landfills have relatively low capital outlay and cost of operation and are traditionally accepted by the public. They are adaptable and flexible to accept a wide variety of wastes of varying composition and amount with no pretreatment required.

The cost of a sanitary landfill consists of the initial investment for land, equipment, and construction features, and the operating costs.

The magnitude of the initial investment depends on the size and sophistication of the landfill. A typical breakdown of the major items that normally constitute the initial investment is as follows:

1. LAND

2. PLANNING AND DESIGNING

    a. Consultant
    b. Solid Wastes Survey
    c. Site investigation
    d. Design, plans, & specifications

3. SITE DEVELOPMENT

    a. Land development -- clearing, landscaping, drainage features, etc.
    b. Access roads
    c. Utilities – water, electricity, telephone
    d. Fencing, signs

4. FACILITIES

    a. Administration
    b. Equipment maintenance
    c. Sanitation
    d. Weight scales

5. EQUIPMENT -- TRACTOR, SCRAPER, ETC.

Generally, the major portion of the initial investment is for the purchase of the land and equipment. Often a sizable part of the initial investment for land and equipment can be recovered through the development or use of the land and the salvage value of the equipment or recycling of waste materials such as metals and glass.

If funds are not available for the proposed investment, consideration should be given to leasing land or equipment, or both, to spread the cost over the life of operation.

The operating cost of a sanitary landfill depends on the cost of labor and equipment, the method of depreciation, and the efficiency of the operation. The principal items in operating cost are:

1. PERSONNEL

2. EQUIPMENT

    a. Operating expenses -- gas, oil, etc.
    b. Maintenance and repair
    c. Rental, depreciation, or amortization

3. COVER MATERIAL -- MATERIAL AND HAUL COSTS

4. ADMINISTRATION AND OVERHEAD

5. MISCELLANEOUS TOOLS, UTILITIES, INSURANCE, MAINTENANCE TO ROADS, FENCES, FACILITIES, DRAINAGE FEATURES, ETC.

Wages ordinarily make up about 40 to 50 percent of the total operating cost. Equipment equals 30 to 40 percent; cover material, administration, overhead, and miscellaneous amount to about 20 percent.

Operating costs per ton versus the amount of solid wastes handled in tons and the population equivalent may be charted (FIGURE I-4). Operating costs for a small sanitary landfill handling less than 50,000 tons per year varies from $1.25 to approximately $5.00 per ton. This wide range is primarily due to the low efficiency of the smaller operations which are usually operated on a part-time basis.

Full-time personnel, full-time use of equipment, specialized equipment, better management, and other factors that lead to high efficiency are possible at large sanitary landfill operations. The increased efficiency results in lower unit cost of disposal. The unit cost of a large landfill handling more than 50,000 tons per year will generally fall between $1.25 to $2.00 per ton.

To compare the true cost of sanitary landfilling with that of incineration or composting, it is essential that the costs and returns of the initial investments and the hauling costs of a collection system that uses the sanitary landfill disposal method may be higher than the hauling costs of a system using incineration or composting, since sanitary landfills are generally located farther from the waste-generating area than are incinerators or compost

plants. A sanitary landfill, however, may increase the value of a plot of unusable land by converting the site to a playground, golf course, park..., thereby obtaining a major investment cost advantage over incineration and composting.

