WES BGS
TCC JDW
DWS DRL
REF PCB
DAG SGE
JGL JLB
MGA PSO
LM

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STATE OF ARIZONA

ENVIRONMENTAL SERVICES NEEDS STUDY for Apache County

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Planning Division • Office of Economic Planning and Development

STATE OF ARIZONA

APACHE COUNTY

ENVIRONMENTAL SERVICES NEEDS STUDY

1970-1990

Prepared by

PLANNING DIVISION

OFFICE OF ECONOMIC
PLANNING AND DEVELOPMENT

June 1974

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financed in part through a 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 of 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 Apache 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 or 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 program administered by the Farmers Home Administration (FHA) to aid 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 the county. 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 facilities and services in rural areas of Apache County. The projection of future needs is based upon an analysis of natural resources social and economic conditions, present and future general land use patterns, and existing environmental service facilities within the county. This projection is of a dual nature, focusing at both the community level and the county level. In reviewing environmental service needs, it is intended that this report will be of value as a preliminary study to other more specific planning and engineering studies, and eventually to the development of projects to meet these needs.

Water demands in Apache County for domestic purposes is currently estimated at 3,300 acre-feet of water per year. Delivery of this water to the public is presently carried out by 68 water utilities (TABLE II-13). Of these utilities 33 percent are investor-owned and operated systems, which are primarily associated with private land development activities, i.e., trailer parks, subdivisions, etc. The locations of existing water systems are noted on PLATE 3, CHAPTER II.

Future water supply demands which will be placed on all these utilities are estimated to range from 3,458 to 3,716 acre-feet per year by 1975; from 3,861 to 4,165 acre-feet per year by 1980; and from 5,916 to 6,384 acre-feet per year by 1990. These increasing demands will result, depending on rates of growth in respective areas, in varied modifications, expansions and incorporations of new water supply equipment in all utility systems found in the county.

Future water supply demands will correspondingly place increasing demands upon the available water resources of the county. Future availability of surface water resources are difficult to estimate due to involved water rights. Groundwater reserves for the area of the county contained within the Little Colorado River sub-basin of the state are adequate as potential sources of water.

Considering the above along with factors of climate, topography and soil characteristics in general, water resources appear adequate to meet the future domestic water demands of the county. It should be noted that no effort has been made to define or assess the water needs of agricultural or industrial interests within the county, whose demands exceed domestic demands by a sizeable margin. The availability, as well as the quantity of water resources should also be considered. Such factors as topography and dropping water tables will present problems to water utilities attempting to augment their existing supplies with new well or surface water sources.

Corresponding with the increase in domestic water demands will be the increased production of sewage wastewaters. At present, the smaller rural areas of the county have marginal needs for centralized sewage collection and disposal facilities. However, as these rural areas develop there will be more need for such systems.

Currently, sewage wastewaters are generated at an estimated rate of 1,800 acre-feet per year. Approximately 12 percent of this quantity originates in the towns of St. Johns, Eager and Springerville where it is treated and discharged into the Little Colorado River. The remaining portion of these wastewaters is treated by septic tank systems. Ultimate disposal of septic tank effluents is achieved through percolation and seepage into underlying groundwater reservoirs.

TABLE II-15 provides an inventory of existing wastewater treatment facilities in Apache County. The communities noted above will experience the earliest need for expansion and/or modification of existing treatment facilities as the result of increasing sewage flows (PLATE 3). Sewage production levels are projected to range from 1,825 to 1,903 acre-feet per year in 1975; from 2,184 to 2,358 acre-feet per year in 1980; and from 3,270 to 3,524 acre-feet per year in 1990. It is estimated by 1990 that 80 percent of the sewage wastes will originate in communities having centralized sewage collection and disposal facilities.

The production levels of refuse, garbage and other forms of solid waste will increase as a result of population growth in Apache County. Currently, solid waste materials are produced at an estimated rate of 18,000 tons per year. The largest part of this tonnage finds its way to dumpsites located in the county (PLATE 3).

The primary method of waste control at all but one dumpsite is open burning. The one dumpsite is operated as sanitary landfill on a full-time basis. All other dumpsites receive periodic maintenance by county road crews and often maintenance is provided on a sporadic, or as the need arises, basis. This type of management may be sufficient for the present, but full-time management of solid wastes disposal sites will become increasingly important in future years.

Solid waste production levels will range from 19,904 to 22,254 tons per year in 1975; from 24,504 to 26,510 tons per year in 1980; and from 36,963 to 40,054 tons per year in 1990. The citizens of Apache County would be benefited by a coordinated county-wide program of solid waste management. This would involve the establishment of regional sanitary landfill sites with regularly scheduled inspections and maintenance. Planning for regionally located sanitary landfills with associated salvage operations serving all areas of the county would be basic to an effective solid waste management program.

Review of the information contained in this report leads to the general conclusion that Apache County could have problems related to the proper and timely development of environmental services. This appears evident from the standpoint of existing needs. Assuming that problems will occur with respect to providing future environmental services and that these problems are best handled on a local level, the creation of a separate county agency or department, having jurisdiction over the development and control of all environmental services would facilitate the development of such services. Such an agency would also simplify the administrative procedures and problems inherent in the development of environmental services projects in the future.

CHAPTER II. COUNTY PROFILE

This chapter presents a profile of the physical characteristics, social and economic conditions, and land use and ownership patterns of Apache County. The physical structure of the county is discussed in terms of topography, geology, vegetation and climate. Natural resources are considered with respect to their supply, accessibility and quality. The review and analysis of social and economic condition includes projections of population and economic growth for the county as a whole are then utilized in the projection of environmental services needs of the county, and of the individual communities outlined in CHAPTER III.

HISTORICAL PROFILE

Apache County was created out of the eastern two-fifths of Yavapai County on February 24, 1879. Before this division, Yavapai County included, roughly, the northern half of that part of the state which lies east of Yuma and Mohave Counties. In 1881, part of the southern Apache County between the Black and Gila Rivers was cut off to form part of Graham County and later, in 1895, the remainder of Apache County was nearly halved, and the western portion became Navajo County. Apache County's present area is 7,151,360 acres. Snowflake was designated the county seat when the county was first formed. After the first elections in the fall of 1879, the county government was set up at St. Johns. In 1880, St. Johns was superseded by Springerville. Springerville remained the county seat for only two years until 1882, when St. Johns again became the county seat and has remained so to the present time.

Apache County was named for the Indians of Arizona and New Mexico. Apache Indians did not exist as a single group or nation, but the term had been adopted as applying comprehensively to many tribes known for their warlike characteristics. Even the Navajos were considered Apaches as late as 1800.

Cattle raising and farming were the main sources of livelihood for the earliest settlers in what is now Apache County. In the early 1900's, lumbering operations were begun in the White Mountains.

PHYSICAL CHARACTERISTICS

Apache County contains portions of two major physiographic provinces: the Plateau Uplands and the Central Highlands (only about 10 percent of the county is located in this latter province).

Generally speaking, these regions within Apache County consist of consolidated sedimentary rocks which have undergone considerable erosion by surface drainage courses. Land in the northern portion of the county is barren and soil is extremely thin. Southern Apache County consists of Paleozoic sedimentary rock, such as sandstone, siltstone, claystone and limestone. Broad alluvial areas common in other portions of the state are not found in Apache County. Alluvium generally occurs instead in long narrow strips along the larger drainages.1/

Forested soils developed on basalt and cinders cover the southern portion of the county. Central and northwestern portions of the county are covered with three basic soil types: (1) Developed soils from sandstone and associated parent material; (2) developed soils from basalt parent material; and (3) soils on clay and shale parent material. The land in northern Apache County (Navajo Indian Reservation) is covered with strips of (1) forested soils developed on sandstone; (2) deep soils of the mesic region, i.e., area where soil temperatures range between 49°F and 59°F year round; and (3) developed soils from sandstone and associated sandy parent material. There is also a strip of land running north and south near the Chinle Wash in Northern Apache County known as the "Badlands." It is designated a "non-soil area" and contains approximately 250 square miles of unproductive but scenic land.

Elevations in Apache County range from approximately 5,500 feet above sea level to over 11,500 feet in the White Mountains, which lie across the southern part of the county. Undulating plains on basalt flows extend from them northward to the general vicinity of Lyman Reservoir. Many volcanic cinder cones are on the basalt plains. Plains, broken by numerous canyons and drainageways leading to the Little Colorado River, extend over the rest of the county to the Utah border. The Chucka Mountains are in the northeastern part of the county and the Black Mesa, with high rough broken land, extends into the northwest part west of Chinle. The deep canyons of Canyon de Chelly National Monument adjoin Chinle on the east.

Climate

In general, Apache County experiences warm summer and cold winter temperatures. Rainfall is abundant throughout most of the county, ranging from 10 to 30 inches per year, depending on altitude variations. The average annual precipitation for the county is more than 14 inches. Generally, more than 50 percent of the precipitation falls during the summer months from July through September. Winter precipitation results largely from storms from the Pacific Ocean. This winter precipitation usually falls as snow with higher elevations receiving as much as 65 inches per year. Below freezing days are common throughout the county during winter months (TABLE II-1).

Exceptions to this are found in the hot steppe climatic regions around St. John's (elevation 5,730 feet). Most of the moisture is gone from western storms by the time they reach this area and, consequently, the region receives only slightly more rainfall than desert regions. Crops in the area are sustained through irrigation.

Natural Vegetation

Vegetation within the boundaries of Apache County consists primarily of short plains grasses and northern desert sage brush. Pinon pine and Juniper are also prevalent throughout the county--especially in the eastern portions. South of Springerville, Ponderosa Pine is the predominant vegetation type. Spruce, fir and Ponderosa pine are found in the northeastern parts of the county from the Carrizo Mountains to the Fort Defiance-Window Rock area.

TABLE II-1

CLIMATOLOGICAL DATA FOR SELECTED COMMUNITIES IN APACHE COUNTY

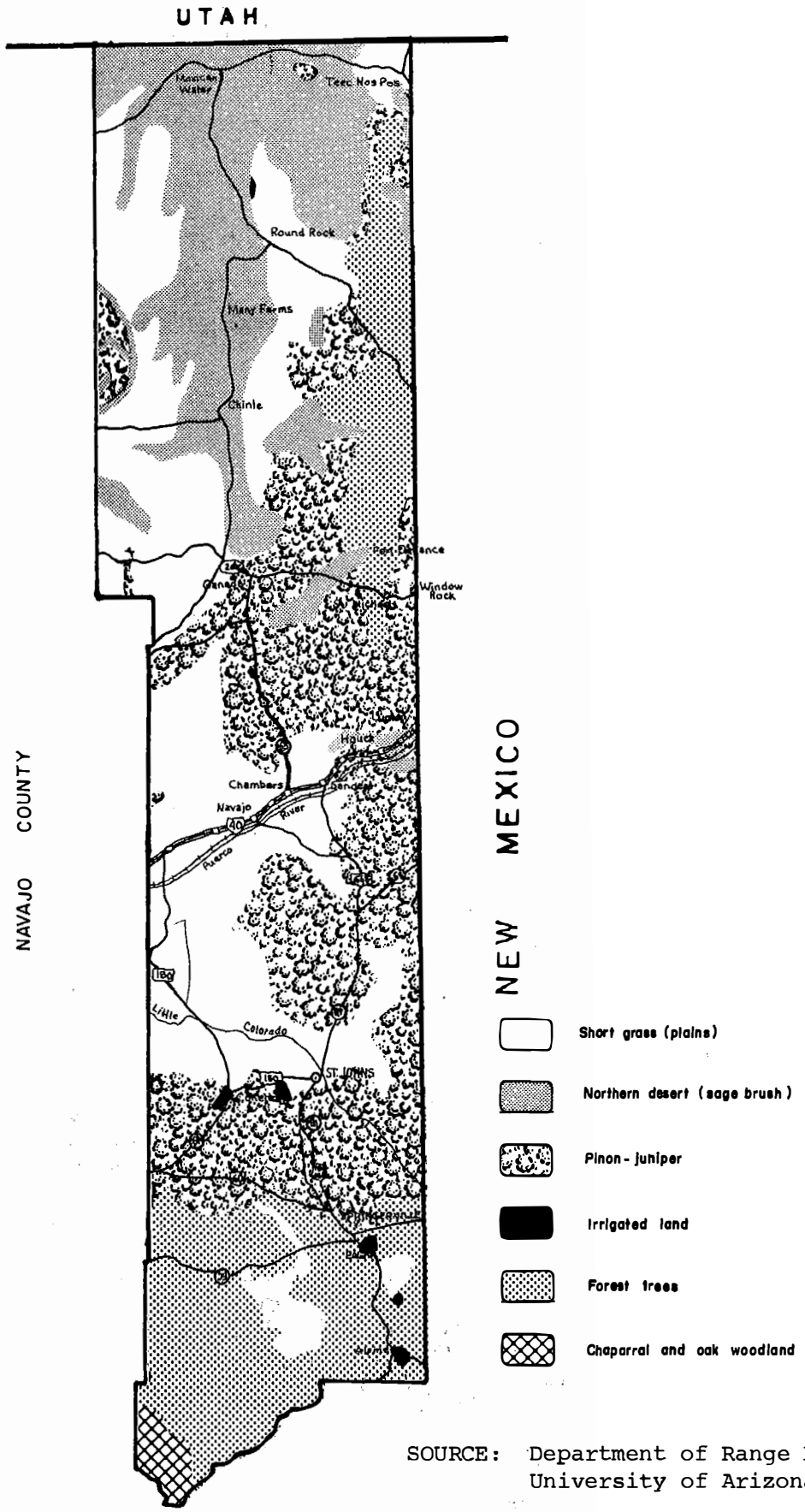
Community	Elevation (Feet above mean sea level)	Average Precipitation (Inches)	Temperature Aver. Summer Max. (°F)	Aver. Summer Min.	Aver. Winter Max. (°F)	Aver. Winter Min.
St. Johns	5,730	11.6	89	53	51	18
Window Rock	6,750	12.6	84	50	44	15
Springerville	6,964	12.1	81	49	50	16
McNary	7,320	24.7	79	45	45	18
Alpine	8,000	20.7	77	40	47	11

Source: "Arizona Climate," University of Arizona Press, Tucson, Arizona, 1964.

There are portions of two National Forests located in Apache County: 46,031 acres of the Sitgreaves National Forest and 439,532 acres of the Apache National Forest. In addition to these National Forest holdings are 32,648 acres of forest lands held under state or private ownership. 2/

The U. S. Forest Service reports that the growing stock of sawtimber (pine, fir, aspen) on commercial forest lands in Apache County is approximately 2,220,000 board feet. Timber resources and lumbering activities are greater in Apache County than are sawmills in operation at four locations within the county: St. Johns, Nutrioso, Springerville and McNary.

FIGURE II-1 shows the general locations of the various types of natural vegetation in Apache County.



SOURCE: Department of Range Ecology
University of Arizona

FIGURE II-1. VEGETATION OF APACHE COUNTY

NATURAL RESOURCES

MINERAL RESOURCES

Although mining activity in Apache County is limited at the present time, a number of mineral resource locations exist in the county and are, therefore, mentioned in this study. (FIGURE II-2)

The county's potential for natural gas and crude oil production is high. Several of these gas and oil fields are located in the northeast corner near Walker Creek and the Carrizo Mountains.

Large accessible outcroppings of sandstone are found in eastern Apache County north of the Puerco River. Sandstone deposits containing molybdenum (with uranium) are found in the extreme northwest corner of the county. Vanadium deposits in sandstone are abundant in the Carrizo Mountains area and the Chilchinbito area on the Navajo Indian Reservation in northern Apache County. Large deposits of uranium ore are found in northern portions of the county with smaller deposits scattered throughout the area as far south as St. Johns.

Bentonite and other clays occur at various locations throughout the region. Mines are located near the Puerco River in the east and smaller deposits of clay are found in the northwestern and central portions of the county.

Basalt, used primarily for concrete, aggregate, cinder block and railroad ballast, is found throughout the area south of St. Johns from Silver Creek to Nutrioso.

Minor occurrences of diatomite (diatonzceous earth) are found south of St. Johns near Concho and small deposits of gem materials such as quartz, peridot and garnet are found scattered throughout the county.

WATER RESOURCES

An accurate appraisal of water resources within a region necessitates at least a general understanding of the climate, terrain and geologic characteristics of the area, since these are the factors which determine the occurrence and availability of water. The brief descriptions of these factors presented in the preceding sections should, therefore, be kept in mind while considering the water resources of Apache County.

Surface Water. In addition to the physiographic provinces discussed in a previous section, 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. Apache County contains portions of four major drainage systems: (1) The eastern part of the Colorado River area above Parker Dam; (2) The Little Colorado River area; (3) Salt River area; and (4) The Upper Gila River area. For the purpose of this report, surface water resources for Apache County will be discussed generally and in terms of the above areas (FIGURE II-3).

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." 3/ Storage is water which has been artificially impounded in surface or underground reservoirs, or water which is naturally attained in a drainage basin.

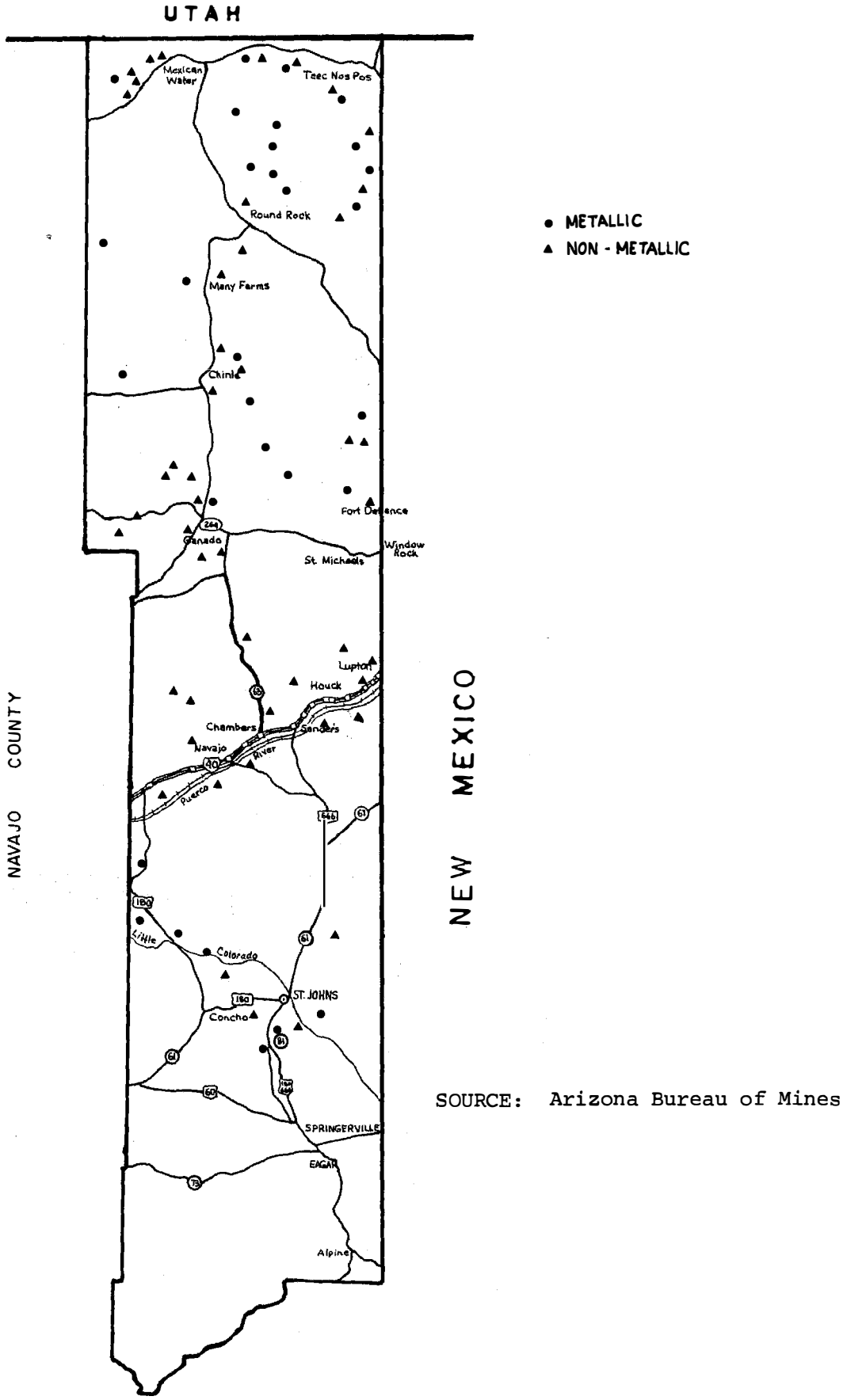
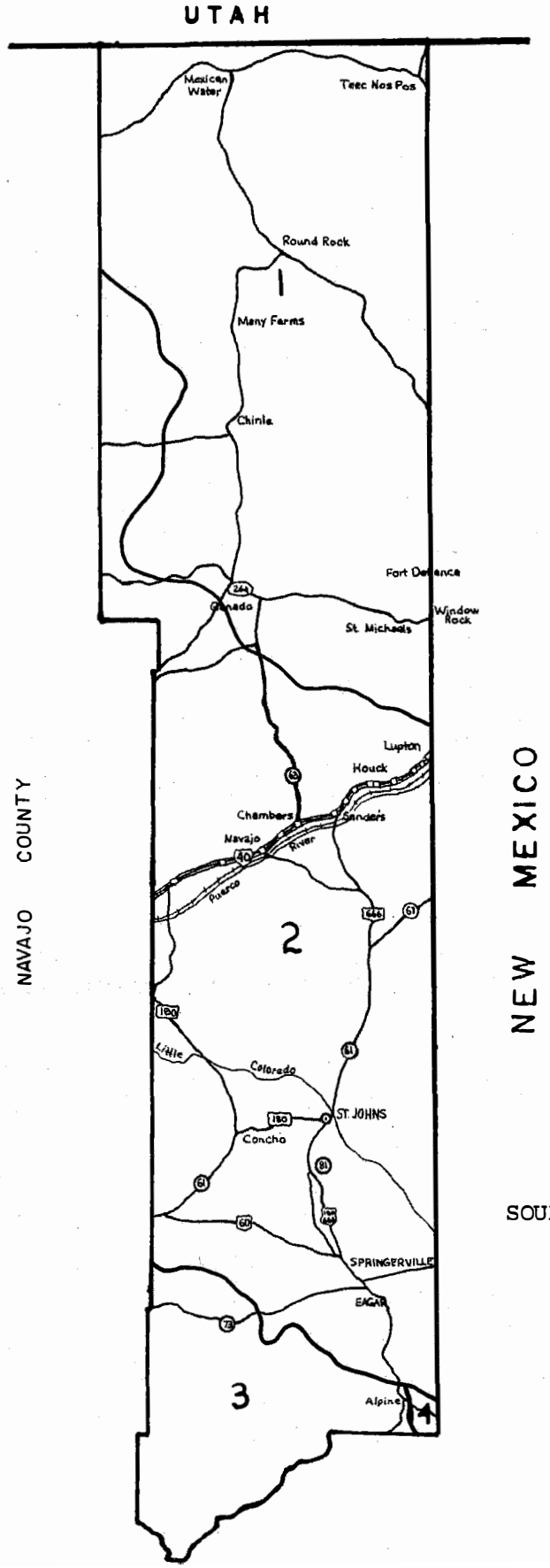


FIGURE II-2. MINERAL OCCURRENCES IN APACHE COUNTY



1 EASTERN PART OF COLORADO RIVER ABOVE PARKER DAM AREA

2 LITTLE COLORADO RIVER AREA

3 SALT RIVER AREA

4 UPPER GILA RIVER AREA

SOURCE: Arizona Bureau of Mines Bulletin 180

FIGURE II-3. HYDROLOGIC STUDY AREAS OF APACHE COUNTY

Climatic conditions vary throughout the county, influencing to a great extent the amount of runoff available from precipitation in the area (TABLE II-1). Although the county receives an estimated 9 million acre-feet of precipitation each year, evapotranspiration processes reduce the amount of available water by more than 80 percent. A striking example of this is seen at Chinle, Arizona. The small northern Apache County community is 5,538 feet above mean sea level, receives an average of 9.2 inches of precipitation per year and has a potential evapotranspiration figure of 26.5 inches. 4/ Average annual runoff figures for most of the area are less than one inch compared to a national average of 9.4 inches. This lack of significant runoff volume makes an additional water supply necessary in much of the area in order to provide for irrigation, industry and growing municipal demands. It should, however, be mentioned that runoff figures increase to two inches along much of the eastern county border and to 10 inches at the higher county elevations in the White Mountains and along the Mogollon Rim.