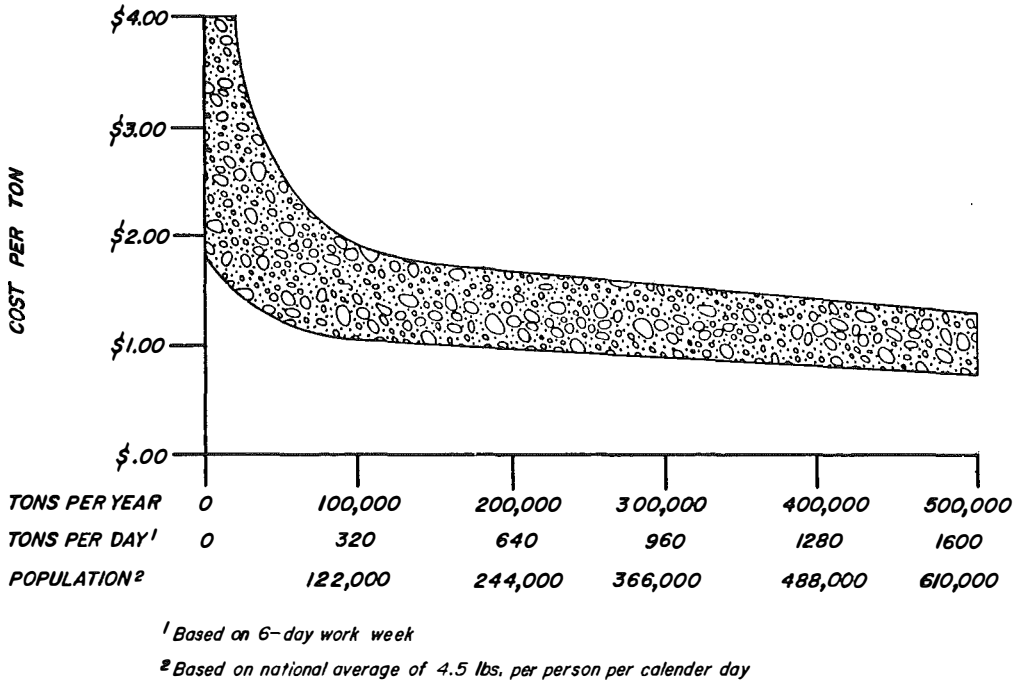

FIGURE I-4. SANITARY LANDFILL OPERATING COSTS

CHAPTER II. FINANCING ENVIRONMENTAL SERVICES

INTRODUCTION

The intent of this chapter is to acquaint community officials with the different means available for financing environmental services systems. The descriptions are meant only as references and not as a substitute for either the opinions of city and county attorneys, the advice of qualified federal program specialists or bond council.

Local communities have found it necessary to construct improve and expand their water and sewer systems, sewage treatment facilities, and solid waste disposal facilities. However, due to the growing complexities of municipal and county finance, careful examination must be made of the various sources of funding to insure that each dollar is spent cost effectively.

BONDING

Cities and towns often find it necessary to incur a large debt to finance capital improvements, i.e., water and sewage facilities. The state has authorized incorporated cities and towns to issue various kinds of bonds to finance this debt. There are a number of bond types which can be used for financing capital improvements for environmental systems. Examples are: general obligation bonds, revenue bonds and special improvement bonds.

General Obligation Bonds

The most common method of bonding for municipal purposes is the general obligation bond. These bonds are retired from revenues generated from property taxes, which are part of the municipalities general revenue sources. These bonds are often referred to as "full faith and credit" bonds because they are guaranteed by the taxing authority of the issuing governmental unit.

Because these bonds are backed by the taxing powers of the issuing governmental body and are based on municipal revenues for retirement, the local government is limited to the amount of debt incurred and the interest rate paid. The Arizona Revised Statutes (ARS) allow a maximum interest rate of nine percent per annum. Also, the amount of debt incurred with general obligation bonds cannot exceed four percent of the total assessed valuation of the taxable property.5/

This type of bonding is generally not encouraged for water and waste disposal projects. The debt limit as defined by the Arizona Revised Statutes is often very low for small communities. This type of bonding is usually reserved for other types of capital expenditures which cannot be financed by other forms of bonding or federal assistance.

Communities may find that mixing general obligation bonds with revenue bonds can be advantageous in marketing the bonds and acquiring federal backing. This is a decision which is dependent upon the bond market, current interest rate and the community's financial planning.

Revenue Bonds

Revenue bonds are used to finance revenue generating facilities. This form of bond is secured by the revenues of the facilities for which they were issued. If these revenues are not sufficient to repay the bonds, the related governmental unit is not obligated to provide tax revenues for the repayment. Because these bonds are not secured by the taxing power of the government, they usually bear a higher interest rate than general obligation bonds.

A lower interest rate may be achieved through the assistance of federal insurance and support. The Federal Government (in the case of rural areas the Farmers Home Administration) will buy issues which cannot be sold at a reasonable rate of interest. These issuing communities must meet specific conditions to qualify for support, one of which is that the project will reduce the user costs for required services to a level equal to the average of the surrounding communities.

Issuance of revenue bonds are authorized for specific purposes, including electric, water, gas, transportation waste disposal systems, and airport and off-street parking facilities. Revenue bonds do not have to meet the debt limitation required for general obligation bonds. They do have to meet the following statutory requirements; they must be approved by a majority of the voters in a referendum; they must mature within thirty years of the date of issue; they may not bear an interest rate over nine percent and may not be sold for less than par. 6 /

Special Improvement Bonds

Special improvement bonds are issued to finance capital improvemetns on projects such as streets and sewers. The bonds are secured by assessments levied against the properties which are receiving benefits by the improvements. 6 /

SPECIAL DISTRICTS

Special Improvement Districts

There are two types of special districts which may be formed to finance environmental improvements. The first is the Special Improvement District. This type of district is formed by the County Board of Supervisors for a defined geographic area and for special functions. The creation of a special improvement district is easy and straightforward, however, each district has its own set of required procedures for initiation. 7/ To determine what functions each special district may perform and the required procedures for delineation, a review of the appropriate statutes and legal precedent should be carried out.

Special Assessment Improvement District

The second type of special district is the special assessment district. This is the common method of financing required capital improvements, especially for small areas. 7 /The basic premise of this type of district is that the individual properties receiving the primary benefits of the improvement should pay for the improvement. An improvement district may be formed by a city or town council by its own initiative or by petition of the local property owners.

FEDERAL GRANTS AND LOAN PROGRAMS

The Federal Government has a multitude of programs for assisting local governments in financing public facilities. There are five federal agencies which make monies available specifically for water systems and waste disposal facilities.

Rural communities with a population of up to 5,500 are eligible to receive federal assistance from the U.S. Department of Agriculture, the Farmers Home Administration (FHA). FHA provides assistance in the form of loans and grants and technical assistance to rural communities, nonprofit organizations, new towns, and under special conditions, responsible land developers. Eligibility and grant approval is on an individual project basis within the guidelines established by the administrating agency. (See TABLE II-1.)

Communities in excess of 5,500 population must apply to HUD for federal community services assistance. Also included under HUD's jurisdiction are councils of government, counties, special districts, state and nonprofit organizations serving urban communities.

To encourage the expansion and development of a designated areas' economy, the Economic Development Administration (EDA) of the Department of Commerce also provides grants and loans for water and waste disposal facilities. To qualify, a state, county or community must be designated an economic redevelopment district or area. In certain cases, these EDA grants can be used to supplement other federal grant-in-aid programs which may be received by the applicant.

The Environmental Protection Agency (EPA) provides grants for the development of solid waste disposal projects which demonstrate new techniques of disposal or recycling. At the present time, Arizona does not have a state agency designated to administer this program nor a statewide solid waste disposal plan. The EPA also administers grants for the construction of sewage treatment facilities and outfalls which are needed to prevent inadequately treated sewage from being discharged into the environment.

TABLE II-1 provides an overall outline of the federal programs available to assist rural communities in procuring the basic environmental services facilities required by their residents.

TABLE II-1

MAJOR FEDERAL AID PROGRAMS UTILIZED FOR PROVIDING ENVIRONMENTAL SERVICES*

Program Title	Authorizing Legislation	Administering Agency	Program Description
Rural Water & Waste Disposal Assistance	Consolidated Farmers Home Administration	Farmers Home Admin., U.S. Dept. of Agri. Andrew J. Mayberry Rm.6026, Federal Bldg.,230 N. 1st Ave., Phoenix Arizona 85025	Loans, grants & technical assistance are made available to towns under 5,500 population or profit & non-profit organizations for the engineering, construction, repair or expansion of domestic water, sewage treatment & solid waste disposal facilities.
Public Works Planning Advances	Section 701 Housing Act	Community Resources Develop. Admin., Dept. of Housing & Urban Development 2500 Wilshire Blvd. Los Angeles California 90056	Interest-free advances are to states, municipalities & other public bodies to aid in financing the engineering & architectural design work which is preliminary to the construction of a public works project.
Advance Acquisition of Land	Section 704 Housing & Urban Dev. Act	Community Resources Dev. Admin., Dept. of Housing & Urban Dev., 2500 Wilshire Blvd., Los Angeles California 90056	Grants for interest charges on funds borrowed to provide for the propitious acquisition of land needed up to five years in advance of public works projects.