A summary of the county's surface water resources and additional streamflow data is provided in TABLE II-2.

TABLE II-2

SURFACE WATER RECORDS - STREAMFLOW DATA
APACHE COUNTY

Gaging Station and Number*		Drainage Area (square mi.)	Elevation of Gage (ft. above mean sea level)	STREAMFLOW Average Acre-ft.	Average cfs**	Maximum (cfs)	Minimum (cfs)	Unit Runoff (acre-ft per square Mile)	Period of Record (years)
3833	Filler Ditch at Greer, Arizona	--	8,500	1,590	2.20	15	0		1960-71
3834	Little Colorado River near Greer, Arizona	30.9	8,500	11,300	15.6	414	0.8	363.0	1960-71
3840	L.C.R. above Lyman Reservoir	747.0	5,988	15,210	21.0	16,000	0	20.0	1940-71
3850	Lyman Canal near St. Johns	--	5,943	8,330	11.5	74	0		1950-71
3855	L.C.R. below Lyman Reservoir	790.0	5,925	1,950	2.69	603	0		1950-71
3865	L.C.R. above Zuni River	3,680.0	5,399	3,760	5.19	1,100	0	1.0	1940-71
3880	L.C.R. near Hunt, Arizona	6,280.0	5,372	10,650	14.7	8,000	0	1.7	1929-33
3959	Black Creek near Lupton, Arizona	500.0	6,700	8,110	11.2	5,470	0		1964-71
4892	Pachele Creek at Maverick	14.8	7,850	6,010	8.29	122	1.1	408.0	1957-71
4897	Big Bonita Creek near Ft. Apache	119.0	5,910	45,430	62.7	1,640	4.1	377.0	1957-71
4908	North Fork White River - Greer	39.0	8,400			299	7.7		1965-71
4910	North Fork White River near McNary	66.0	7,750	30,940	42.7	1,290	4.0	463.0	1945-47,49-54 57-71
4924	East Fork White River near Ft. Apache	38.8	6,050	23,260	31.1	663	2.6	577.0	1957-71

* Gaging Station numbers are those used by USGS in surface water records.
**cfs Cubic feet per second.

Source: Bulletin 180, Arizona Bureau of Mines, Tucson, 1969; Water Resources Data, Part 1, U. S. Department of Interior, 1969.

Streamflow in the Little Colorado River area in Apache County is used extensively for irrigation. Average annual runoff for the area ranges from less than 0.1 inch north of the Puerco River to approximately five inches. Most tributary runoff for the region comes from the Mogollon and White Mountain areas.

The eastern portions of the Lower Colorado River area above Parker Dam covers northern Apache County. Average annual runoff ranges from one to five inches. Chinle Wash, which drains the Chuska Mountains, Black Mesa and Chinle Valley, flows north out of Arizona into Utah.

The upper Gila River area encompasses a small portion of southeastern Apache County and includes Luna Lake and the communities of Nutrioso and Alpine. The area receives abundant precipitation and averages between five and eight inches of annual runoff.

The eastern portion of the Salt River drainage area is located in southern Apache County in the Central Highlands Province. The average annual runoff for this area is the highest in the county and surpasses much of the rest of the state. The gaging station on the eastfork of the White River near Fort Apache is 577 acre-feet per square mile, or approximately 11 inches of runoff per year. Other gaging stations in the area record similarly high runoff figures. The perennial flow of many of the small streams in the area is sustained by springs on the slopes of the Mogollon Rim.

Principal storage reservoirs and lakes in Apache County are listed in TABLE II-3. Many storage facilities in the county retain measurable amounts of surface water only after heavy rains making meaningful data accummulation regarding their capacities and drainage areas difficult. For this reason, these areas are, in most instances, not included in TABLE II-3. Average annual lake evaporation in Apache County varies between 48 and 60 inches depending on the location of the water body.

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. Groundwater in Apache County is found in both alluvial aquifers of unconsolidated deposits of sand and gravel and in consolidated deposits of sandstone, limestone and volcanic material under artesian pressure. These bedrock aquifers provide a good source of water for areas where demand is small. Alluvial aquifers generally provide the best source of large quantities of water. In Apache County the principal areas of groundwater storage are (1) The San Juan Hydrological Basin; (2) The Blanding Basin and (3) The Black Mesa Basin. The approximate locations of these areas are shown in FIGURE II-4.

The areas of the most productive alluvial aquifers in the county are near Chinle Wash and on the Defiance Plateau in the northern part of the county, and between the Puerco River and the White Mountains in the central and southern portions of the county. Groundwater is withdrawn primarily from Navajo sandstone in the north, Coconino and Kaibab Limestone in the central region and from the lava and cinder deposits in the southern portions of the county. Except in the White Mountains, the Defiance Plateau and along the flood plain of the major rivers, groundwater in Apache County occurs under artesian conditions.

Groundwater reservoirs in the county receive recharge primarily from the direct penetration of precipitation on the hydrologic basins. However, recharge also occurs from runoff from precipitation in the mountains and underflow from outside the basin. Recharge areas are generally above 6,000 feet and receive more than 15 inches of precipitation each year. Principal recharge areas in Apache County are the White Mountains and the Mogollon Rim area.

TABLE II-3

SELECTED STORAGE RESERVOIRS AND LAKES IN APACHE COUNTY

Reservoir or Lake	River Basin	Drainage (square mile)	Type of Structure	Use*	Capacity (Ac-ft.)	Surface Area (Acres)
Atcheson #1	Little Colorado	2.1	Earthfill	IK	204	51.0
Bailey	Little Colorado	-	Earthfill	I	321	100.0
Beckers Res.	Little Colorado	3.0	Earthfill	PKR	300	50.0
Beckers Lake	Little Colorado	.5	Earthfill	PRIW	350	120.0
Big Lake	Salt	3.1	Earthfill	RW	12,200	575.0
Bunch Lake	Little Colorado	2.2	Earthfill	IW	900	626.0
Carnero Lake	Little Colorado	3.0	Earthfill	I	375	59.0
Colter Res. #1	Little Colorado	8.0	Earthfill	I	724	100.1
Concho Springs	Little Colorado	4.5	Earthfill	ISW	1,197	155.0
Coyote	Little Colorado	7.2	Earthfill	IK	239	33.4
Crescent Lake	Salt	1.5	Earthfill	RW	5,800	197.0
Eagar-Slade	Little Colorado	3.7	Earthfill	I	522	97.0
Earl Park Lake	Salt	6.4	Earthfill	R	310	48.0
Ei. Wiltbank	Little Colorado	21.0	Earthfill	I	200	26.4
Fish Creek Irrigation Co.	Little Colorado	--	Earthfill	I	250	40.0
Ganado	Little Colorado	190.0	Earthfill	IR	3,800	300.0
Glen Livet	Little Colorado	3.0	Earthfill	IS	110	21.0
Hawley Lake	Salt	7.3	Earthfill	R	4,700	240.0
Hog Wallow #4	Little Colorado	.7	Earthfill	I	1,000	57.6
Hurricane Lake	Salt	2.2	Earthfill	IKR	120	19.0
Jarvis	Little Colorado	--	Earthfill	I	135	20.0
Lake #2	Little Colorado	--	Earthfill	I	821	150.0
Lee Burgess	Little Colorado	4.5	Earthfill	I	289	10.0
Lee Valley #5	Little Colorado	1.7	Earthfill	IW	464	45.0
Luna Lake	Upper Gila	36.0	Earthfill w/ conc. core	IRW	1,390	151.0
Lyman Reservoir	Little Colorado	785.0	Earthfill	IRMW	21,900	1,400.0
Many Farms	Little Colorado	1,133.0	Earthfill	IR	24,500	1,300.0
Martin, Lee & Lund	Little Colorado	65.0	Earthfill	I	188	17.6
Mex. Hay Lake	Little Colorado	4.0	Earthfill	TW	821	164.0
Padre Lake	Little Colorado	750.0	Earthfill	P	563	114.0
Red Lake	Little Colorado	160.0	Earthfill	IR	9,800	700.0
River #3	Little Colorado	30.0	Earthfill	IW	1,669	127.0
Wheatfield	Little Colorado	80.0	Earthfill	IR	6,200	272.0
White Mountain #1	Little Colorado	.9	Earthfill	IW	2,391	451.0
Tunnel	Little Colorado	.2	Earthfill	IRW	694	44.0
Tsailee	Little Colorado	110.0	Earthfill	FR	10,000	360.0
Tonto Lake	Salt	6.4	Earthfill	IKR	231	41.0
Round Rock	Salt	100.0	Earthfill	IR	870	80.0
Rudd Reservoir	Little Colorado	2.0	Earthfill	I	609.3	174.3
St. Josephs	Little Colorado	.3	Earthfill	IKN	271	32.5

F Flood Control
I Irrigation
M Municipal
N Industrial
P Power
R Recreation
W Fish & Wildlife
S Silt control
K Stock Watering

Source: "Water Resources", Arizona Interstate Stream Commission, October 1967.

Water Quality and Use. Most of the groundwater pumped in Apache County is used for stock and domestic purposes. Generally speaking, depth to water does not exceed 500 feet, but in some deeply buried aquifers the depth to water may be as much as 1,000 feet below the land surface. A few of the irrigation wells completed in Coconino Sandstone in the Black Mesa area flow at the land surface. 5/

The amount of groundwater withdrawn from reservoirs in Apache County has not yet caused significant declines in the water level. Water levels for some irrigation wells in the county experience declines in the summer because of heavy pumping, but generally recover during the winter. 6/ Wells yielding 500 to 900 gallons per minute have been found along Chinle Wash and the Puerco River, however, most wells in the county produce between 10 and 200 gallons per minute.

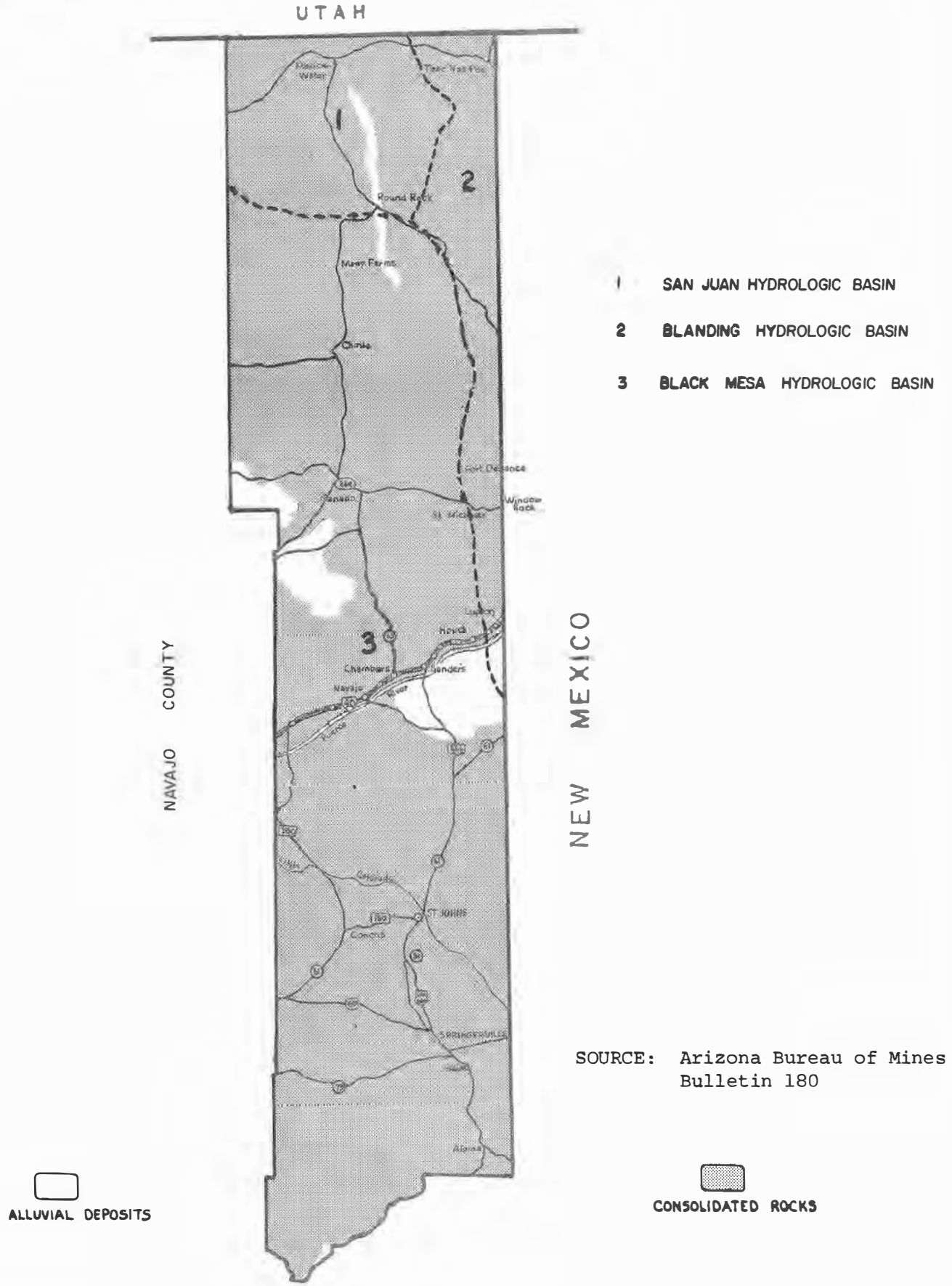


FIGURE II-4. PRINCIPAL AREAS OF GROUNDWATER RESOURCES IN APACHE COUNTY

Most of the water in major groundwater storage areas in the county can be considered permissible to unsuitable for irrigation. The variety is a result of natural chemical changes in the land areas over and through which the water travels as well as changes brought about by agricultural and industrial water uses. The quality of water from volcanic materials is generally good. FIGURE II-5 illustrates the distribution of dissolved solids in groundwater resources in Apache County. Mean annual discharge-weighted suspended-sediment concentrations for streams in the county range between 2,000 parts per million (ppm) and 49,000 ppm.

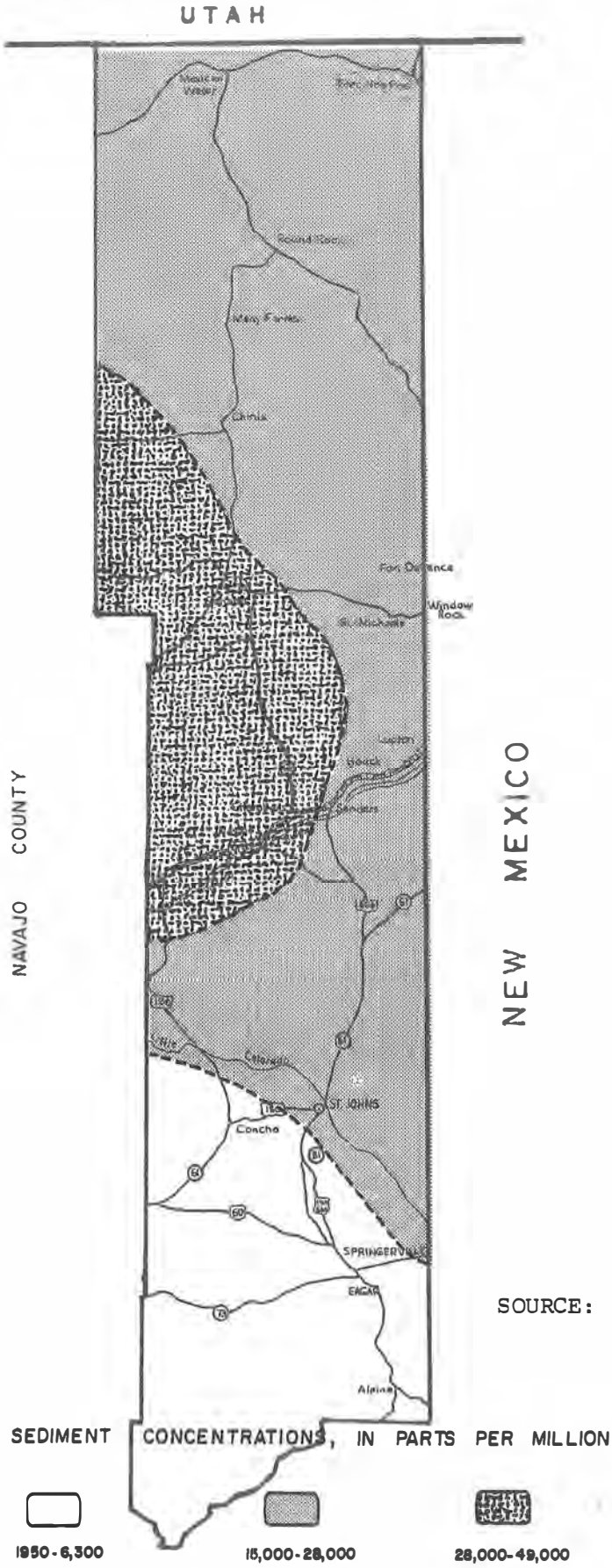
Although the quality of water to be used for industry or agriculture may vary greatly with respect to chemical composition and physical properties, the same variance is not possible where domestic use is concerned. All water sources developed for domestic uses must comply with the 1962 U. S. Public Health Service Drinking Water Standards. These standards, which set concentration limits for chemical parameters present in the water sources, are summarized in TABLE II-4.

TABLE II-4

WATER QUALITY STANDARDS FOR DOMESTIC WATER SOURCES

Chemical Parameter	Limiting Concentration milligrams/liter
Arsenic	0.01
Chloride	250.0
Copper	1.0
Cyanide	1.0
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
Zinc	5.0

*dependent upon ambient temperature.



SOURCE: Arizona Bureau of Mines Bulletin 180

FIGURE II-5. MEAN ANNUAL DISCHARGE-WEIGHTED SUSPENDED SEDIMENT CONCENTRATIONS FOR MAJOR STREAMS IN APACHE COUNTY

POPULATION AND ECONOMY OF APACHE COUNTY

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

Data are presented in this section on pertinent 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 major emphasis of this report is upon the nonreservation lands for the Indian Reservations will be treated individually in separate reports. When considering the nonreservation portion of the county, the most significant feature supporting growth and development is the increasing use of the White Mountains by tourist and recreationists.

Population Growth and Projections

Apache County presents a difficult problem in terms of population counts. According to the 1970 Census the resident population was 32,304. This is only an increase of 1,860 over the decade. Records of vital statistics show that the ten-year natural increase (number of births over number of deaths) was 11,897. Therefore in order for the Bureau of the Census figures to be true, substantial out-migration must have taken place throughout the decade in Apache County. This would have been largely out-migration of Indians since about 78.4 percent of all births in the county were Indian.

The nonreservation lands amounts to about 38 percent of the 11,180 square miles in the county–half of which is privately owned and half of which is owned by federal and state agencies. Using the 1970 Census about 20 percent of the resident population (5,322 people) live on this land. It should be emphasized that this is resident population. There are a large number of seasonal residents who use the White Mountains for vacations, particularly during the summer. The largest town in the southern section is St. Johns, the county seat, with a population in 1970 of 1,320 people. This represents 25 percent of the nonreservation population. It is followed in size by Eagar and Springerville with resident populations of 1,279 and 1,151.

FIGURE II-6 shows the county's past population and projections to 1990. These figures are based upon Bureau of the Census data. Accordingly a median population projection of 34,700 residents has been projected for 1975, 38,300 by 1980 and 46,900 by 1990. Low and high projections are also shown in FIGURE II-6. All of the projections are based on the long-term relationship between county and state population and assume that the Apache County portion of the state population will continue to decline in the future as it has in the past. Part of this growth will be on the reservation, part off the reservation. The support for the population growth off the reservation, our particular concern here, will come from several segments of the economy, particularly services and retail trade which should experience significant growth in the White Mountain area. Most of the off-reservation increase in population will probably settle in this area.

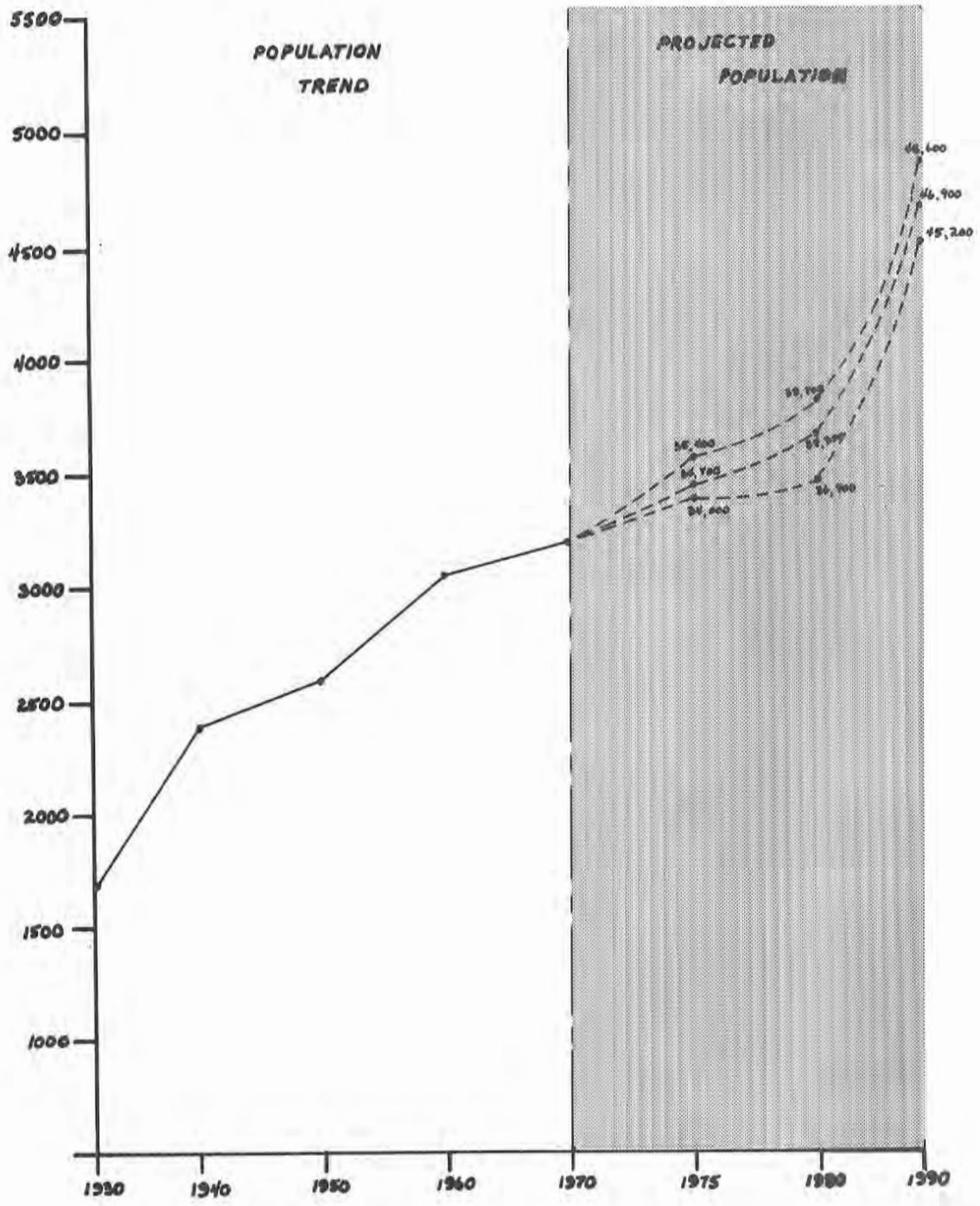


FIGURE II-6. POPULATION OF APACHE COUNTY AND PROJECTIONS TO 1990

Employment, Industry Analysis and Labor Earnings

Apache County has a civilian work force which averaged 8,475 persons during 1970. Annual average employment was estimated to be 7,775. This resulted in an 8.3 percent unemployment rate, much higher than the state rate of 4.5 percent. This is an unusually low rate and is best explained by very low labor force participation rates on the reservations. Since these reservations form such a large part of the county, this reduces the county labor force participation rate. Most of the employment listed in TABLE II-5 is off the reservation. Special note is made in each category where substantial numbers of Indians are employed.

According to TABLE II-5 which gives Apache County's labor force and employment by industry for 1967 through 1970 with projections for 1990, government is the largest sector. It employs 40 percent of those working. Government employment is projected to decrease in relative importance over the next 20 years. In spite of this, it is still expected to be the largest sector in 1990. The second largest sector is presently services. This includes not only categories such as motels, rooming houses and medical services but also employment in Indian tribal government. Tribal government is listed under services because it is considered a nonprofit organization rendering services to the tribe.

These two sectors, government and services, are also the largest and second largest in terms of labor earnings. This is shown in TABLE II-6 which gives labor earnings by source for selected years since 1950.

Agriculture. Agriculture has played a leading role in the economic life of Apache County. Crops, livestock and lumber have all been important.

Over 9,000 irrigated acres were devoted to crop raising in 1969, almost as much as were in use in 1959. It is estimated that about 5,000 acres are off the reservation. Alfalfa is one of the leading crops in the county and is grown in all parts of it. Corn is also very important, particularly in the St. John's area. Water is scarce and this acts as a limiting factor. For this reason the trend in some areas has been to convert crop land to permanent pasture.

Cattle raising has always been important. Sheep, goats and horses are also raised on and off the reservation. Estimates number cattle at about 26,000 and sheep at 7,000, many on Apache National Forest Land. Timber operations are mainly in the Apache National Forest located in the southern section of the county. In 1970, 36 percent of the lumber harvested in the state was cut in Apache County. This decreased to 29 percent in 1971 but still represents a total of 20,504,080 in board feet (thousands of board feet). Approximately 429,532 acres of the Apache National Forest qualify as commercial forest land.

In 1970, there were 250 persons employed in this sector in Apache County. This was three percent of total employment in the county. The location of the employment within the county is related to acreage. According to the employment projection given in TABLE II-5 employment in this sector in 1990 should decrease slightly. The continued scarcity of water for agriculture in many regions and the conversion of farm lands into subdivisions supports this slight decrease.

Mining. Mining is relatively unimportant in Apache County. There are no major mineral deposits found within the county. Sand, gravel and bentonite clay are mined.

In 1970, only 25 persons were employed in mining within the county. As some operations may increase over the next 20 years, an employment total of 75 persons is forecasted by 1990.

TABLE II-5.

APACHE COUNTY LABOR FORCE AND EMPLOYMENT ANNUAL AVERAGE 1967-1990

	1967	1968	1969	1970	1990
Civilian Work Force	6,325	8,450	9,300	8,475	13,601
Unemployment	375	550	575	700	816
Percent Unemployment	5.9	6.5	6.2	8.3	6.0
Total Employment	5,950	7,900	8,725	7,775	12,785
(a) Nonagricultural Wage and Salary	5,250	6,775	7,425	6,500	10,425
Manufacturing	650	750	875	700	1,000
Nonmanufacturing	4,600	6,025	6,550	5,775	9,425
Mining & Quarrying	50	50	75	25	75
Contract Construction	450	150	75	100	200
Trans., Comm., and Public Utilities	325	350	325	350	511
Trade	475	525	550	600	1,200
Finance, Insurance & Real Estate	50	50	100	125	255
Services	1,625	2,125	1,450	2,200	3,425
Government	1,625	2,775	3,125	3,225	3,759
(b) All Other Nonagricultural Employment	400	825	1,000	1,025	2,135
(c) Agriculture	300	300	300	250	225

Source: Employment Security Commission of Arizona, Unemployment Compensation Division.

TABLE II-6

LABOR EARNINGS - APACHE COUNTY
(In Thousands of Dollars)

	1950	1962	1966	1967	1968	1969.
Total Earnings	17,306	27,701	30,889	40,536	42,453	48,213
Farm Earnings	4,529	685	608	3,382	5,496	7,479
Total Nonfarm Earnings	12,777	27,016	30,281	37,154	36,957	40,734
Government Earnings	3,582	10,882	14,875	17,551	19,191	21,095
Total Federal	2,699	7,815	10,338	12,467	13,779	15,184
Federal Civilian	2,582	7,486	9,995	11,902	13,138	14,527
Military	117	329	343	565	541	657
State and Local	883	3,067	4,537	5,084	5,412	5,911
Private Nonfarm	9,195	16,134	15,406	19,603	17,766	
Manufacturing	3,667	4,703	3,758	3,876	4,385	5,382
Mining	333	989	230	522	538	607
Contract Construction	546	2,978	1,523	4,575	1,639	1,176
Trans., Comm., and Public Utilities	1,657	1,544	2,268	2,559	2,567	2,720
Wholesale and Retail Trade	1,055	2,321	2,802	2,898	2,940	3,199
Finance, Insurance and Real Estate	10	241	304	278	345	499
Services	1,761	3,291	4,448	4,824	5,273	5,968
Other	166	67	73	71	79	88

Source: Office of Business Economics.

Contract Construction. During 1970, an average of 100 persons were employed in contract construction in Apache County. Most construction is in the White Mountains and consists mainly of vacation cabins and facilities to accommodate vacationers. In the future this type of building activity is expected to grow, particularly in the Pinetop area and also in Concho and Alpine. By 1990 employment in construction is projected to reach about 200.

Manufacturing. Manufacturing is not very well developed in Apache County. Most employment is with Southwest Forest Industries, Inc., in the Springerville-Eagar area. All manufacturing employment in 1970 totaled 700 people or almost nine percent of total employment in Apache County. This is a decline from 875 in 1969 and was due mainly to a decline in Southwest Forest Industry's employment. There is talk of a plywood plant in the Eagar-Springerville area. If this does occur there will be an increase in employment in manufacturing in the county over the next 20 years. The assumption is made for this study that the plant will be in operation by 1990. Based on this assumption and allowing for some new manufacturing activity, either near St. Johns or on the reservation, an increase in manufacturing employment from 700 to 1,000 is projected for 1990.

Wholesale and Retail Trade. During 1970 an average of 600 persons were employed by the trade sector within the county. Only a small fraction of these people were working for wholesale trade establishments. The majority were employed in small retail operations such as service stations, grocery stores and restaurants. Most businesses are found in the towns in the southern section or along Interstate 40.

An increase in retail trade is anticipated over the projection period. An employment total of 1,200 in wholesale and retail trade is forecast for 1990. Demand for these new establishments will come mainly from retirees moving into the county, vacationers and summer residents in the White Mountain area. It should be noted that some of this demand will be seasonal. However, as the county develops its winter attractions the seasonality of demand will decline. An example of this is the recent building of the Sunrise Ski Resort in the White Mountains. This will serve both as a source of income for the Fort Apache Indians, as it is owned by them, and as a means of attracting winter visitors.

Finance, Insurance and Real Estate. Employment in this sector has averaged less than two percent of total employment in Apache County in the past four years. About 40 percent of this employment is with the Navajo Tribe in its housing authority.

Labor earnings were only one percent of total earnings in 1969. Despite the fact that the sector forms such a relatively small part of Apache County's economy, it has exhibited rapid growth in the period observed. Labor earnings increased from $10,000 in 1950 to $499,000 in 1969.

All indications are that earnings and employment should continue to grow during the coming decade as facilities expand to meet the needs of a larger population. This will not necessarily be a larger resident population so much as a larger number of seasonal visitors. As shown in TABLE II-5, employment is projected to increase to approximately 255 by 1990, an increase of approximately 130 persons from 1970 employment in this sector.

Services. Employment in this sector had averaged about 27 percent of total employment until 1970. The large decline in employment between 1969 and 1970 was due mainly to a decline in employment in the Navajo Office of Economic Opportunity due to cutback in funds. These figures are expected to pick up again in future years as these funds are restored.

Employment in services is projected to reach 3,400 by 1990. In order to arrive at this figure the assumption was made that there would be an expansion in tribal government activities. Any increase in tribal government employment up to this point has been classified as an increase in services rather than an increase in government. The assumption is made that this classification will be maintained over the next 20 years. Based on this and the fact that the increasing use of the White Mountains as a vacation area will support additional service facilities such as motels, the projected increase in employment is justified.

Transportation, Communications and Public Utilities. This has not been a dominant sector in the economy of Apache County. Labor earnings have been small compared to other industries comprising only 5.6 percent of total earnings in the total county during 1969. From 1967 through 1970 employment has been fairly constant. The major employers in the sector are El Paso Gas and the Navopache Electric Co-Op, a tribal enterprise.

Employment is projected to maintain its relative position in the economy through 1990. This means an employment total of 511 or four percent of the projected 1990 employment.

Government. Government has been the largest sector in Apache County in terms of employment. A total of 3,125 persons were employed in 1970. The majority worked for the federal government. This includes those working in the Forest Service, Public Health Service and the Bureau of Indian Affairs. In projecting future employment in government the same assumption was made that was used in projecting service employment. That assumption was that there would be an increase in Indian Tribal Government. This would mean a relative and perhaps absolute decline in Bureau of Indian Affairs employment. As a result while government employment is projected to increase over the next 20 years, it is projected to decline in relative importance. Employment is projected to reach 3,759 by 1990.

LAND OWNERSHIP AND LAND USE

Land Ownership

Land ownership is an essential component of any land use study in that it is a major determinant of where various types of land uses occur. The more intensive types of land uses, i.e. urban land development, occur almost exclusively on privately owned land.

Apache County contains a land area of 7,150,000 acres. The ownership of most of this land area is divided among various federal, state, and local governmental agencies and private individuals as indicated in TABLE II-7.

The Navajo and Fort Apache Indian Reservations encompass 62.5 percent of the county land area (PLATE 1). The Navajo Indian Reservation is located in the northern half of the county and is mostly high plateau land. Except for small clusterings of residential and commercial developments the reservation lands are predominantly used for livestock grazing.

TABLE II-7

EXISTING LAND OWNERSHIP FOR APACHE COUNTY - 1970

Federal Lands		5,170,663		72.3%
National Forest	486,000		6.8	
BLM	136,663		1.9	
Indian Reservation	4,468,000		62.5	
National Park Service	68,000		.9	
Other Federal Lands	12,000		.2	
State of Arizona		711,578		9.9
Private & Local Government Lands		1,267,859		17.8
TOTAL COUNTY LAND AREA		7,150,000		100.0

Sources: Bureau of Land Management, U. S. Forest Service, Department of Property Valuation, State Land Department.

The Fort Apache Indian Reservation encompasses part of the White Mountains, which is the largest recreational area in Arizona. Both the Navajo and Fort Apache Indian Reservations are discussed in detail in the Indian Reservation Reports.

Except for the Indian trust lands the State of Arizona owns the largest amount of land. The State Land Department is trustee for the 711,578 acres of state owned lands in Apache County. Over 710,000 acres of lands are leased for livestock grazing purposes.

The United States Forest Service administers the 486,000 acres of forest land in Apache County. The management of this land is divided between the Sitgreaves and Apache National Forests as indicated in PLATE 1. The U. S. Forest Service administers their lands under the Multiple-Use Sustained Yield Act of 1960, P.L. 89-517. The National Forests establish management use plans for their lands using the natural resources in combination which best meet the needs of the people while protecting the productivity and resources of the land.

The Bureau of Land Management (BLM) administers 136,663 acres of public domain in Apache County. The bureau is required to classify all their lands as either being for sale or for retention under the Classification and Multiple Use Act of 1964. The lands which are retained are managed under a similar land use program as the Forest Service.

The BLM lands are in a checkerboard pattern as shown on PLATE 1 which resulted from the granting of alternate sections of land along railroad right-of-way during the early days of westward expansion. The bureau has found that this scattered pattern of ownership is difficult to properly manage, therefore they are attempting to consolidate their lands through land exchanges with the State of Arizona and private individuals.

The Petrified Forest National Monument and the Canyon De Chelly National Monument are administered by the National Parks Service. The land held in free title account for 17.8 percent of the county land area. The predominance of this land is used for livestock grazing with less than 2,000 acres being devoted to urban land uses, although over 30,000 acres have been subdivided. The future land development patterns of the county will largely be determined by the collective actions of these subdividers and the ability of the county to regulate future subdividing and development activities.

PRESENT LAND USE PATTERNS

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

Urban lands are defined as those lands which are used primarily for residential, commercial, and industrial purposes, in contradistinction to those lands which are either undevelopable or which are predominantly rural in character, i.e., agricultural and grazing lands. Urban land uses account for 1.2 percent of the land area in Apache County (TABLE II-8). Slightly more than 80 percent of the urban land uses are concentrated within the areas adjacent to Springerville, Eagar and St. Johns (PLATE 2).

The exception to this is the residential land use classification. As indicated on TABLE II-8, 77.6 percent of the urban land uses are categorized as residential. Only 1,594 acres of these lands have been developed. The majority of the lands which have been developed for residential purposes occur within Springerville, Eagar, and St. Johns. The remaining improved residential land is composed of small homesteads and ranch residences located in smaller communities and rural development found in the county.

The unimproved residential land encompasses 65,590.76 acres. This land is primarily composed of subdivisions which are recorded then sold to individuals for investment purposes. Usually the improvements are minimal and the lots remain undeveloped. Most of these undeveloped subdivisions are in the central portion of the county, with many of them located between the checkerboard sections of BLM land. This speculative subdividing of land has made it difficult for the Bureau of Land Management to consolidate their ownership.

Commercial and industrial land uses account for less than three percent of the urban land acreage. The commercial uses are concentrated within the centers of settlement and along the highways. The acreage classified as industrial is primarily that land used for two sawmills located in Eagar and McNary.

Public and quasi-public land uses comprise 13.5 percent of the urban land uses. This subclassification consists of land uses which are owned by public or semi-public bodies

TABLE II-8

LAND USE - APACHE COUNTY - 1970

Classification			Acres	Percent of Total
Urban Land Uses			86,533.46	1.2
Residential		67,184.76		
Improved	1,594.00			
Unimproved	65,590.76			
Commercial		2,395.16		
Improved	268.85			
Unimproved	2,126.31			
Industrial		41.98		
Public and Quasi-Public		16,911.56		
Agricultural			2,694.85	0.0
Grazing[1]			1,789,255.32	25.0
Undeveloped Lands[2]			5,271,516.37	73.7
TOTAL COUNTY LAND AREA			7,150,000.00	100.0

[1]Estimated from State Department of Property Valuation, Bureau of Land Management, State Land Department and U. S. Forest Service records.

[2]This category includes all lands not found in all other categories.

Sources: State Department of Property Valuation, State Land Department, U. S. Forest Service, Bureau of Land Management and the Apache County Comprehensive Plan.

and used for the public good, i.e. parks, townhalls, and churches. These uses are concentrated within the centers of urban settlement.

Agricultural land uses are small due to the harsh climatic conditions, poor soils and limited water supplies. Most of the agricultural activities are adjacent to the Little Colorado River, and most intensive in the Springerville, Eagar and St. Johns areas.

Livestock grazing is the largest land use in Apache County encompassing 1,789,255.32 acres. This activity is the most extensive during the summer months as the winters are too harsh and the livestock is usually moved to the lower desert valleys. This activity is often found on public domain lands.

Recreation

Outdoor recreational facilities in Apache County are provided by the Sitgreaves and Apache National Forests, the Fort Apache and Navajo Indian Reservations, the State Parks Department and the National Parks Service.

The summer types of outdoor recreational experiences are the most popular according to U. S. Forest Service figures (TABLE II-9 and TABLE II-10). Camping is the most popular activity and is usually associated with fishing and water sports. This is reflected in the fact that most of the camping sites are located adjacent to either a lake or stream.

Winter recreational activities are just beginning to increase in popularity throughout the state. Winter fishing and hunting along with general snow play have always been popular activities in the White Mountain area but recent development of winter sports facilities has expended the popularity of the winter recreation. In 1971, the White Mountain Apache Tribe opened a ski resort at Sunrise Park, 20 miles east of McNary. This new recreation complex offers facilities for year-round activity. The skiing facilities include a 6,800 foot double chair lift, seven miles of ski trails, a lodge and resort facilities. An estimated 25,000 skier day season is projected for its first year of operation (Apache County Independent News, January 1970). This new facility replaces the smaller facility at Big Cieniega.

TABLE II-9

PARTICIPATION IN OUTDOOR RECREATION
SITGREAVES AND APACHE NATIONAL FORESTS-APACHE COUNTY
1969

ACTIVITY	VISITOR-DAYS (000's)	PERCENT OF TOTAL
Sight-seeing	57.9	9.8
Hiking	12.0	2.0
Bicycling	.5	.0
Horseback Riding	14.5	2.4
Boating	4.0	.6
Swimming	.4	.0
Fishing	75.2	12.8
Camping (General)	204.1	34.9
Camping Trailer	114.5	19.5
Lodges	14.5	2.4
Picnicking	16.5	2.8
Rec. Residence	12.8	2.1
Skiing	.1	.0
Winter Sports	4.7	.8
Hunting	37.1	6.3
Other	14.5	2.3
TOTAL	583.3	99.9

Approximately 79 percent of the recreation enthusiasts using the White Mountain area, originated from Arizona, six percent from California, four percent from New Mexico, three percent from Texas and eight percent from other areas. The average length of stay is from one and one-half days to ten days.

TABLE II-10

NUMBER OF VISITORS TO NATIONAL PARKS
IN APACHE COUNTY - 1966-1970
(In Thousands)

	1966	1967	1968	1969	1970
Canyon De Chelly	344.4	344.6	350.4	408.3	369.1
Petrified Forest	849.8	797.2	869.4	1,002.0	1,151.4

Source: U. S. Department of Interior, National Parks Service.

The demand for outdoor recreation experiences in the White Mountains area is increasing in relationship to three factors: (1) the rate of population growth in the Tucson and Phoenix Metropolitan areas; (2) the increased amount of leisure time available in relationship to available excess personal income and (3) the improved accessibility of the area to the major population centers of Arizona and California.

The National Park Service maintains the Petrified Forest and Canyon De Chelly National Monuments, both of which are either wholly or partially within Apache County. These monuments are maintained in their original setting with only those man-made features being made where needed to provide access to the scenic attractions.

The rate of increase in outdoor recreation participation in Apache County is occurring at dramatic rates. The National Forest and White Mountain Apache Tribe both project a 460 percent increase in recreation participation by 1975. The White Mountain Indian Tribe feels that they need to construct between 150 and 200 new campsites annually for the next 20 years to meet this anticipated demand. Not all of these will be in Apache County, but since they are planning on placing these sites adjacent to lakes and streams, Apache County will receive a large portion of them.

Generalized Future Land Use

This report will respect the county's right to develop specific land use projections and controls and will therefore, deal with land use by generalized categories.