TABLE II-1 (Continued)

Program Title	Authorizing Legislation	Administering Agency	Program Description
Public Works & Econ. Dev. Facilities	Public Law 89-136 Title II	Economic Dev. Admin., Dcpt. of Commerce 522 N. Central Phoenix, Arizona 85025	Grants up to 50% of project costs & loans up to 100% of land acquisition & improvements for public works and service facilities to encourage industrial or economic expansion. Only projects designated "redevelopment areas" eligible.
Basic Water & Sewer Facilities Grants	Section 702 Housing & Urban Dev.	Community Resources Dev. Admin., Dept. of Housing & Urban Development 2500 Wilshire Blvd. Los Angeles, Calif. 90056	Direct grants up to 50% of the cost of land & construction are made to assist communities in the construction of basic water & sewer facilities, excluding sewage treatment, necessary to improvement of health and living standards.
Public Facility Loans	Title II Housing Admendments of 1955	Community Resources Dev. Admin., Dept. of Housing & Urban Development 2500 Wilshire Blvd. Los Angeles California 90056	Long-term, low interest loans are made to finance local public works projects where credit is not otherwise available on reasonable terms.

TABLE II-1 (Continued)

Program Title	Authorizing Legislation	Administering Agency	Program Description
Grants for Waste Treatment Works Construc - tion	Section 8, FWPC Act 33 U.S.C. 466 et seq	Environmental Protection Agency c/o Ariz. State Dept. of Health, Water Supply and Water Pollution Control Div. Bob Follett 4019 N. 33rd Ave. Phoenix, Arizona	Grants are made to states & municipalities to assist in the construction of waste treatment works, including outfall & Interceptor sewers, which are needed to prevent discharge of inadequately treated sewage.
Solid Waste Disposal	Solid Waste Disposal Act	Bureau of Solid Waste Management, Environmental Protection Agency 100 California St. San Francisco California 94101	State and local agencies may receive grant support for demonstrations relating to the application of new or improved methods of solid waste collection, storage, processing & ultimate disposal.
Grants & Loans Waste Treatment Works, Solid Wastes Planning, Pollution Abatement, Planning Grants Water Improve - ments	Rural Development Act of 1972	Farmers Home Administration	Grants and loans made to rural communities for essential environmental services.

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5. Constitution of Arizona, Article IX, Sec. 8 and ARS 35-451 through 475.

6. Arizona Revised Statutes 9-521 through 9-540.

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SECTION III

CHAPTER I. POPULATION PROJECTIONS METHODOLOGY

In this study, population projections are presented for the county and all well-defined communities with less than 5,500 residents. In general, county projections are easier to make, and wider choice of method is available than for communities. A lengthy time series is available for Arizona county populations and these data are sufficient to lend themselves to several different approaches for population projections. Community data, however, are quite often difficult to find, and this limitation constrains the choice of projected population methods that can be utilized. For these reasons, different methodological approaches are used for the county and the community level.

COUNTY POPULATION PROJECTIONS

The method used to project county population growth was based on a ratio of the county population to the state total. The method is explained below with Graham County used as an example.

TABLE I-1

GRAHAM COUNTY POPULATION PROJECTION

Year	Arizona Population	Graham County Population	County as a % of State	Annual Average Rate of Growth
1950	749,857	12,985	1.73	-4.6
1960	1,306,161	14,045	1.08	-1.48
1970	1,777,482	16,578	0.93	-0.98
1975	2,081,500	18,525	0.89	-0.48
1980	2,381,500	21,195	0.89	-0.15
1990	3,108,500	27,355	0.88	

Table I-1 shows the data used to project Graham County's population. The first row shows the population of the state and below that is the population of Graham County. The third row shows Graham County's population as a percent of the state's and the fourth row shows at what rate that ratio has declined over time. For instance in 1950 Graham County had 1.73 percent of the state's population and by 1960 it had only 1.08 percent.

Over the ten-year period, Graham County's share of the total state population declined at an average annual rate of -4.82 percent per year. Likewise, the rate of decline of the county's share of state population between 1960 and 1970 was -1.48 percent per year. That is, the ratio of the county's population of the state still declined, but not as fast as it did from 1950 to 1960. The projected annual average rate of growth of the ratio between 1970 and 1975 is -0.98 percent per year and seems to be in line with the past trend. If the ratio between 1970 and 1975 does decline at this annual rate (-0.98 percent per year) then in 1975 Graham County will contain 0.89 percent of the state's population as seen in row three, column four. That percent is then applied to the projected state population for 1975 to get a county projection for that year of 18,525. (The state population projection has previously been made by the U.S. Bureau of Census.) The same method is then used to project the county's population for 1980 and 1990. One final refinement is then made. After each county's population was projected in the above manner, the projections were forced (proportionally increased or decreased) to sum to the projected total for the state.