Existing urban land uses are clustered either along major transportation routes or areas of high agricultural potential. Most of these urban concentrations are located within the central part of the county (PLATE 2). Future urban development will probably continue in these centers where public services and water are readily available.

There is a potential for large scale land subdividing activity, especially on a speculative basis. Already there are 65,590.76 acres of land which have been subdivided yet remain unimproved. Most of this type of activity is in the central portion of the county.

The southern portion of the county is mostly within the National Forest. Approximately 25,000 acres of this area have been homesteaded. These homesteads are now being subdivided for summer home and recreational purposes causing problems in management of forest lands. Summer home development will continue especially in the more popular areas of Lakeside and Showlow.

The amount of agricultural land is expected to decrease but not appreciably. The county and community land use plans realize the economic importance of agriculture to both the county and the local community. Most of the agricultural activity is adjacent to the existing urban areas and is in conflict with urban development. The plans describe this problem and define methods of minimizing the conflict and maintaining the agricultural lands at a level close to the existing acreage while accommodating the projected urban growth.

The need for land by the livestock grazing industry will probably decrease, but will remain the dominant land use in the central part of the county. The decrease will be influenced by the implementation of "dry lot" feeding practices instead of range grazing for beef and sheep production. Livestock grazing activities on the Navajo Reservation and the public domain lands will probably not decrease appreciably during the study period.

COUNTY NEEDS FOR ENVIRONMENTAL SERVICES

This section provides a compendium of existing and projected environmental services needs for Apache County. The information presented is a compilation of facts and calculations which are outlined individually in CHAPTER III of this report for the areas surveyed in the county. Opinions related to existing needs were based upon field survey work carried out in the areas noted. Future needs projections were based upon methodologies discussed in Section III of this report and qualitative judgments as to life expectancies of existing facilities, if any.

Water Supply and Distribution Systems

Existing and future water supply and distribution needs for communities surveyed in Apache County are outlined in TABLE II-11. The needs expressed in TABLE II-11 are categorized in terms of varied system modifications and/or expansions, water supply augmentation, or additional engineering evaluation of existing or needed systems.

Review of the table indicates that four of the six areas noted have existing water supply system needs.

Future water supply demands for the rural communities of Apache County are presented in TABLE II-12. The total demand data for the county include estimates for the Navajo Indian Reservation located in the northern part of the County. The demands noted will result in the projected needs for the major water supply utilities serving the areas indicated in TABLE II-11. There are presently 68 water utilities in Apache County of which approximately 33 percent are investor-owned operations (TABLE II-13).

The locations of these utilities are illustrated on PLATE 3. New systems would primarily be associated with private land development activities in the county particularly along the Little Colorado River.

TABLE II-11

EXISTING AND FUTURE*
WATER SUPPLY AND DISTRIBUTION NEEDS
IN RURAL COMMUNITIES OF APACHE 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
St. Johns	●										●									●
Springerville-Eagar	●	●		●		●		●							●	●	●			
McNary	●						●							●	●	●				
Concho										●	●					●				
Greer	●		●				●				●				●				●	

*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 network (well motors, booster pumps, etc.).

Source: Staff estimates.

TABLE II-12

SUMMARY OF PROJECTED ANNUAL
WATER DEMANDS FOR APACHE COUNTY
IN 1975, 1980 AND 1990

(Acre feet per year)

Developed Area	Projection Year	Domestic Water Demands Projection Levels* Low	Median	High
Eagar	1975	160	176	185
	1980	202	215	228
	1990	300	313	330
Springerville	1975	154	166	179
	1980	195	208	222
	1990	290	306	321
St. Johns	1975	174	178	187
	1980	194	204	225
	1990	236	261	318
Indian Reservations	1975	2,385	2,420	2,555
	1980	2,590	2,675	2,760
	1990	4,125	4,255	4,380
All Other Areas of Development**	1975	586	600	610
	1980	680	710	730
	1990	965	1,010	1,035
County Total	1975	3,458 90	3,540	3,716
	1980	3,861	4,012	4,165
	1990	5,916 117	6,145 117	6,384

*Water demands are based on low, median and high population projection levels.

**All Other Areas of Development (AOAD) includes McNary, Concho and Greer.

Water resources for the county as a whole appear adequate to meet future domestic water needs which could conceivably reach an estimated 6,384 acre-feet in 1990. Present demands are estimated at 3,300 acre-feet per year. Groundwater supplies at the present are adequate. The projected demands presented in TABLE II-12 do not include estimates for agricultural or industrial water needs. These two categories of water use are considerable in relation to domestic water needs. Overdraft of groundwater supplies will result in further depression of water tables underlying the major water bearing aquifers of the county. Surface water supplies are primarily related to the Little Colorado River. The surface waters originating in Apache County are seasonal.

Water rights associated with the Little Colorado River limit the withdrawals that may be made. As a consequence, it is difficult to make reference to quantities of water that may be available for domestic uses.

TABLE II-13

TYPES OF WATER UTILITIES IN APACHE COUNTY

Type of Owner	Number
Investor	23
Municipal	3
Co-Op	3
State	9
County	3
Federal	27
Total	68

Source: Arizona State Department of Health, Water Supply Division.

Sewerage and Wastewater Treatment

Existing and future needs for sewage treatment facilities are presented in TABLE II-14. Most of the developed areas noted have an existing need for more detailed engineering studies related to future development of sewerage and treatment facilities. As of June 1973, there were 16 operating sewage collection and treatment systems in the county (PLATE 3 and TABLE II-15).

TABLE II-14

EXISTING AND FUTURE*
SEWERAGE AND WASTEWATER TREATMENT
NEEDS IN RURAL COMMUNITIES OF
APACHE 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
St. Johns				●				●				●					●			
Springerville-Eagar		●		●			●						●	●			●	●	●	
McNary		●					●						●						●	
Concho					●					●					●	●				
Greer	●						●					●						●		

*Based on high population projection levels
**Needs classifications:

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 existing sewage collection network.
3. Expansion and/or modification of treatment facilities.
4. Areas with centralized sewage treatment systems: Consideration of wastewater reclamation for agricultural or industrial uses should be reviewed.
5. Areas utilizing septic tank disposal systems: Septic tanks and urban densities are compatible for time frames noted.

Source: Staff estimates.

TABLE II-15

DOMESTIC WASTE TREATMENT INVENTORY
APACHE COUNTY

Installation	Location	Type of Treatment
Alpine Work Center	Alpine	Extended Aeration
Benny Creek Campground	Greer	Evaporation Lagoon
Big Lake Recreation Area	Big Lake	Aerated Lagoon
Canyon de Chelly Trailer Park	Chinle	Evaporation Lagoon
Chinle-East	Chinle	Oxidation Lagoon
Chinle-West	Chinle	Oxidation Lagoon
Cottonwood Boarding School	Chinle	Evaporation Lagoon
Cove	Cove	Evaporation Lagoon
Diamond Rock Lodge	Alpine	Extended Aeration
Dennehotso	Dennehotso	Evaporation Lagoon
Houck	Houck	Extended Aeration
Fort Defiance	Fort Defiance	Evaporation Lagoon
Ganado Presbyterian Mission	Ganado	Oxidation Lagoon
Good Shepard Mission	Fort Defiance	Evaporation Lagoon
Hunter's Point Boarding School	Hunter's Point	Oxidation Lagoon
Kinlichee School	Kinlichee	Evaporation Lagoon
Lukachukai	Lukachukai	Aerated Lagoon
Many Farms	Many Farms	Evaporated Lagoon
McNary	McNary	Oxidation Lagoon
Nazlini Boarding School	Nazlini	Stabilization Lagoon
Petrified Forest		
a) Painted Desert	Petrified Forest	Evaporation Lagoon
b) Puerco Ruins	Petrified Forest	Evaporation Lagoon
Pine Springs Boarding School	Pine Springs	Stabilization Lagoon
Red Mesa Elementary School	Red Mesa	Evaporation Lagoon
Red Rock	Red Rock	Evaporation Lagoon
Rock Point	Rock Point	Oxidation Lagoon
Rough Rock Boarding School	Rough Rock	Evaporation Lagoon
Rough Rock Demonstration School	Rough Rock	Oxidation Lagoon
Round Rock Day School	Round Rock	Evaporation Lagoon
St. Johns	St. Johns	Stabilization Lagoon
Sawmill	Sawmill	Evaporation Lagoon
Springerville-Eagar	Springerville	Stabilization Lagoon
Sunrise Park		
a) Resort	Big Lake	Extended Aeration
b) Ski Area	Big Lake	Extended Aeration
Tes-Nos-Pos	Tes-Nos-Pos	Oxidation Lagoon
Toyei Boarding School	Toyei	Aerated Lagoon
Wide Ruins Boarding School	Wide Ruins	Evaporation Lagoon
Window Rock	Window Rock	Evaporation Lagoon

Wastewater production levels within the county are presently estimated at 1,800 acre-feet per year. Projected future levels of sewage wastes that may be generated per year by 1990 are presented in TABLE II-16. Currently, approximately 12 percent of the sewage originates in the larger communities which have some form of wastewater treatment. By 1990, it is estimated that between 75 and 80 percent of sewage produced will receive treatment other than by septic tank systems. Such a high percentage of the sewage generated being provided treatment of a more sophisticated nature than septic tanks suggests that long range planning related to the ultimate re-use of reclaimed wastewater should be carried out particularly in the Round Valley and St. Johns regions. Using reclaimed wastewaters for irrigation or industrial application is currently an accepted practice, provided modern forms of sewage treatment are utilized. Sewage reclamation could augment existing and future irrigation water demands in these regions.

Solid Waste Disposal Practices and Techniques

The production levels of refuse, garbage and other forms of solid waste materials will grow as population densities increase. Projected levels of solid waste production are presented in TABLE II-17. At present, solid wastes are generated in Apache County at an estimated rate of 18,000 tons per year (1973). Levels of solid waste production in 1975, 1980 and 1990 are projected to increase 13, 42 and 113 percent, respectively, over the 1973 level of estimated production. (mean projection level).

Solid waste materials are disposed of at nine (9) dumpsites (PLATE 3). Control of accumulated wastes is accomplished by burning at all but two of these sites. Management of these facilities, with the exception of the Round Valley site, is carried out on a part-time basis by the County Health Department. Part-time maintenance and operation of dumpsites may be sufficient for the present, however, full-time management will become increasingly important in future years. A management program involving the development of sanitary landfill disposal sites with regularly scheduled inspections and maintenance would be of benefit to the citizens of Apache County.

Planning for site selection and development of centrally or regionally located sanitary landfills and the consideration of associated salvage operations serving all areas would be basic to an effective solid waste management program. Review of existing dumpsite locations and their relationship to projected land use patterns in the county suggests that possibly three (3) regional sanitary landfills could serve the county in the future. Possible area locations for these facilities are: (1) Round Valley (present site); (2) St. Johns-Concho; (3) McNary. Finalization of actual site locations, land requirements and detailed design could be made a part of a regional plan developed by the county.

A county agency could possibly be financed by reallocation of certain county revenues. Also such an agency would be eligible for federal grants to finance additional planning studies. The advantages to be gained would be orderly and timely construction of future environmental services facilities on a schedule coinciding with future demands.

TABLE II-16

SUMMARY OF PROJECTED AVERAGE ANNUAL SEWAGE PRODUCTION LEVELS FOR APACHE COUNTY IN 1975, 1980 AND 1990

(Acre feet per year)

Developed Area	Projection Year	Sewage Production Projection Levels* Low	Median	High
Eagar	1975	76	83	87
	1980	96	102	109
	1990	164	172	181
Springerville	1975	73	79	84
	1980	92	99	105
	1990	160	168	177
St. Johns	1975	71	73	77
	1980	81	85	94
	1990	101	112	136
Indian Reservations	1975	1,320	1,340	1,360
	1980	1,580	1,635	1,690
	1990	2,325	2,400	2,470
All Other Areas of Development**	1975	285	290	295
	1980	335	350	360
	1990	520	550	560
County Total	1975	1,825	1,865	1,903
	1980	2,184	2,271	2,358
	1990	3,270	3,402	3,524

*Sewage production levels are based on low, median and high population projection levels, as outlined in SECTION III of this report.

**All Other Areas of Development (AOAD) include the communities of McNary, Concho, Greer and Forest Service Facilities.

Source: Project Staff Estimates.

TABLE II-17

SUMMARY OF PROJECTED AVERAGE ANNUAL
SOLID WASTES PRODUCTION LEVELS
FOR APACHE COUNTY
IN 1975, 1980 AND 1990

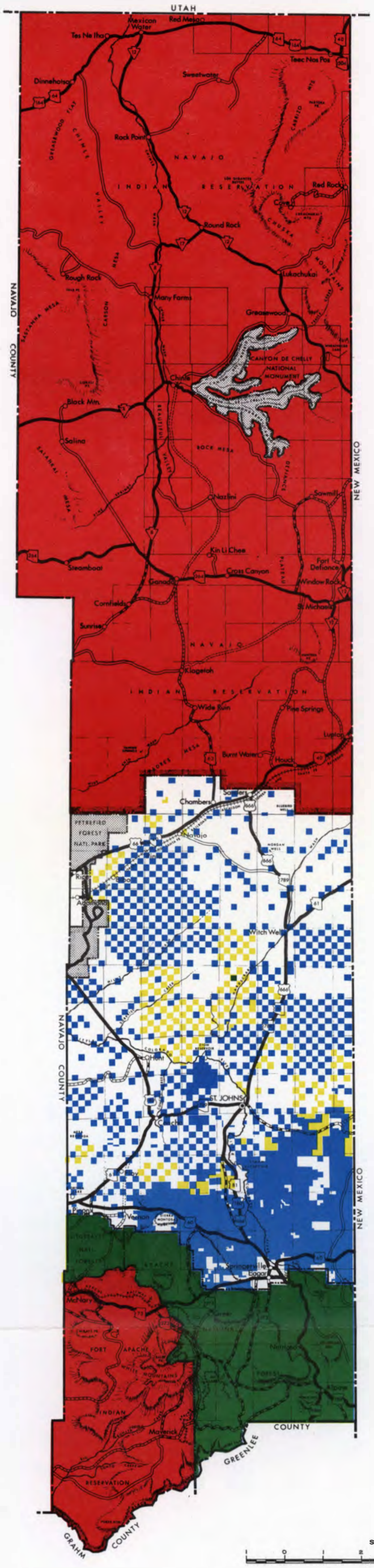
(Tons per year)

Developed Area	Projection Year	Solid Wastes Production Projection Levels* Low	Median	High
Eagar	1975	1,205	1,320	1,390
	1980	1,580	1,690	1,790
	1990	2,470	2,600	2,730
Springerville	1975	1,159	1,251	1,344
	1980	1,524	1,629	1,735
	1990	2,403	2,534	2,664
St. Johns	1975	1,255	1,285	1,350
	1980	1,460	1,530	1,690
	1990	1,895	2,100	2,550
Indian Reservations	1975	11,615	11,770	13,340
	1980	14,290	14,760	15,220
	1990	21,770	22,450	23,100
All Other Areas of Development**	1975	4,670	4,760	4,830
	1980	5,650	5,900	6,075
	1990	8,425	8,820	9,010
County Total	1975	19,904	20,386	22,254
	1980	24,504	25,509	26,510
	1990	36,963	38,504	40,054

*Solid waste production is based on low, median and high population projection levels as outlined in SECTION III of this report.

**All Other Areas of Development (AOAD) include the communities McNary, Concho, Greer and Forest Service Facilities.

Source: Staff calculations.



LEGEND

- Bureau of Land Management
- State Trust Land
- Private
- Indain Resevation
- National Forest
- National Parks

SYMBOLS

- Interstate Highway
- U.S. Highway
- State Highway
- City, Town, Settlement
- Railroad
- River
- Lake
- Mountain
- County Boundary
- State Boundary

ENVIRONMENTAL SERVICES NEEDS STUDY

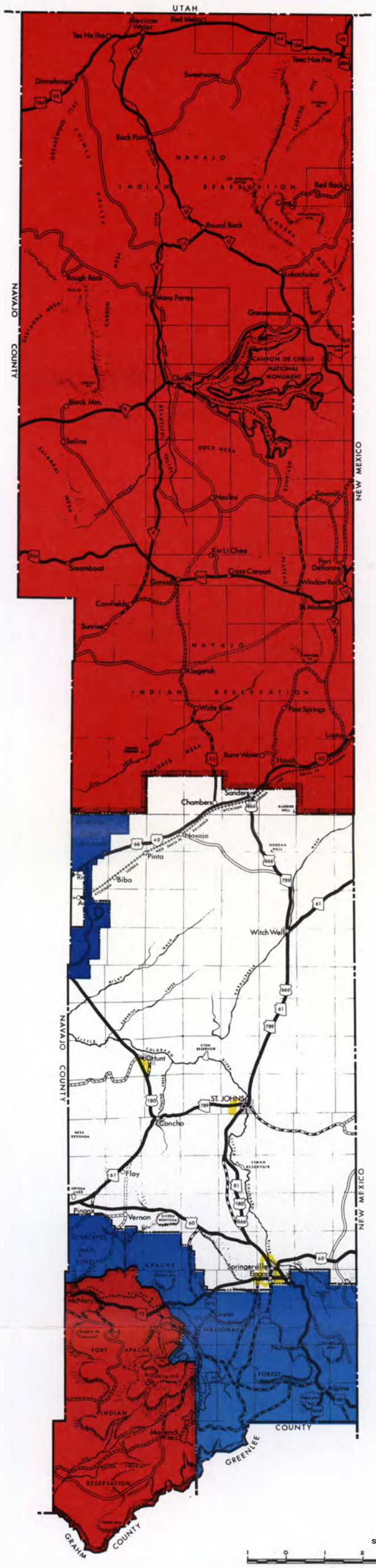
PREPARED BY

DEPARTMENT OF ECONOMIC
PLANNING AND DEVELOPMENT

APACHE COUNTY, ARIZONA
LAND OWNERSHIP

N

PLATE 1



LEGEND

- Urbanizing Areas
- Agriculture
- National Parks & Forests
- Grazing & Mining
- Indian Reservation

SYMBOLS

- Interstate Highway
- U.S. Highway
- State Highway
- City, Town, Settlement
- Railroad
- River
- Lake
- Mountain
- County Boundary
- State Boundary

SCALE—MILES

ENVIRONMENTAL SERVICES NEEDS STUDY

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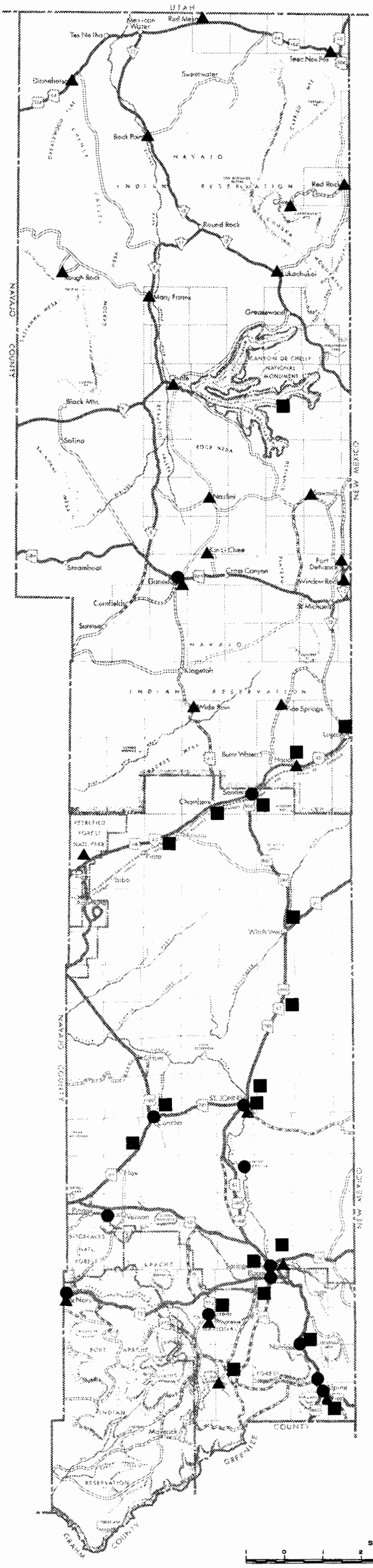
PLANNING AND DEVELOPMENT

APACHE COUNTY, ARIZONA

LAND USE PLAN

N

PLATE 2



LEGEND

Water Systems ●

Sewer Systems ▲

Dumpsites ■

SYMBOLS

Interstate Highway

U. S. Highway

State Highway

City, Town, Settlement

Railroad

River

Lake

Mountain

County Boundary

State Boundary

SCALE—MILES

0 1 2 3 4 5 6 7

ENVIRONMENTAL SERVICES NEEDS STUDY

PREPARED BY

DEPARTMENT OF ECONOMIC
PLANNING AND DEVELOPMENT

APACHE COUNTY, ARIZONA
LOCATION OF FACILITIES

N

PLATE 3

CHAPTER III. COMMUNITY PROFILES

The primary intent of this series of Environmental Services Needs Reports, has been the presentation of background information on small rural communities as to their present situations and projected needs for water supply system improvements, sewage disposal facilities, and for solid waste management services. In this chapter, profiles on rural communities of Apache County are presented. These profiles are made up of a brief discussion of historical background, natural physical systems (environment), the population and its economic base conditions and man-made systems including land use, water supply networks, sewage treatment systems and current solid waste disposal practices.

From the available information generated in part by community surveys, projections are developed which outline the needs (demands) the community can reasonably expect in future years upon environmental services systems.

COMMUNITY OF ST. JOHNS

HISTORICAL PROFILE

The community of St. Johns was originally a Spanish settlement called El Vadito at the site of an early crossing on the Little Colorado River. In 1873, Solomon Barth, an Indian Trader, won cattle and land in a poker game played with residents of the settlement, and remained there with his brothers, Nathan and Morris. The Barth's changed the name from El Vadito to San Juan (Spanish for St. Johns). The name was Americanized to St. Johns sometime before 1879, when it first became the county seat. In 1875, Solomon Barth sold his land holdings to a Mormon agent, Ammon Tenney, but the Mormons did not become a part of the community there until 1880. Ammon Tenney and Welford Woodruff established a community called Salem a mile north of St. Johns. It was abandoned about six months later when the Mormons moved into St. Johns.

A post office was established at St. Johns in 1880 when the community lost the distinction of being County Seat to Springerville from 1880 to 1882. However, in 1882, St. Johns was again made County Seat and has remained as such to the present.

NATURAL CHARACTERISTICS

The community is situated on the western bank of the Little Colorado River about 65 miles southeast of Holbrook and 29 miles north of Springerville-Eagar. Topography of the area consists primarily of rolling plains with slopes seldom greater than five percent, in an area of the state known as the Colorado Plateau Province. The elevation is 5,725 feet above mean sea level (PLATE 4).

A sector of the community is within the flood plain of the Little Colorado River. Soils found in this area are typical of flood plains as they are characterized as deep loamy, clay or sandy placed on alluvial fills.

These soils are ideal for agricultural use, being nearly level (0 to 2 percent slopes) flood plains or gently sloping (2 to 5 percent) fans with clay textures which have slow permeabilities. West of St. Johns the soils take on sandy loamy horizons while to the east soils are given the classification of "bad lands". In this area soils are actively eroding clayey shales with some rock outcrops exhibited. It has been estimated these soils contribute about 1-3 acre feet of sediment per square mile to the surface runoff entering the Little Colorado River.

Deeper geologic formations consist of sand, silt, gravel alluviums which take on a conglomerate horizon deep beneath the Little Colorado River which become shallower moving away from the water course.

Average annual precipitation for St. Johns amounts to about 10-12 inches per year. Pan evaporation rates are estimated at 54 inches per year. Daily temperatures range from about 100 degrees in the summer to about 0 degrees in the winter with an average annual temperature of 53 degrees.

The climate and soils establish the basic conditions for vegetal cover found in the area. Vegetation is primarily Oak woodland to the south. Principal species include the Emory oak, Mexican blue oak and Arizona white oak. Found within this vegetative complex are several species of grasses, i.e., bluestem, sideoats, black and blue grama, which begin to dominate the terrain moving north of St. Johns. Here, the oak woodland transgresses to the northern grassland classification. The predominant grass species found are blue grama, sideoats, hairy grama and galleta. As is the case wherever you find grasses, you also find weeds, and for this area principal species are Winterfat, Lilaria and Indian Buckwheat.

SOCIO-ECONOMIC PROFILE

The town has basically been a farming community in the past. There are a few retail stores and a motel on the main street. St. Johns is the county seat and as a result there is a large amount of government employment. St. Johns also has a high school and elementary school.

With its increased water supply, there is a possibility that new industry will locate in the town. However it is difficult to predict what size firm would locate there. For this reason, the population projection given in Figure III-1 precludes the possiblity of a large firm locating in St. Johns. The community had a population of 1,320 according to the 1970 Bureau of the Census report.

MAN-MADE SYSTEMS

Land Use-Present Patterns

St. Johns encompasses a land area of 3,520 acres. Land which has been developed for urban purposes, (residential, commercial and industrial uses) accounts for only nine percent of this total land area. The remaining 91 percent of the city is either classified as agricultural or as vacant land (PLATE 5).

Residential land uses occupy 56 percent of the developed land area (TABLE III-1) and is predominantly composed of single family dwelling units. Approximately one-third of the single family housing units are considered either delapidated or deteriorating. These substandard units are scattered throughout the community, a heavy concentration along the River in the original townsite.

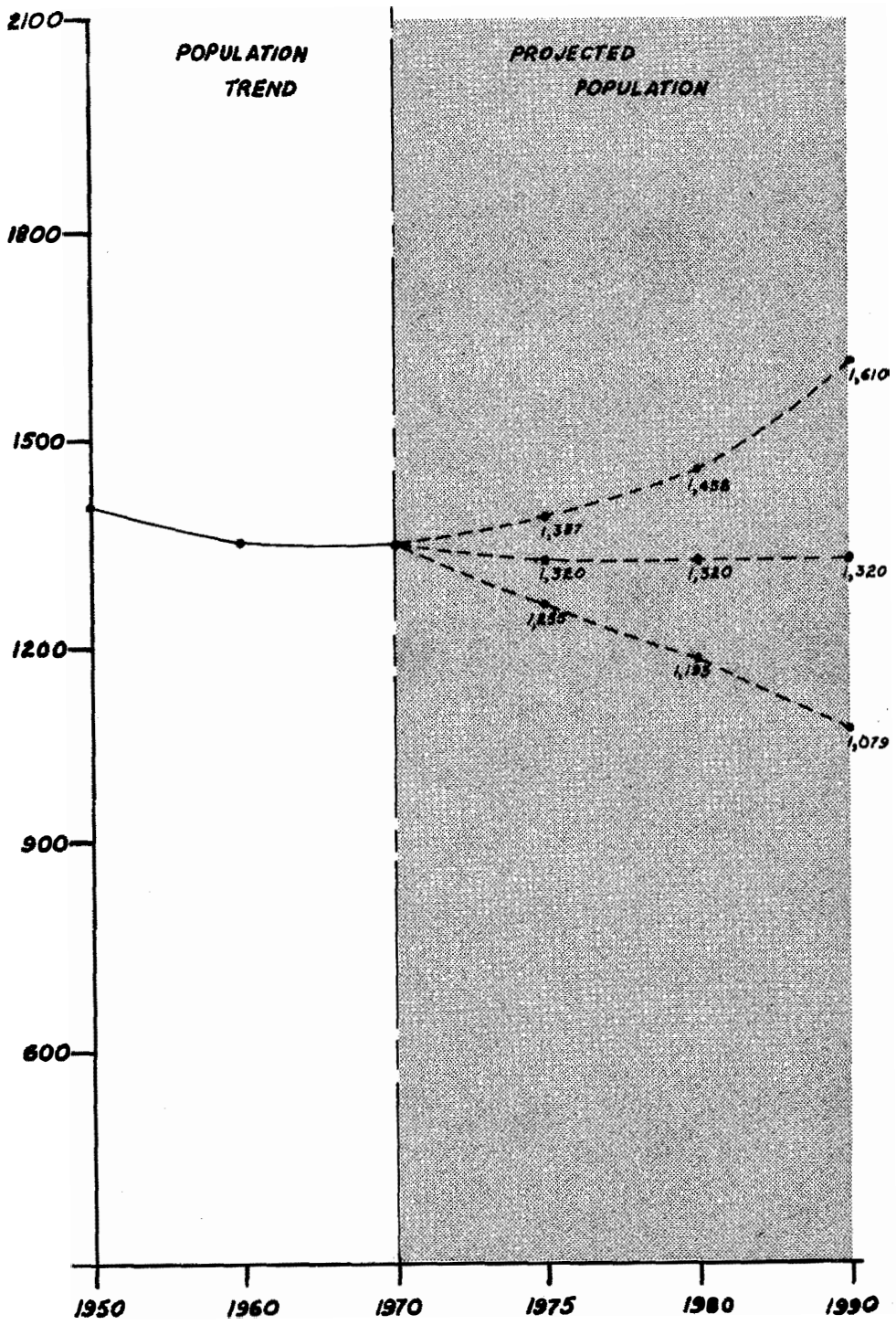


FIGURE III-1. POPULATION OF ST. JOHNS AND PROJECTIONS TO 1990

TABLE III-1

LAND USE IN ST. JOHNS

Type of Use	Number of Acres	Percent of Developed Area
Residential	191	56
Retail and Service	9	3
Heavy Commercial and Industrial	7	2
Public and Semi-public (Except Airport)	19	6
Roadways	113	33
Total Developed	340	100
Undeveloped Land	3,180	
Total Land Area	3,520	
Percent Undeveloped	90.4	

Source: Comprehensive Plan, City of St. Johns and Vicinity, by I. Dale Despain and Associates.

Commercial land uses account for three percent of the developed land area within the city limits. Except for the highway businesses, i.e., restaurants, and service stations, they are predominantly service oriented stores, such as clothing, food and specialty shops. Public and quasi-public land uses account for six percent of the developed land area. This category does not include the airport which is classified as industrial by a recently completed comprehensive plan.

Industrial land uses consist of the airport, open storage yards and equipment repair shops. This category of land use utilizes two percent of the developed land area of the city.

Land Use - Projected Patterns - 1990

Community planning efforts and philosophies have maintained the approach that agricultural activity should be protected from the intrusion of urban uses. This is one of the primary factors used in establishing land use guidelines for various types of land uses, (PLATE 6). By doing this, emphasis is placed upon integrating agricultural activity with anticipated urban growth.

Residential development has been projected to take two forms; multi-family and single-family developments. The multi-family residential development is being encouraged to locate immediately south of the central business district. The existing neighborhoods are being encouraged to initiate redevelopment of substandard housing and public facilities.

Existing residential areas are projected to move west and south. This places these new developments above the flood plain of the Little Colorado River and away from the agricultural activity.

The commercial development is projected to continue along Commercial and Cleveland Streets expanding towards the city limits.

Little projected expansion of public and quasi-public land uses are included in the land use guideline beyond the requirements for new schools and parks to accommodate the anticipated growth of new residential areas.

It is anticipated that future industrial development will continue to be agriculturally and locally oriented rather than manufacturing types of industrial activities. The land use guideline suggests that new industrial uses be located adjacent to the airport property.

WATER SUPPLY AND DISTRIBUTION NETWORK

Existing Facilities

The St. Johns Water Works Company was started about 1899 when water was hauled from a spring and sold at retail throughout the town. Twenty years later some mains were installed and water was piped in from McIntosh Spring about 4-1/2 miles east of town. A few years later, water from Schuster Spring, about 8-1/2 miles west of town, augmented the McIntosh Spring supply. These supplies were soon found not to be adequate and further supply augmentation was instituted by use of Lyman Dam water out of the Lyman Canal. The "Water Works" purchased 40 acres of land which at that time carried 40 shares in the project. The company has constructed two earth dam reservoirs with a combined capacity of 5,000,000 gallons in which to store canal water taken from the Little Colorado River. These reservoirs are also used as settling basins for removal of suspended matter prior to filtering. These reservoirs are about 2-1/2 miles from the city.

A series of pressure sand filters, were installed in 1961 to treat the water prior to delivery to the distribution network through a transmission main running from the filter plant to the steel storage tanks. These units together with a chlorinator, a wash water tank (2,500-gallon capacity), and the raw water and backwash pumps are all housed in a building located near the reservoirs.

A share in the Lyman Water Company entitled the owner of said share to the quantity of water that would pass over weir under a 7-inch head during a specified period of time. The time period was set each year by the Lyman Water Company and has varied from one hour to four hours, depending on storage in Lyman Dam and estimated runoff.

In 1918 a Final Decree was issued in the Superior Court of the State of Arizona, in and for the County of Apache, that recognized and delineated the rights of the Lyman Water Company and designated the lands on which the water could be used. It is a common practice for parties to rent shares from other parties as required in order to secure additional water for certain project lands.

In addition to Lyman water, waters from McIntosh Spring and Schuster Spring (approximately 5 gpm and 15 gpm, respectively) are still being used.

The normal irrigation season is from the middle of April to the middle of September. The balance of the time, five months, the canal is normally dry, and it is during this period that the water in the earth reservoirs and the springs constitute the source of supply for the community. The transmission mains from the sources of supply are: a 1 1/2 inch steel pipe from McIntosh Spring to town; and a 2 1/2 inch and a 2-inch steel pipe from Schuster Spring to the tank site. A 6-inch main carries the water from the filters to the 35,000-gallon and the 100,000-gallon storage tanks. A three-inch steel tubing and a 6-inch cement asbestos pipe carries Lyman Dam and Schuster Spring water from the storage tanks to the community.

In 1952 a thorough study was made of sources of water supply in an around the City of St. Johns. The results of that study show that the most economical source of good water were the present sources - Lyman Dam water, Schuster Spring and McIntosh Spring. Evaluation of the springs at that time indicated that it was doubtful if the Spring water flow could be augmented appreciably, but additional shares of Lyman Water Company could be purchased or rented by the City as required to insure an adequate source during dry years of during future periods.

The 1918 Decree allotted water to specific acreage (15,000) in the project area for the purpose of sucessfully cultivating the lands thereof and no mention is made of domestic use. In this regard the City attempted to obtain from the Lyman Water Company a specific number of shares and the water available therefrom for domestic use. It was thought that about 80 shares together with the available Spring water should provide an adequate supply of water for the City for the next 25 to 30 years.

This plan did not come to fruition whereby the City applied for and eventually obtained a grant in aid through the Farmers Home Administration in 1971 for constructing an eight inch transmission main extending from a well acquired in Concho approximately 15 miles west of the community.

Water quality data for the new well source and the Lyman Lake source are noted in TABLE III-2

The new well supply is of better chemical quality than the surface sources in addition to being a much safer source of water for the community. This well has a delivery capacity of approximately 215 gallons per minute which augments the 90 gallons per minute supply from Lyman Lake reservoir. Under the same grant program a 600,000 gallon storage reservoir was built 1.6 miles west of the community including connection to the existing distribution network (PLATE 7).

The distribution network serves an estimated 425 customers. Most of the water mains within the city are two inches or less in diameter. In fact, there are several thousand feet of water mains that are less than one inch in diameter. TABLE III-3 summarizes size and number of feet of water mains.

Peak average daily flows for the community are estimated at 150,000 gallons per day or 200 gallons per capita per day during the summer. Average yearly daily per capita demands drops to 85 gallons.

TABLE III-2

WATER QUALITY DATA - ST. JOHNS
(Milligrams per liter)

Chemical Constituent	Lyman Lake Reservoir	New Well Concho
Total Dissolved Solids	375.0	294.0
Total Hardness	188.0	144.0
Calcium	41.0	34.0
Magnesium	21.0	14.0
Sodium A	53.0	45.0
Alkalinity	178.0	184 (Total)
Chlorides	18.0	21.0
Fluoride	0.8	0.7
Nitrates	4.0	4.0
Sulfates	98.0	46.0

Source: Arizona State Health Department.

TABLE III-3

ST. JOHNS EXISTING WATER SYSTEM

Mains and Distribution Lines

Size of water mains (Diameter in inches)	Total number of linear feet (Distance to the nearest 10 feet)
6	8,500 (out to storage tanks)
3 1/4	2,700 (out to edge of map)
3	5,000
2 1/2	450
2	13,700
1 1/2	3,720
1 1/4	15,550
1	10,920
3/4	11,900
1/2	4,750
All sizes	77,190
All sizes under 6 inches	68,690 or 89% of total linear footage

Projected Future Needs.

The basic need of the St. Johns water system at this time is to replace small water mains with larger more efficient lines. This would offset fire insurance rates and reduce water loses through the network. Future water supply demands for the community are noted in TABLE III-4.

The projected summer demands are noted to be greater than twice the winter demands primarily because of evaporative cooling units and increased irrigation practices.

TABLE III-4

PROJECTED AVERAGE DAILY AND YEARLY WATER DEMANDS FOR ST. JOHNS IN 1975, 1980 AND 1990

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		Acre-feet Per Year
Summer High	291,000	187	338,000	225	451,000	318	
Winter	124,000		153,000		226,000		
Summer Median	277,000	178	306,000	204	371,000	261	
Winter	118,000		139,000		185,000		
Summer Low	271,000	174	291,000	194	335,000	236	
Winter	115,000		132,000		167,000		

Source: Staff Calculations.

SEWAGE COLLECTION AND WASTEWATER TREATMENT SYSTEMS

Existing Facilities

Domestic sewage disposal facilities in St. Johns consist of a collection network and a lagoon treatment facility. (PLATE 8). There is an estimated 385 residential and commercial connections to the system. Eighty-three dwellings, mostly in the outlying areas of the city, are not connected to the system. Most of the lines are eight inches in diameter. The system contains approximately 55,000 linear feet of collection mains, (175 feet per connection,) and 12,000 feet of outfall to the treatment facility located about one mile north of the central part of the city. Service charges are $3.00 per month per dwelling and $3.50 per month for commercial establishments.

The lagoon facility, built in 1963, has a surface area of 7 1/2 acres and was designed for an average flow of 85,000 gallons per day. Presently peak sewage flow to the lagoons is estimated at 115,000 gallons per day resulting in a loading of 230 pounds per day of biochemical oxygen demand. (BOD). This gives an estimated sewage loading of 31 pounds of BOD per acre per day in the facility. Criteria established by the Arizona State Department of Health indicate that the lagoons should be expanded and treatment efficiencies increased.

Effluent from the lagoons is discharged to the Little Colorado River. The practice will possibly cease in the future with respect to water quality criteria developed for this reach of the Little Colorado River by the Arizona State Department of Health. Treatment by lagoon will not provide the degree of treatment necessary to meet these standards which call for a minimum of secondary treatment prior to discharge. The criteria set up by the State of Arizona are based upon directives of the US Environmental Protection Agency.

Projected Future Needs

The sewage collection network will require periodic maintenance and expansion to accomodate future growth. The lagoon facility will require modification to meet EPA and State effluent criteria regardless of the fact that the lagoon facility appears to be working satisfactorily. Projected sewage flows for the community are presented in TABLE III-5.

TABLE III-5

PROJECT AVERAGE DAILY AND YEARLY
SEWAGE FLOWS FOR ST. JOHNS IN 1975, 1980 AND 1990

Projection Level	YEAR 1975 Gallons/day		YEAR 1980 Gallons/day		YEAR 1990 Gallons/day		Acre-feet Per Year
Summer	119,000		140,000		190,000		
High		77		94		136	
Winter	51,000		64,000		98,000		
Summer	114,000		127,000		156,000		
Median		73		85		112	
Winter	48,600		58,000		81,000		
Summer	111,000		121,000		141,000		
Low		71		81		101	
Winter	47,000		55,000		73,000		

Source: Staff Calculations.

As sewage flows increase and it becomes necessary to better the quality of treated effluent a situation arises where it may be worth investigating the off setting of increased treatment costs by use of effluent for agricultural purposes. In essence water reclamation with use of effluent for irrigation of crops which need a rich source of nitrogen and phosphates has been shown to be worthwhile.

Many water short and agriculturally oriented communities in the southwest are now considering the advisability of improving the treatment of their sewage to a point where the water can be recycled into agricultural sectors. Since costs for such treatment, above the normal treatment costs, can be moderate, it is suggested that St. Johns investigate such a program in the near future.

SOLID WASTE MANAGEMENT SYSTEMS

Existing Facilities

At the present time, a private franchise garbage collection service is available to the people of St. Johns. As a result, interests related to tidiness about the yards and premises of many of the dwellings throughout the community has been minimal due to relatively high costs of disposal through private collection services.

It is estimated at this time that the citizens of St. Johns generate 986 tons per year of solid waste materials which must be disposed of at the place of residence (burned) or hauled off to a dump site.

Projected Future Needs

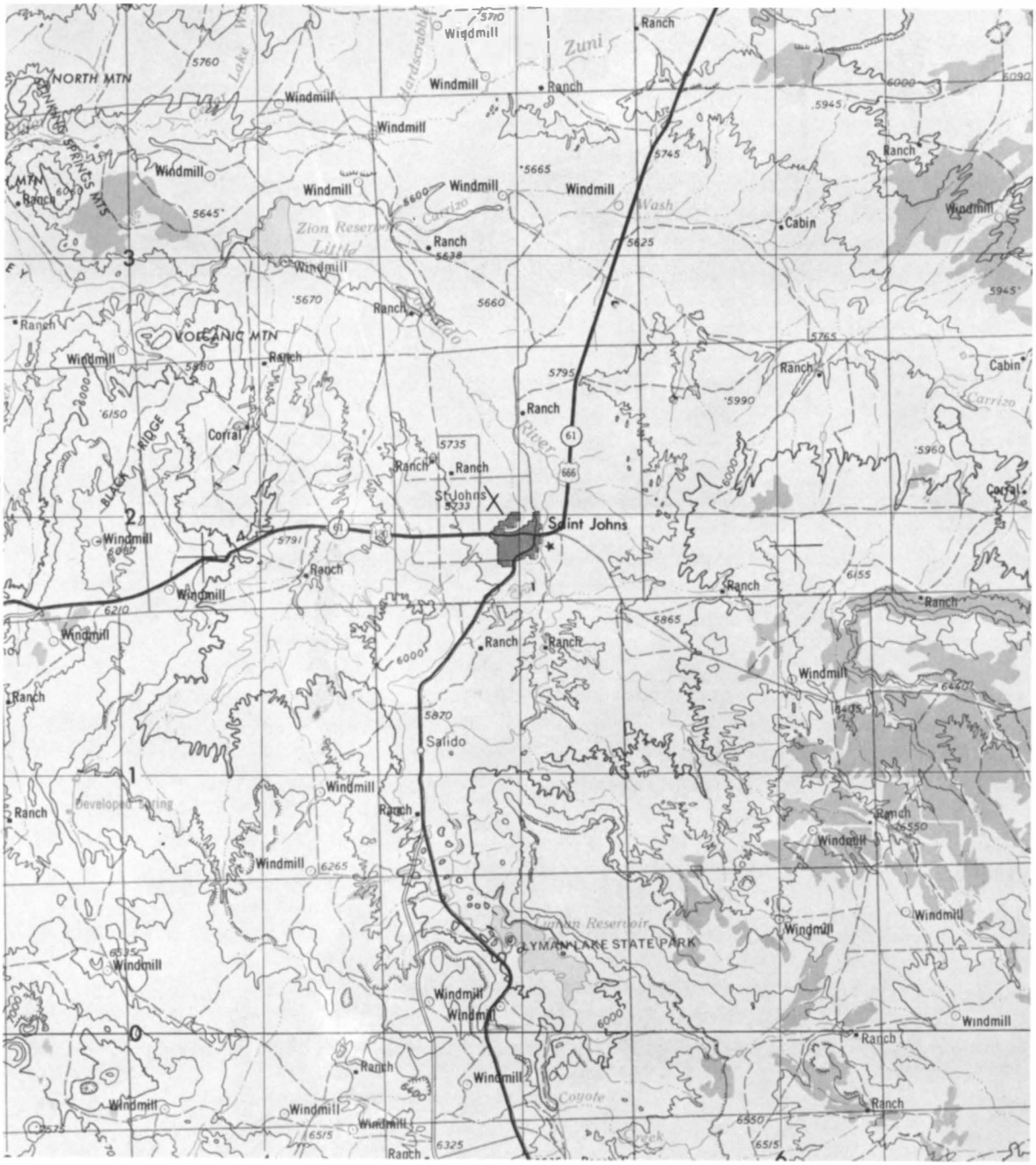
Current and future needs in St. Johns will be associated with development of a municipally run collection and disposal service. The first step in such a program is a feasibility study which would delineate the costs, capital and maintenance costs, and mechanisms for financing needed facilities.