COMMUNITY POPULATION PROJECTIONS

Small Arizona communities for which good population time series are available seem to be the exception rather than the rule. Payson, for instance, is one of the communities under study in Gila County and a Payson population projection is required. However, no census population data have ever appeared for that particular community, thus eliminating the use of the ratio method in projecting Payson's population. Other communities, for which good historical data are available, have demonstrated wide population swings in past years and there often appear to be no close relationships between the community population and the county. Once again, the ratio method is inappropriate.

The method that has been chosen for community population projections is based upon annual average growth rates. Where a good community time series is available, the annual average rate of growth over the previous twenty years is calculated. If there are no apparent factors that are expected to cause the community to deviate from that rate, then the population is simply extrapolated into the future using the historical rate. If dynamic factors are apparent that can cause a significant deviation from past trends, then the judgment of the researcher is required to anticipate the magnitude and direction of these changes. There is no "formula" available to accomplish this, and often times local knowledge, plans and judgment are the most important factors in the projection. Judgment is usually preferable to a strict adherence to a rigid methodology.

Judgment also plays an important role in projecting population for a community such as Payson. Where no officially documented current population data are available, estimates by local sources (banks, utilities, post offices, etc.) are used as a base. If no past trends are available to indicate future growth, then judgment is again called for and potential growth rate that seems appropriate for the community must be selected and extrapolated to the future. Again this rate is based upon knowledge of local resources and plans for development.

Rates of growth based upon the above method are designated the medium projection and are thought to be the most probable. But, since a high degree of error is possible, a projection range is desirable. By reviewing the historical growth of a cross section of

small Arizona towns, it appears that the growth rate for a short period (ten years, for instance) may deviate by as much as two percentage points from the long-term growth rate. Thus a community may have increased in population at an annual rate of growth of four percent per year over a thirty-year period. But in one particular decade of that period it may have increased as little as two percent per year or as much as six percent. This range of plus or minus two percent could, then, be taken as the high and low projections for the community and the probability should be quite high that the actual future population will fall somewhere in that range. The problem is that by ranging the high and low projections by plus or minus two percent from the median rate, the resultant projections are so wide as to be practically meaningless. An alternative range was therefore chosen.

The majority of the small communities in the state have not exhibited deviations significantly greater than plus or minus one percentage point in terms of the annual average rate of growth. The exceptions are those that annexed large numbers of persons in a particular decade and those that either gained or lost population due to dramatic changes in employment opportunities. But, it is felt that these types of dramatic population changes cannot be accurately incorporated into a twenty year projection. Therefore, the range of plus or minus one percent is utilized herein.

CHAPTER II. EMPLOYMENT PROJECTION METHODOLOGY

In this study, an employment projection has been prepared for the county on an industry by industry basis for 1990. The projection of total-employment in Pima County is related to the 1990 median population and labor force projections. The labor force is projected as a percentage of the population. In this case, the labor force participation rate is increased from 36.5 percent of the population in 1970 to 38.0 percent in 1990 in accordance with established trends.

The percent of the population which might be unemployed was applied to the projected civilian work force to obtain an estimate of unemployment. A 3.0 percent unemployment rate was used which assumes full employment in the economy. This results in a projection of 221,308 total employment in Pima County in 1990.

The distribution of employment among the broad industry groups is based primarily on the 1967 through 1970 trends of employment data by industry and thy 1950-1958 labor earnings distributions. However, knowledge of local plans and conditions and the judgment of the analyst have been used to modify statistical trends.

The finance, insurance, real estate, transportation, communication and public utilities industries reflect a reasonably stable employment to population ratio; therefore, the ratio is projected forward with some confidence. In the case of trades, services, and government, the absolute increase obtained through the approach is modified to provide what is believed to be a reasonable estimate in the judgment of the researchers as related to changes occurring in the economic structure. In the remaining sectors, mining, manufacturing, contract construction, and agriculture, dynamic factors were apparent from the industry analysis which are certain to cause significant deviation from 1967-70 employment trends. Both mining and manufacturing were increased significantly to reflect increased relative importance of both sectors. The proportion of employment in contract construction was decreased to make allowances for the boom presently occurring in Tucson. This modification still projects an increase in absolute employment to meet the demands of a bigger population. Agricultural employment was decreased absolutely to reflect developments projected to take effect in the sector by 1990.