Projected solid waste production levels for the community are presented in TABLE III-6

TABLE III-6

PROJECTED YEARLY SOLID WASTES
PRODUCTION LEVELS FOR ST. JOHNS
IN 1975, 1980 AND 1990
(Tons per year)

PROJECTION YEAR	SOLID WASTE PROJECTION LEVELS		
	LOW	MEDIAN	HIGH
1975	1,255	1,285	1,350
1980	1,460	1,530	1,690
1990	1,895	2,100	2,550



Scale 1:250,000

SOURCE: U.S. Department of the Interior
Geological Survey 1969

ENVIRONMENTAL SERVICES NEEDS STUDY

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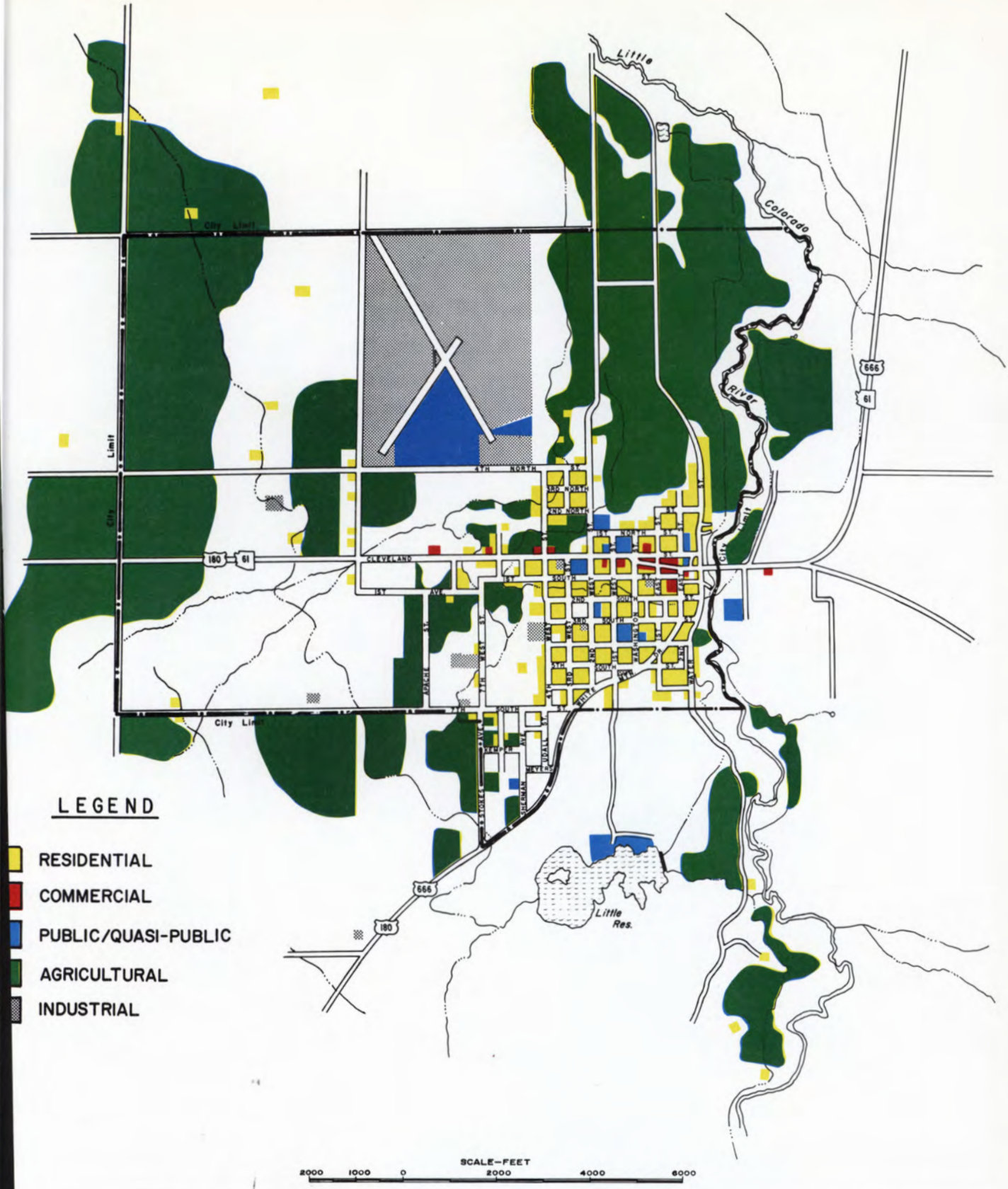
PLANNING AND DEVELOPMENT

St. JOHNS, ARIZONA

TOPOGRAPHIC FEATURES

PLATE 4



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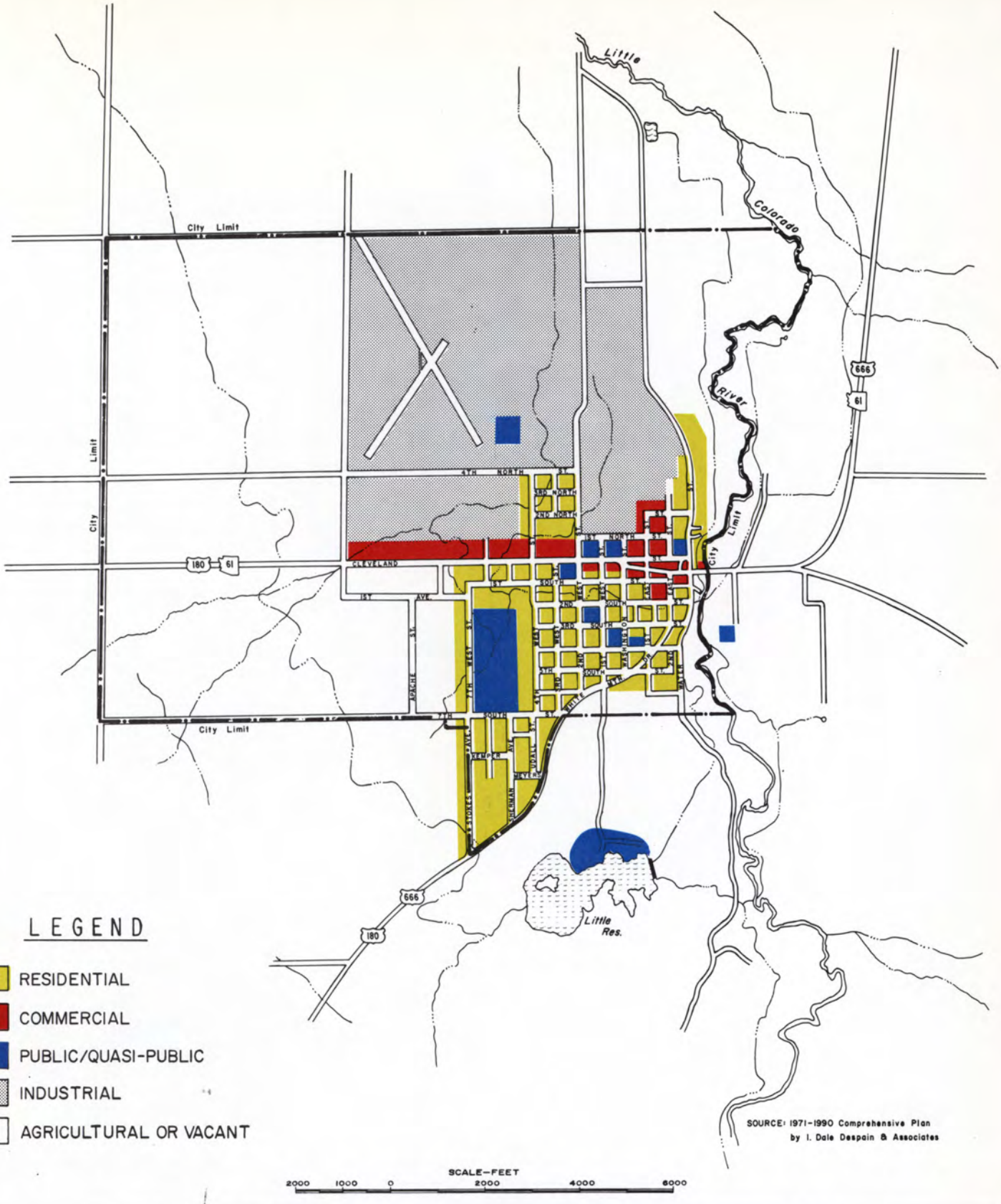
LAND USE

PLATE 5



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PROJECTED LAND USE

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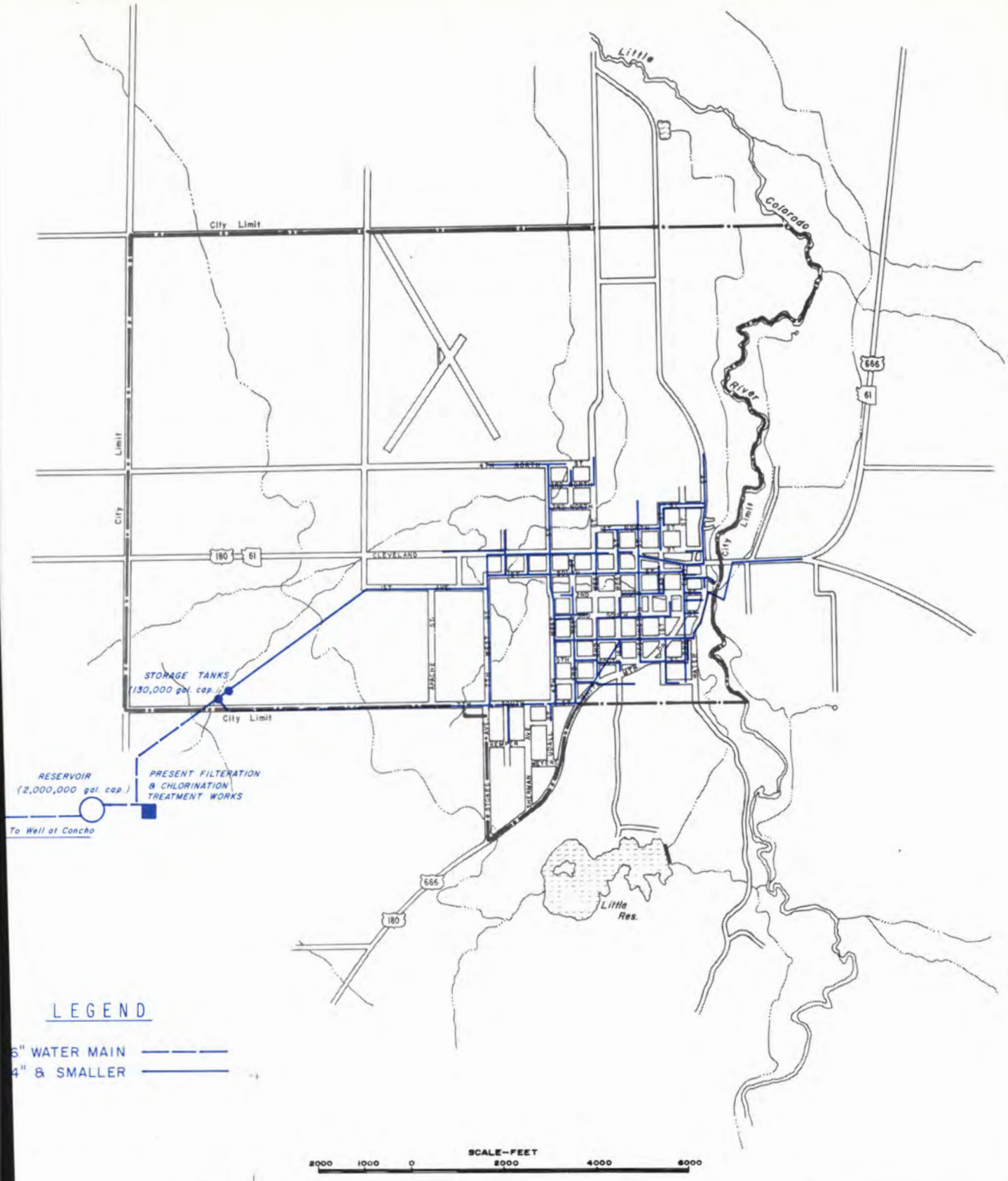
PLATE 6



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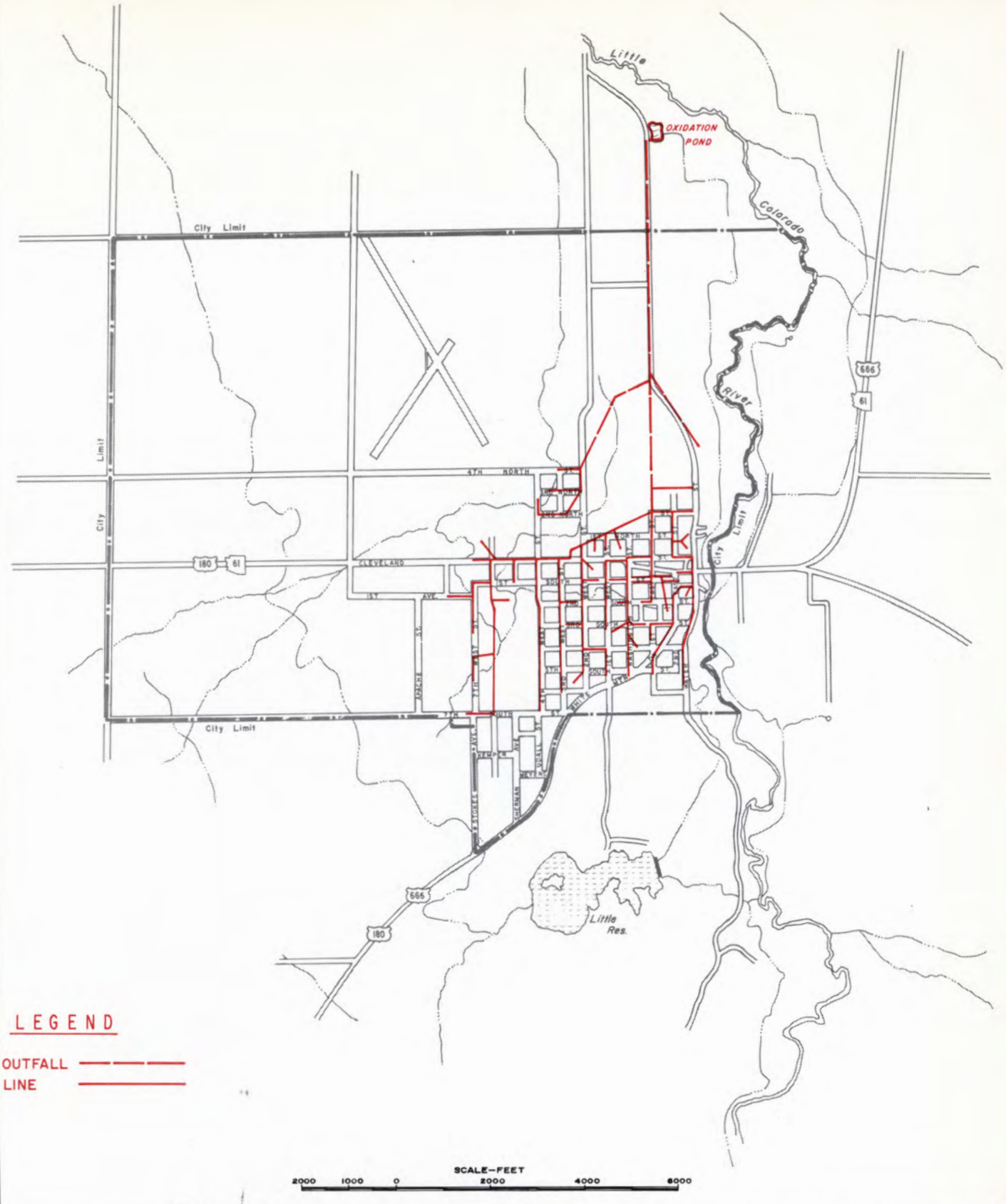
ST. JOHNS, ARIZONA

WATER SYSTEM

N

PLATE 7



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ST. JOHNS, ARIZONA

SEWER SYSTEM

N

PLATE 8

COMMUNITIES OF EAGAR AND SPRINGERVILLE

HISTORICAL PROFILE

The town of Eagar was established in 1888 on lands donated by William, Joel and Robert Eagar who, with their father, John Thomas Eagar, had homesteaded in the area during the 1870's. Originally, the community was called Union, but in 1882, the popular name became Eagar. The post office was established on February 4, 1898.

Springerville was the second known non-Indian settlement in Apache County. In 1875, Harry Springer established a store, bringing merchandise from Albuquerque. The place was known then as Springer's Store. Springer made the mistake of trusting outlaws with feed and seed and soon went broke. The townspeople jokingly called their town Springerville after he left, and that was the name given to the post office when it was established in 1879.

Shortly after Springer's failure and departure, Julius and Gustav Becker established a store in the same area in August of 1876. The Beckers used ox trains to bring in supplies until 1890, when they changed to horses and mules. After 1895, a branch railroad was completed to Magdalena, New Mexico, to speed transportation. Development and population growth in the area occurred on a slow but steady pace. The two communities gained official status through incorporation in 1948.

NATURAL CHARACTERISTICS

The Springerville-Eagar area is located in east-central Arizona near the New Mexico border on the eastern bank of the Little Colorado River in an area locally referred to as Round Valley. The communities are situated in an area where some of the finest high altitude grazing land in Arizona is found. Elevations average about 7,000 feet above mean sea level with the surrounding terrain being relatively flat to hilly. (PLATE 9). Generally flat terrain is exhibited to the northwest and northeast broken by numerous low, grassy hills. Topography takes on a mountainous character to the south with elevations rising rapidly. Escudilla Mountain, about fifteen air miles to the southwest, is 10,955 feet high at the summit. Baldy Peak, the second highest peak in the State, at an elevation of 11,490 feet, is in the White Mountains about 22 air miles to the southwest. Vegetation in these mountains consists of pine forests, the predominant species being Yellow Pine.

Geologic formations found in the immediate area are comprised of sand, silt, and gravel of basaltic origin. An extensive deposit of sandstone, limestone and shale is found about two miles north of Springerville. South of Springerville deposits of sandstone, shale and associated conglomerates become evident. The mountainous areas are composed of basaltic formations.

Surface soils found in the area normally contain over one percent organic matter having a clay or clay loam texture. Carbonates have been leached from the upper part of the soil profile and have accumulated in the deeper subsoil. Parent material consists of basalt rock and associated volcanic ash and cinders. Rock outcroppings are prevalent in the area.

The Round Valley area gets the major part of its precipitation in the summer. About sixty percent of the total average for the year falls in July, August and September. The summertime precipitation falls almost entirely during thundershowers which form in the moist, warm flow of air moving over Arizona from the Gulf of Mexico. Winter precipitation comes largely from storms originating over the Pacific Ocean that move into the state from southern California. Since the moisture associated with these storms normally moves into the state from the southwest, a large part of it falls as rain or snow over the slopes of the Mogollon Rim and the White Mountains before reaching the Round Valley region. For this reason, Round Valley does not have the marked secondary precipitation maximum in the winter characteristic of many northern Arizona cities. Because of its altitude, nearly all of the precipitation occurring during December, January, and February and the majority of that in November and March falls as snow.

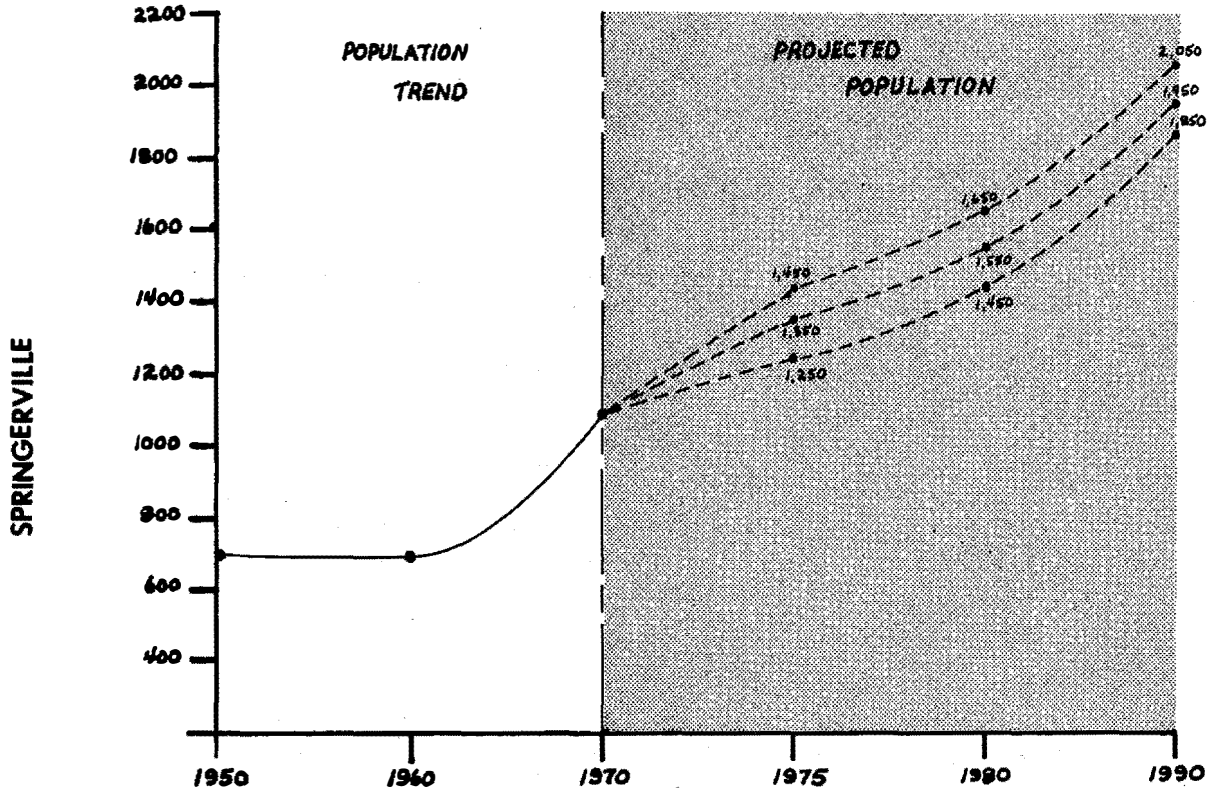
Summer weather in the area is characterized by warm afternoons and cool nights. Average maximum temperatures during the hottest part of the summer are in the low 80's and, on the average, the temperature reaches 95 degrees or higher in one summer out of ten. Winter temperatures are low, reaching as low as zero degrees on the average with ten degrees below zero also being recorded on the average of two out of five years. Below freezing temperatures are common in all but the warmest months. As a result, the average growing season extends from about the last week in May to the first week of October.

SOCIO-ECONOMIC PROFILE

These two communities are located so close to each other that they can be treated as one economy. The two communities share schools, hospital, and other public facilities.

Most manufacturing activity is in lumber processing. There is a mill which is an important source of employment for the two communities located in Eagar. A new plywood plant which will increase manufacturing employment significantly may be opened at Eagar within the next few years. Cattle raising is the main type of agricultural activity near the two communities. Retail trade and services account for most of the remaining employment. This latter type of employment should continue to grow through the next two decades. Land near the communities is being subdivided. When these subdivisions are developed, Springerville and Eagar can serve as basic service centers. The increasing popularity of the White Mountain area as a vacation site could also bring additional tourist trade into the towns.

Population figures from the 1970 U.S. Census for Springerville and Eagar are 1,038 and 1,279, respectively. Figure III-2 gives population projections for both communities. The growth forecast is partially dependent upon the opening of a new lumber mill at Eagar, increased settlement of retirees in the two communities, and growth of tourism. Springerville is forecast to have a population of 1,950 by 1990, while Eagar is forecast to have a population of 2,000. Water and sewer improvements should facilitate this growth.



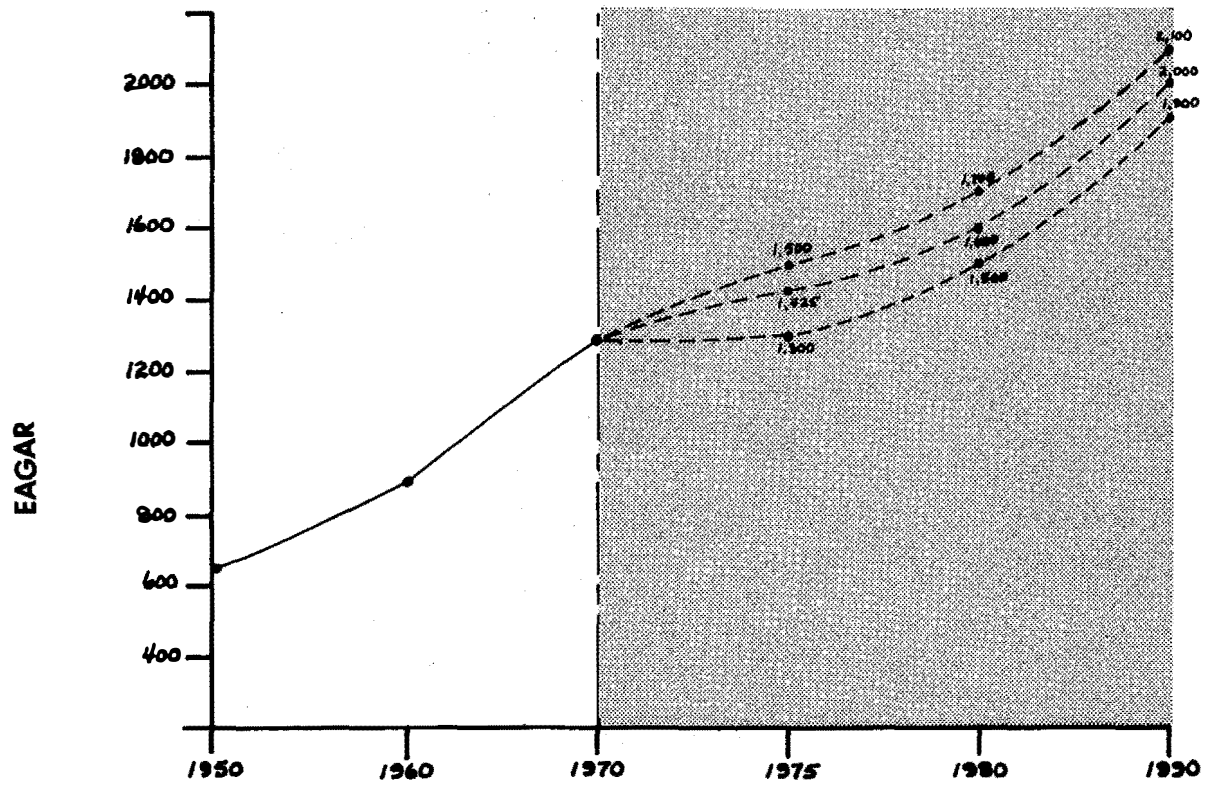


FIGURE III-2. POPULATION OF SPRINGERVILLE AND EAGAR AND PROJECTIONS TO 1990

MANMADE SYSTEMS

Land Use - Present Patterns

The towns of Springerville and Eagar, being contiguous to each other, are often considered a single locale. Although the communities have many interests in common, they retain an obvious individuality with respect to separate elementary schools and post offices. However, it facilitates the production of this report if land use patterns are discussed generally on a combined basis.

Both towns were originally laid out and platted in rectilinear patterns, in a north-south direction. The original pattern of community formation has been significantly altered in Springerville as evidenced by lot subdivision into small irregular lot shapes. In addition to developing in a east-west manner as a result of U.S. Highway 60 (PLATE 10). Eagar has maintained the adopted grid pattern as development has primarily been evident within the original town site.

The combined planning area of both communities encompasses approximately 1,620 acres. Springerville contains 800 acres of which only 245 acres are developed. Approximately 445 acres of 830 are developed in Eager (TABLE III-7).

TABLE III-7

LAND USE IN THE TOWNS OF SPRINGERVILLE AND EAGAR (1972)

Locational Land Use Classification	Springerville		Eagar	
	Acres	Percent of Total Area	Acres	Percent of Total Area
Residential	91	11.38	297	35.78
Commercial	30	3.75	4	0.48
*Heavy Commercial and Industrial	10	1.25	5	0.60
Public and Semi-public	24	3.00	24	2.89
Roadways	90	11.25	115	13.86
Agricultural	230	28.75	225	27.11
Vacant	325	40.62	160	19.28
Total Land Area	800		830	

*Heavy commercial is sometimes referred to as light industry.

Source: Comprehensive Plan, Round Valley, 1971-1990, Despain, I. 1971.

The communities are primarily people oriented in that public services are readily accessible to residents. The airport is situated in an area which is essentially isolated from the residential and public sectors while main commercial areas are found on main arterials. However to the east of Eagar and south of Springerville a terminal playa (known as Voight River) exists which has a swamp character. The area to date has been unsatisfactory for any use including agricultural.

Land Use - Projected Patterns 1990

The proposed land use plan for Round Valley was developed from a HUD 701 Planning Study prepared by I. Despain and Associates. PLATE 11 indicates the land use plan proposed by the HUD study for the Springerville-Eagar Planning area with minor modifications.

The plan describes four types of residential neighborhood development. These are: high and median density development which are located around the Springerville and Eagar commercial districts; low density residential development which makes up most of the projected residential land uses; and specialized residential development such as mobile homes and cluster development, which are indicated on PLATE 11.

The existing commercial uses for both Springerville and Eagar are concentrated in the central sector of each community. The HUD 701 plan retains these business districts. Newer commercial districts will probably not develop outside of these areas. The retail trade and services functions will remain primarily locally oriented except for those along U.S. 60 which will be tourist oriented.

The industrial uses indicated on PLATE 11 are small due to the fact that the economic base of both communities is primarily agriculturally oriented. The Southwest Forest Industries lumber mill south of Eagar is the major industrial use. A second industrial site has been proposed for the area east of the Springerville central business district.

Agricultural land uses account for the most significant amount of land both within and adjacent to the communities. The HUD 701 study proposes the maintenance of these productive lands and limiting urban development to those areas which are vacant within the existing urban area, and for the land not suited for agriculture.

A slow but steady rate of development has been the trend for the Springerville-Eagar area during the past ten years. Residential development has been the primary form of land development. Much of this residential development (second homes) will continue due to the area becoming increasingly popular for summer recreational activity.

WATER SUPPLY AND DISTRIBUTION SYSTEMS

Existing Facilities

Domestic water for Eagar and Springerville is primarily obtained from wells which are summarized with respect to size and capacity in TABLE III-8. About 20 percent of the total supply for Eagar comes from series of springs to the southwest of the town.

Available water quality data for these wells are presented in Table III-9.

TABLE III-8

WATER SUPPLY SOURCES AND DELIVERY CAPACITY
SPRINGERVILLE - EAGAR
(1972)

Source and Location	Diameter (Inches)	Delivery Capacity (gpm)*	Source and Location	Diameter (Inches)	Delivery Capacity (gpm)*
Well #1 4th & Harless	6	75	Well #1 Harmony & E. Navajo		105
Well #2 South Eagar	6	75	Well #3 Town Hall		105
Well #3 Coon Springs	10	122	Voigt River:		
			Well #1	12	90
			Well #2	8	110
Total		262			455

*Gallons per minute

TABLE III-9

WATER QUALITY DATA
EAGAR-SPRINGERVILLE WELL SYSTEM
(1972)

Chemical Constituent	Eagar Well #1	Springerville Well #1	Springerville Well #3
Total Dissolved Solids (TDS)	340.0*	290.0	325.0
Total Hardness	204.0	152.0	140.0
Calcium	46.0	36.0	34.0
Magnesium	22.0	15.0	13.0
Sodium	49.0	37.0	60.0
Iron	0.4	--	--
Alkalinity	268.0	208.0	228.0
Chlorides	10.0	4.0	8.0
Fluorides	0.8	0.6	0.8
Nitrates	1.0	1.0	1.0
Sulphates	16.0	9.0	12.0

*Milligrams per liter.

PLATE 12 indicates the location of the wells in addition to location and size of the water mains and reservoirs and other features of the water system. Most of the water mains within the two municipalities are 3 inches or less in diameter. Reportedly there are several thousand feet of water mains that are less than 1 inch in diameter. TABLE III-10 summarizes the size and length of water mains.

The distribution network in Eagar is estimated to have 420 service connections with Springerville having about 450.

While small diameter water mains are sometimes adequate in size to supply enough water to meet domestic needs, they lack sufficient capacity to satisfy fire fighting needs. Consequently, fire ratings established by the Arizona Fire Rating Bureau are reportedly high.

Rates for domestic water are somewhat different in the two towns which can be seen in TABLE III-11.

TABLE III-10

URBAN WATER SYSTEMS
EAGAR - SPRINGERVILLE

Area	Size of Water Mains (inches)	Linear Feet
Eagar	3 or smaller	56,450
Springerville	3 or smaller	10,500
Total	3 or smaller	66,950
Eagar	4	5,750
Springerville	4	27,100
Total	4	32,850
Eagar	6	5,650
Springerville	6	7,450
Total	6	13,100
TOTALS		
Eagar	All Sizes	67,850
Springerville	All Sizes	45,050

TABLE III-11

WATER SERVICE RATES
EAGAR - SPRINGERVILLE

EAGAR		SPRINGERVILLE	
Gallons Inside City	Monthly Rate	Gallons Inside City	Monthly Rate
Up to 4,000	$3.12	Up to 6,000 for one family	$2.65
4,000 to 21,000	50¢ per 1,000 gallons	Up to 9,000 for two family	$4.00
next 25,000	35¢ per 1,000		
next 25,000	30¢ per 1,000		
over 100,000	25¢ per 1,000	Over minimum	50¢ per 1,000 gallons
Outside City		Outside City	
Up to 4,000	$5.20	Up to 6,000 for one family	$4.00
Above 4,000	$1.00 per 1,000	Up to 9,000 for two family	$6.00
		Over minimum	50¢ per 1,000 gallons

Source: Town Clerks

Projected Future Needs

Both towns should implement programs directed towards augmenting their water supplies to about twice the current usage. TABLE III-12 & 13 presents anticipated water supply demands which could be expected in the two communities.

Eagar has recently made significant improvements in its water system. The most pressing need in both communities now is to replace small water mains with larger water mains and to increase available water shortage capacity.

Water storage capacity within the distribution networks of each community should be increased to approximately twice the average daily demand for each community. The projected median daily demands noted in the above tables suggest storage reservoirs of about 400,000 gallons would be adequate reserves for each system.

TABLE III-12

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

Projection Level	YEAR 1975 Gallons/day		1980 Gallons/day		1990 Gallons/day		Acre-feet Per Year
Summer High	276,000	179	330,000	222	451,000	321	
Winter High	189,000		231,000		328,000		
Summer Median	257,000	166	310,000	208	429,000	306	
Winter Median	176,000		217,000		312,000		
Summer Low	238,000	154	290,000	195	407,000	290	
Winter Low	163,000		203,000		296,000		

TABLE III-13

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

Projection Level	YEAR 1975 Gallons/day		1980 Gallons/day		1990 Gallons/day		Acre-feet Per Year
Summer High	285,000	185	340,000	228	462,000	330	
Winter High	195,000		238,000		336,000		
Summer Median	271,000	176	320,000	215	440,000	313	
Winter Median	185,000		224,000		320,000		
Summer Low	247,000	160	300,000	202	418,000	300	
Winter Low	169,000		210,000		304,000		

SEWAGE COLLECTION AND WASTE WATER TREATMENT

Existing Facilities

Domestic sewage disposal in Eagar and Springerville is provided by a collection system and a lagoon treatment facility. Each town has installed its own collection system, but both towns discharge their sewage into a jointly financed treatment facility. The majority of lines are eight inches in diameter;. An eight inch outfall line leads to the treatment lagoon which is located about one mile north of Springerville. PLATE 13 illustrates the existing sewerage system which was constructed in 1958.

Presently there are an estimated 300 connections to the collection network. Service billings are based on a monthly base fee of $2.50 residential, $3.50 commercial plus $0.25 for each additional toilet.

With adequate maintenance lagoon treatment facilities can work satisfactorily. Some additional work should be done on the facility, however, to bring it up to standard. As is the case with the majority of lagoons located in areas of cooler climate, objectionable odors evolve during the spring and late fall. This problem is, in some cases, usually a result of insufficient surface area or poorly designed loading characteristics. The Springerville-Eagar lagoon has a surface area of 7 1/2 acres. Using a population figure of four people per sewer connection and average waste loading strength of 0.17 pounds of biochemical oxygen demand (BOD) per day per person, this facility has a loading of 27.2 pounds of BOD per acre per day. An accepted design factor for lagoons in cooler climates is 30 pounds of BOD applied per acre per day which indicates possible overloading of the facility in the near future.

Presently the lagoon discharges effluent to Nutrioso Creek which is tributary to the Little Colorado River a short distance north of the facility.

Projected Future Needs

Sound planning and development scheduling of sewerage services can benefit a community from two points of view: by incrementing the collection network to provide adequate service to all growing areas of a community in a coordinated manner; and by allowing more cost effective delivery of services when they are needed.

It would be to the advantage of Eagar and Springerville to implement a planning program aimed at future service needs. Population projections indicate the need at this time for expanded waste water treatment facilities. Also the State Health Department and the Environmental Protection Agency have directives to bring about the cessation of effluent discharges from marginal sewage treatment facilities to flowing water bodies.

Projected sewage production levels for Springerville and Eagar are presented in TABLES III-14 & 15.

TABLE III-14

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

Projection Level	YEAR 1975 Gallons/day		1980 Gallons/day		1990 Gallons/day		Acre-feet Per Year
Summer	131,000		157,000		236,000		
High		84		105		177	
Winter	90,000		111,000		178,000		
Summer	122,000		147,000		224,000		
Median		79		99		168	
Winter	84,000		104,000		170,000		
Summer	113,000		138,000		213,000		
Low		73		92		160	
Winter	78,000		97,000		161,000		

TABLE III-15

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

Projection Level	YEAR 1975 Gallons/day		1980 Gallons/day		1990 Gallons/day		Acre-feet Per Year
Summer	135,000		162,000		243,000		
High		87		109		181	
Winter	93,000		114,000		183,000		
Summer	129,000		152,000		230,000		
Median		83		102		172	
Winter	88,400		107,000		174,000		
Summer	117,000		143,000		219,000		
Low		76		96		164	
Winter	81,000		100,000		165,300		

SOLID WASTE MANAGEMENT

Existing Facilities

Efficient and convenient refuse or solid waste collection and disposal contributes to the environmental health and general well being of a community. The Eagar and Springerville communities are served by a site provided by the Forest Service and funded by the county and the two towns. The site was changed during 1971, and is currently administered as a sanitary land fill facility.

Collection of solid wastes is handled by one truck for each community.

Projected Future Needs

In the future extended collection schedules may be needed. Also, compaction and collection bins may be useful to reduce the cost of hauling waste material to the disposal site. Projected solid waste quantities for each town are noted in TABLES III-16 & 17.

TABLE III-16

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

PROJECTION YEAR	SOLID WASTE PROJECTION LEVELS		
	LOW	MEDIAN	HIGH
1975	1,159	1,251	1,344
1980	1,524	1,629	1,735
1990	2,403	2,403	2,664

TABLE III-17

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

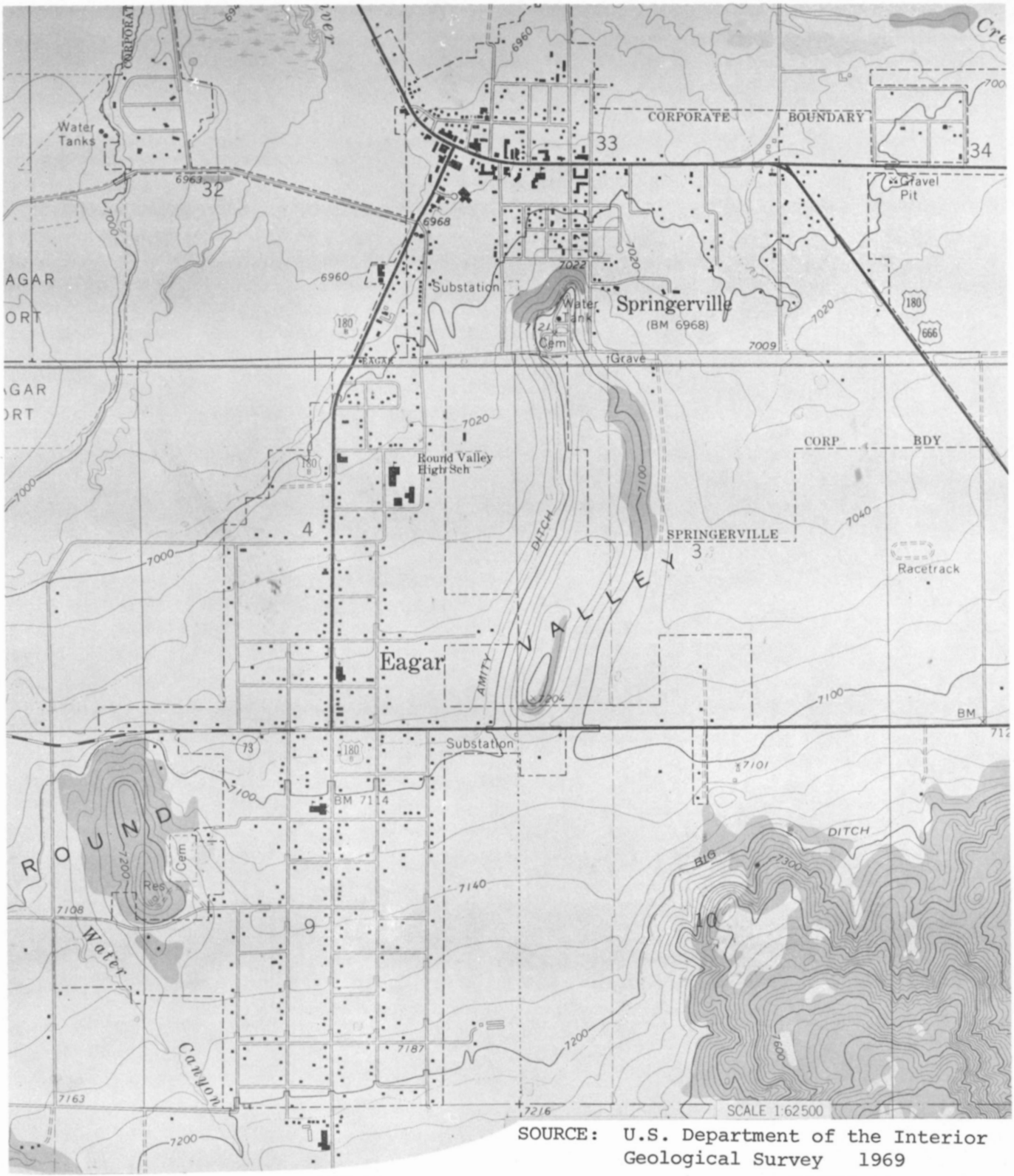
PROJECTION YEAR	SOLID WASTE PRODUCTION LEVELS		
	LOW	MEDIAN	HIGH
1975	1,205	1,320	1,390
1980	1,580	1,690	1,790
1990	2,470	2,600	2,730

SMALL RURAL COMMUNITIES AND RECREATION AREAS OF APACHE COUNTY

This section of the Environmental Services Needs Study discusses the smaller rural communities of Apache County and major areas of the county where recreational activity has resulted in rural development. These areas in all instances, hold an unincorporated status and have populations less than 1,000. Water supply and distribution services are provided by franchised investor owned utilities, sewage treatment is predominantly accomplished through septic tank disposal systems, and solid waste collection services are not readily available to residents.

Environmental services situations of the above nature are characteristically found in small rural areas. The lack of incorporated status and/or formal community governmental organization leads to difficulties in resolving problems of environmental services needs when they occur. While in most situations these areas have viable economic status during summer months, as a result of recreational activity, the permanent based year around populations are not sufficient to establish the mechanisms through which environmental services systems can be financed, operated and maintained.

Therefore, the intent of this section is directed towards development of background information for such areas to meet minimum requirements of federal assistance programs. The information presented will establish the need for additional detailed planning and/or design projects leading towards development of adequate environmental services facilities.