CHAPTER III. PROJECTION METHODOLOGIES FOR WATER SUPPLY DEMANDS AND SEWAGE PRODUCTION LEVELS

GENERAL DISCUSSION

Good management and design of water-supply and wastewater treatment systems demand a knowledge of the volumes and flows involved and their relation to population and time. An idea of water demands is obtained by review of past and current rates of water use stated in terms such as gallons per day per capita or gallons per day and month, etc. The per capita and related figures generalize the experience and are, therefore, useful in comparing the use records of different communities and in estimating future needs of individual communities and areas (county).

The quantities of water delivered in North American Communities tend towards values shown in TABLE II - 1, but with wide variations, because of differences in (1) climate, (2) standards of living, (3) extent of sewerage, (4) type of commercial and industrial activity, (5) cost of water, (6) chemical quality of water, (7) distribution system pressures, and (8) irrigation practices.

TABLE III-1

NORMAL WATER CONSUMPTION

	Quantity, gpcd*	
Class of Consumption	Normal Range	Average
Domestic	15-70	50
Commercial & Industrial	10-100	65
Public	5-20	10
Water Unaccounted for	10-40	25
TOTAL	40-230	150

*Gallons per capita per day.

Source: Fair, G.M.; D.A. Okun, Water and Wastewater Engineering, Volume 1, Water Supply and Wastewater Removal, 1966, John Wiley and Sons.

The "normal range" of variations noted in TABLE I - 1 are complicated, with respect to projecting future needs, in that water use practices of people over time have been increasing. 1,2 /

Concomitant to water use will be the production of sewage wastes. These wastes are disposed of by some form of individual facility or, if available, in a sewage collection system. The quantities of wastewaters produced are related to the factors stated above with the exception of irrigation practices. Sewage flows are usually 60 to 70 percent of domestic water use rates and sometimes greater where sewage collection systems are relatively new and moderate climates prevail. 3,4 /

SPECIFIC PROCEDURES

Future water demands for small rural communities were based on review and analysis of current and past water use data obtained through public works directors or private water utilities. Data obtained for long periods of time were considered as most reliable, while, in some cases, where limited amounts of data were available, generalizations had to be made. Water use for a years time and the variations for the time of year were tabulated. From this information, each month of the year was quantified as a percentage of the maximum month of water use which in all cases occurred during the summer. From these monthly percentages an average was obtained for the year's average monthly use which for most areas surveyed, was in the range of 60 to 80 percent of the maximum month.

From the maximum and minimum month consumption data, which corresponds basically to the summer and winter periods of the year respectively, per capita water consumption rates were calculated. These figures were calculated for each year in which past data were available. Those communities with long series of data, i.e., 10 years, indicated an increasing trend in per capita water use. In some cases where a definable industrial sector of economic activity was present, the increasing trends for domestic water use were, in a sense, overshadowed by the industrial water use rates. For example, the community of Fredonia, Arizona has an industrial classed water user which demands 1,600,000 gallons of water per month while residential classed users demand an average of 18,500 gallons per month.

Considering the increasing trends exhibited by the rural communities under study and information derived from a limited literature review, an assumption of increasing per capita water use amounting to an average of two (2) gallons per capita per year was used in this report.

Although there are definite possibilities of variation in this figure, depending on the local situations, it was felt that for rural areas with populations less than 5,000, two (2) gallons per capita per year is indicative.

Determination of present per capita water use rates and the expansion of these rates to the years 1975, 1980 and 1990; and then multiplying by the population projections for the area results in projected water needs for the respective years above.

Determination of county needs for the years 1975, 1980 and 1990 were obtained by averaging the per capita summer and winter demands for all areas of development in the county. In Coconino County for example, water use rates for the community of Flagstaff were included in the determination of present average county per capita water uses. These figures were again expanded by use of the two (2) gallons per capita per year and multiplied by the residual population figures determined by subtracting from the projected total population figures for the county, the population of selected communities outlined individually. A summation was then carried out to arrive at a total county demand estimate for water supply capabilities. These figures were developed in terms of total yearly water needs in acre-feet.

Sewage production rates levels were assumed proportionate to the domestic water use rates. Sewage flows during winter within an individual community were estimated as being 70 to 75 percent of the water used. Summer sewage flows were estimated at 60 - 65 percent of the water used in the community. 4 / The lower percentage during summer months is indicative of more fresh water used for irrigation and cooling purposes which would correspondingly decrease the contribution to sewage flows by residents of an area.

CHAPTER IV. PROJECTION METHODOLOGY FOR SOLID WASTES PRODUCTION LEVELS

GENERAL DISCUSSION

The measurement of rates of solid wastes production for rural areas in Arizona have never been attempted. Some studies have been prepared for the major metropolitan areas of Arizona on solid waste disposal problems and rates of production. Smaller urban areas and rural communities in Arizona have not been a part of any form of study related to defining disposal problems and techniques or actual rates of waste production.

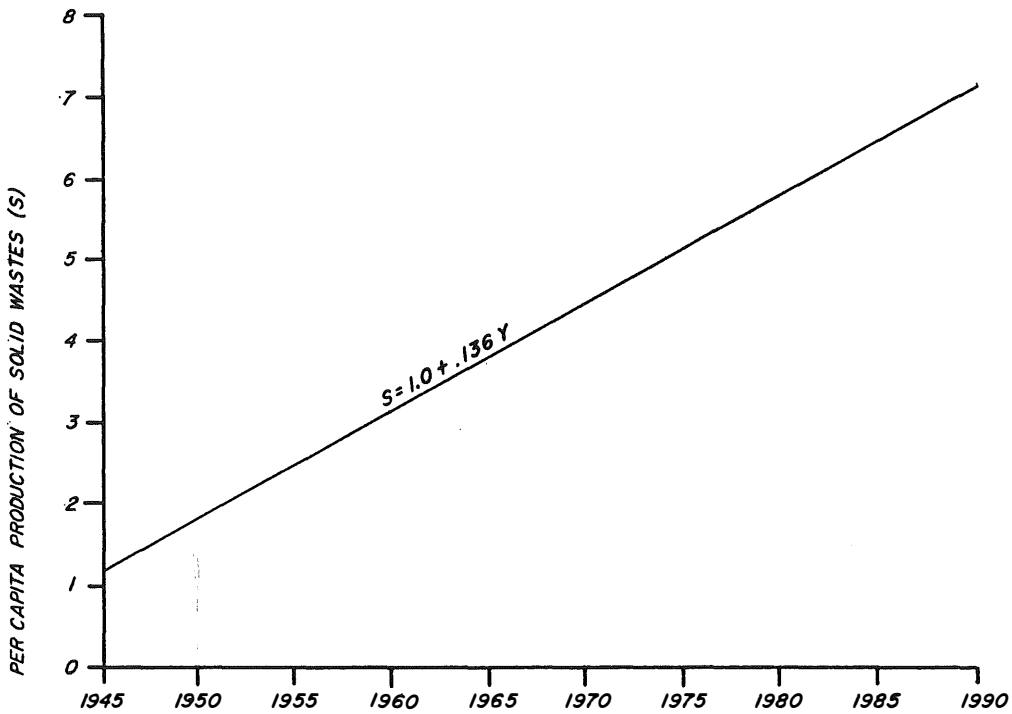
Generally solid wastes are defined as those materials that are solid or semi-solid consisting of refuse, garbage and rubbish. Solid wastes and by-products related to their breakdown constitute one of the forms of environmental pollution that is growing at an alarming rate. It is estimated that per capita quantities of garbage produced in the 1970's will increase 50 percent and that by the 1980's production is estimated to double. 5.6 /

SPECIFIC PROCEDURES

As no valid indicators of solid waste production levels were available with which to quantify levels of production, a literature review was undertaken to develop per capita solid waste production figures. Articles and publications were reviewed which made some reference to rural areas or small communities. Waste production levels on a per capita basis were used to develop an equation which would give an idea of the future solid waste production levels and the anticipated increasing trends.

FIGURE IV - 1 depicts the increase of per capita solid wastes production levels according to the equation indicated which was obtained from regression analysis of data for the 23-year period from 1946 to 1968.

Production levels in tons per year outlined for individual communities and county totals were obtained by multiplying population figures by the per capita production levels obtained from FIGURE IV - 1 for the respective projection years.



S = Solid wastes production, lbs. per capita per day

Y = (A - 1945)

A = Year for which "S" is to be determined from 1946 thru 1990

FIGURE IV-1. PER CAPITA SOLID WASTES PRODUCTION LEVELS FROM 1946 TO 1968 AND PROJECTIONS TO 1990.

Source: Reference 5 through 21.

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