SOURCE: U.S. Department of the Interior
Geological Survey 1969

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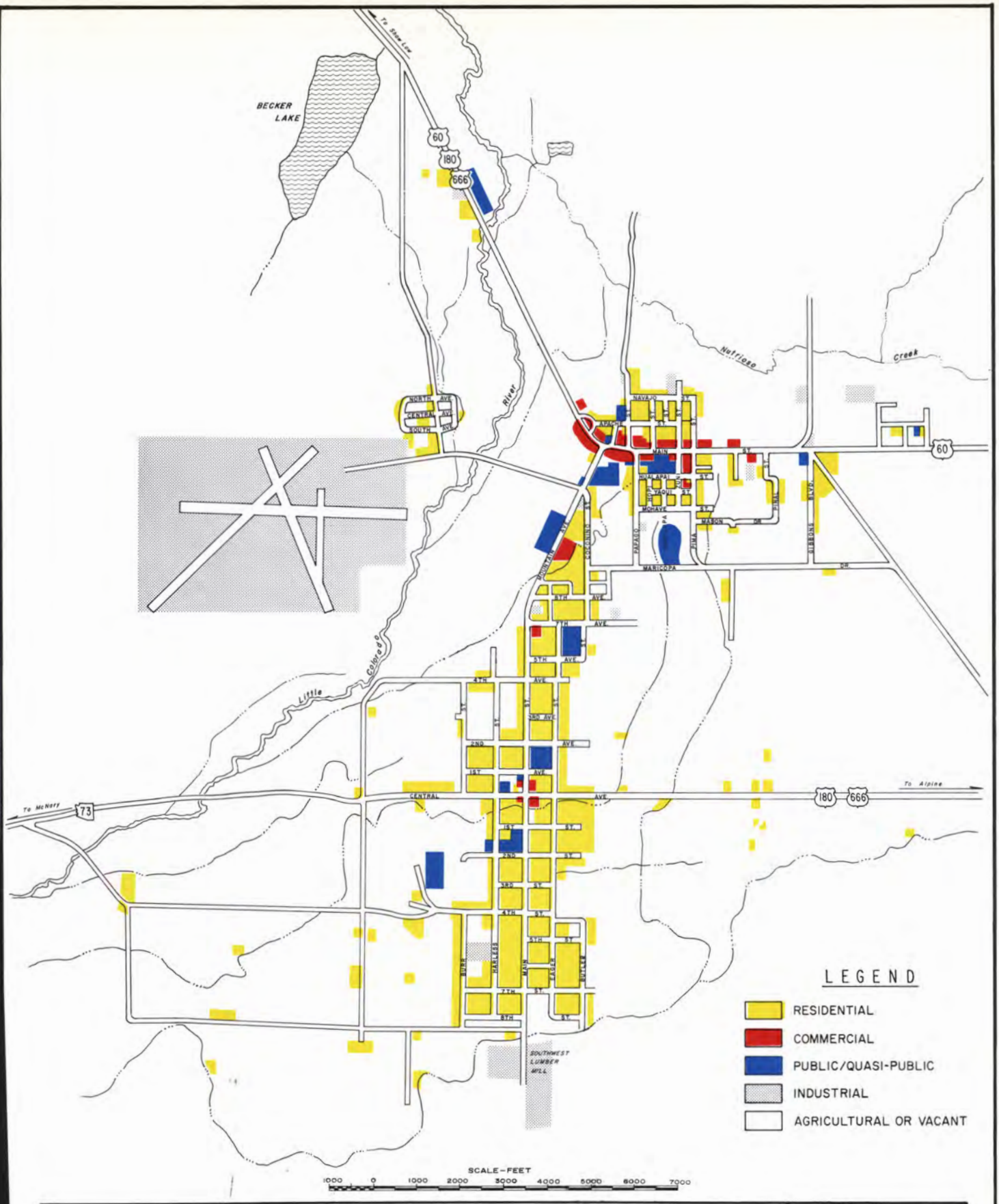
SPRINGERVILLE--EAGAR, ARIZONA
TOPOGRAPHIC FEATURES

N

PLATE 9



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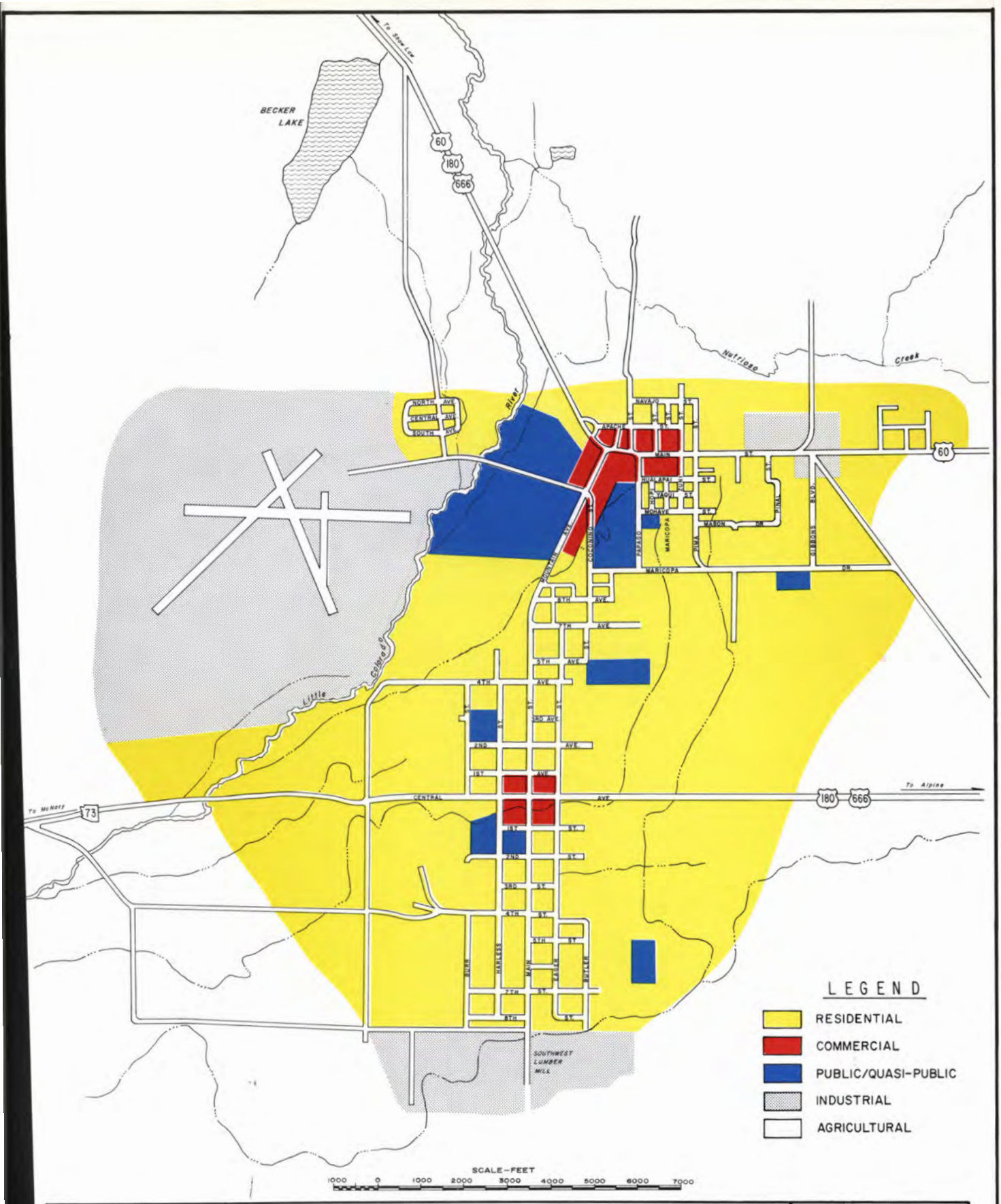
SPRINGERVILLE-EAGER, ARIZONA

LAND USE

PLATE 10



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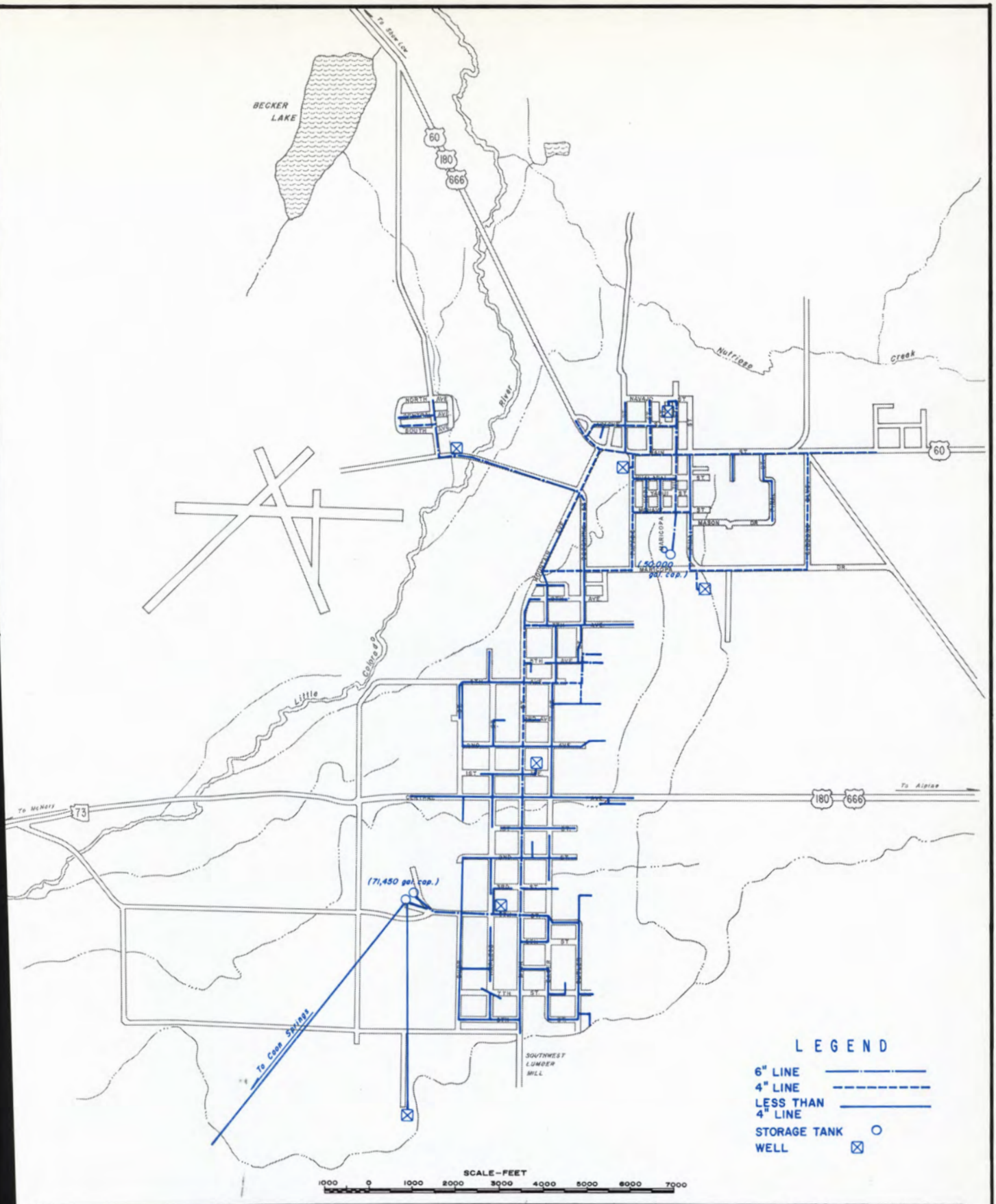
SPRINGERVILLE-EAGER, ARIZONA

PROPOSED LAND USE PLAN

PLATE 11



ENVIRONMENTAL SERVICES NEEDS STUDY

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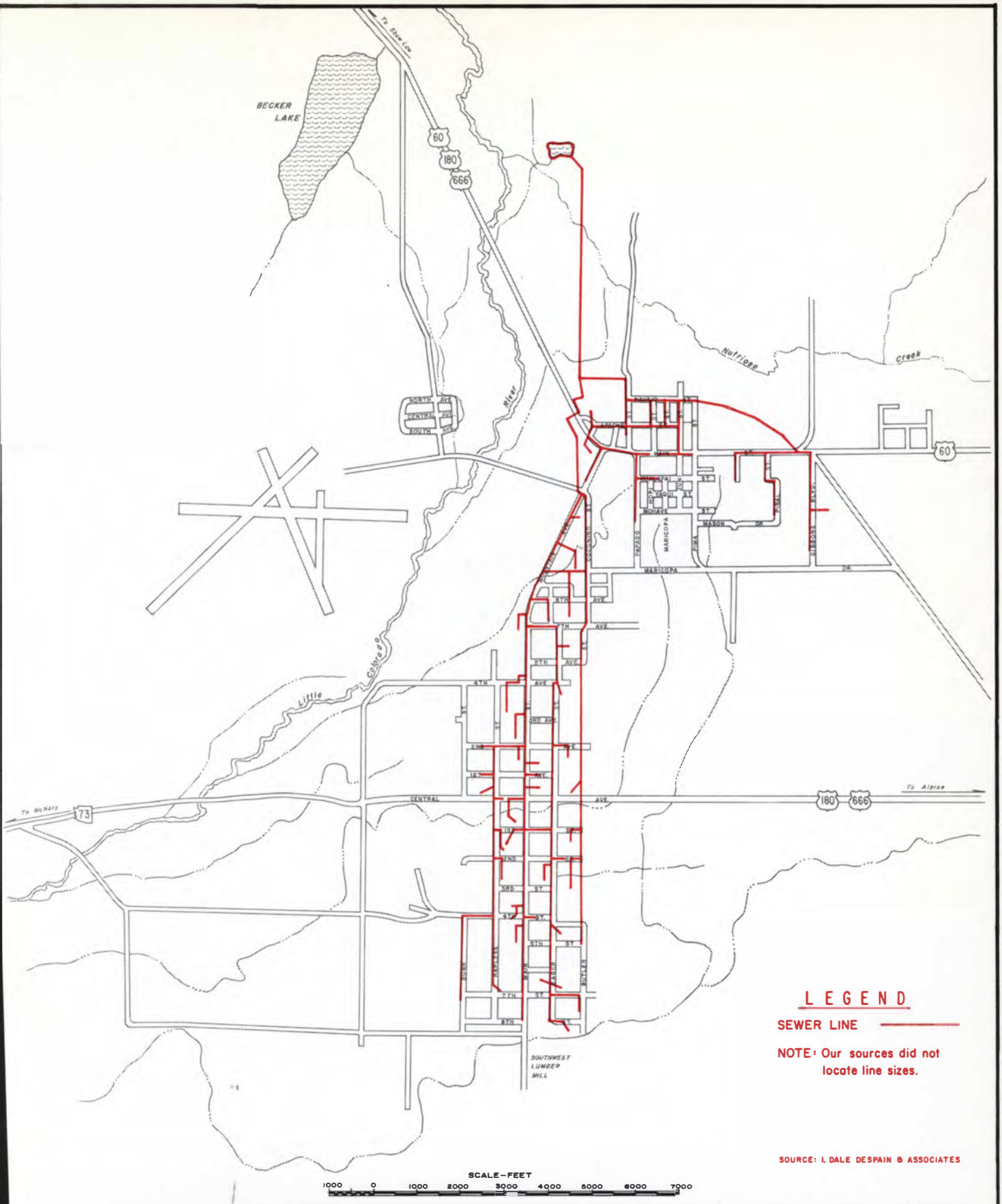
SPRINGERVILLE-EAGER, ARIZONA

WATER SYSTEM

PLATE 12



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SPRINGERVILLE-EAGER, ARIZONA

SEWER SYSTEM

N

PLATE 13

COMMUNITY OF MCNARY

HISTORICAL BACKGROUND

The original name of the settlement, McNary, was Cluff Cienega, after a Mormon Bishop named Benjamin Cluff, who worked in the area in the late 1870's. The area gradually grew into a sawmill town as the lumbering industry developed in the White Mountains during the early 1900's. The town was named Cooley in honor of a scout named Corydon E. Cooley during that period of time. A post office was established under the name of Cooley in 1919. In 1924, James G. McNary bought the lumbering interests of the area and changed the name of the town to McNary on January 11 of that year.

Physical Characteristics

McNary is located in the White Mountains of Arizona at an elevation of 7,200 feet above mean sea level. The area occupies a part of the Tonto Section of the Colorado Plateau physiographic province of Arizona (PLATE 14). South of McNary is the Mogollon Rim, a steep escarpment ranging from 1,000 to 2,000 feet high which separates the northern plateau province from the lower-central Basin and Range Province.

The major geologic structure of the area is made up of basaltic flows and volcanic cinder foundations. South of the community, older sandstone, shale and conglomerate formations are exhibited. Dominant soils over these formations have gravelly or cobbly clay loam surfaces with clay subsoils to moderate depths. The permeability ranges from slow to very slow for these soils with the characteristic of drastic volume change upon wetting and drying.

Generally, the topography is hilly with the exception of low predominantly flat terrain features in the central part of town and moving to the south. These soils support a vegetative complex made up of ponderosa pine, pinion pine, gambel oak, mountain nukly, Arizona fescue and Kentucky bluegrass.

Climate for the area ranges from moderate to severe with an average annual rainfall of 25 inches and snowfall of 95 inches.

Average maximum temperature ranges from 44 degrees in January to 80.5 degrees in July. Average minimum temperatures range from 16 to 48 for the same months respectively.

ECONOMIC BACKGROUND

The economy of the community is oriented primarily toward the lumbering industry. A minor segment of the economy is involved in serving the tourists and the summer home-owners of the area.

The area is surrounded by many year around recreational opportunities and points of interest. The Sitgreaves National Forest and Fort Apache Indian Reservation are short distances from the community. Skiing is available at the Big Cienega and Sunrise Park Ski areas. McNary is also the boarding point for the White Mountain Scenic Railroad.

The population of McNary census tract division declined from 1,885 in 1960 to 810 in 1970.

MAN MADE SYSTEMS

Land Use - Present Patterns

McNary is unique in that the majority of the developed area is located on lands leased by a private corporation from the Fort Apache Indian Reservation. The present day townsite was developed by Southwest Forest Industries Corporation on land secured under a long term leasing arrangement. Recent development has occurred on tribal land adjacent to the leased area (PLATE 15).

Within the McNary study area there are 315 acres of developed land. TABLE III-18 summarizes the land area used for each land use category and the percentage of the total developed land area.

TABLE III-18

EXISTING LAND USE FOR McNARY - 1969

Land Use	Acres	Percent of Total
Residential	200	64
Quasi-Public	30	9
Commercial	15	5
Industrial	70	22
TOTAL	315	100

Source: Interim Planning Report, Fort Apache Indian Reservation, Century Systems, 1970.

Residential land uses occupy 64 percent, 200 acres, of the developed land area. There are 111 single family dwelling units which are the predominate form of housing. According to the Fort Apache Indian Reservation Land Use Plan many of these units are considered substandard and in need of renovation or removal.

Commercial development within McNary has concentrated along Main Street around the park. The commercial uses are locally oriented.

There are also two motels along Arizona Route 73 which provide overnight accommodations for tourists.

Public and quasi-public land uses account for nine percent of the developed land in the study area. These uses include the Bureau of Indian Affairs Forestry Office, community center, school, parks and playgrounds and the hospital.

Industrial land uses occupy 70 acres which is a higher percentage of the total developed land area than normally found in communities of equal size. The industrial land uses are almost exclusively comprised of the two sawmills and related facilities.

Land Use - Projected Patterns

Residential lands will expand to the north and west of the existing residential areas (PLATE 16). The plan proposes the redevelopment of existing residential neighborhoods, bringing them up to standard while developing new housing units in new neighborhoods. Housing is anticipated to be predominately single family dwelling units with one area proposed as a multi-family development.

Commercial land uses are projected to remain along Main Street and extending south along Cody Avenue. These uses are expected to remain locally oriented. Roadway commercial uses are projected to remain along Arizona 73 within the general areas of existing highway commercial uses.

The industrial lands have been expanded to the south and east of the existing sawmills and north of Oak Street along the railroad. These new areas will probably support expanded sawmill operations.

The public and quasi-public land uses have been located to provide the required services to the projected residential developments. The school area has been increased and will be the primary area of education and recreation for the town. A new park has been proposed for the areas north and west of the community center.

Open space zones have been proposed for the areas adjacent to State Route 73. This is to protect the scenic value of the highway in conjunction with the further development of the area for recreational purposes.

WATER SUPPLY AND DISTRIBUTION

Existing Facilities

Water supply services are provided by the McNary Utilities Company. Water supplied to the distribution network comes from two wells. The chemical quality of the supply is noted in Table III-19.

The wells deliver water to the storage facilities where it is chlorinated. The distribution network has approximately 190 customers of which 15 are commercial. (PLATE 17)

Future Needs

Development of new neighborhoods as recommended under the projected land use section will generate the need for expanding the water distribution network. Depending on the size of these neighborhoods, there may also be a need for increasing well delivery capacities and/or augmentation of the supply source.

TABLE III-19

REPRESENTATIVE WATER QUALITY DATA FOR
McNARY - McNARY UTILITIES COMPANY

Chemical Species		Concentration, mg/liter
Total Dissolved Solids		100.0
Total Hardness		62.0
Calcium		38.0
Magnesium		6.0
Sodium		6.0
Alkalinity (Total)		68.0
Chlorides		3.0
Fluorides		0.27
Nitrates	(less than)	1.0
Sulfates		6.0

Source: Arizona State Department of Health.

SEWERAGE AND WASTEWATER TREATMENT

Existing Facilities

The developed area of McNary is served by a community sewage collection network which terminates at a sewage treatment plant (PLATE 18) built in 1968.

The treatment facility is designed to treat 150,000 gallons per day of raw sewage with a biochemical oxygen demand (BOD) of 203 milligrams per liter. The facility, based on the contact stabilization process, can take peak sewage loadings of 208 gallons per minute.

Future Needs

New neighborhood development within the community will possibly result in the plant reaching design capacity sooner than expected. High clay content soils prohibit the use of septic tanks sewage disposal facilities which make it necessary that these areas be annexed to the collection network.

The regional area of Pinetop-Lakeside and McNary has a tremendous influx of summer visitors which in the past has resulted in public health problems associated with inadequate disposal of sewage. The State Department of Health has found a number of instances where well water has been contaminated by sewage wastes in this region of Arizona.

Presently the State Department of Health has placed much emphasis on regional wastewater treatment facilities with the intent that they would be more cost effective. In this respect the community should consider such an approach to the resolution of future wastewater treatment needs.

SOLID WASTE MANAGEMENT PRACTICES AND TECHNIQUES

Existing Facilities

The residents of McNary are not provided with public garbage collection and disposal services. The disposal of solid waste materials is an individual responsibility. Dumpsites are located to the west in Navajo County and east near the community of Greer.

As a result of inadequate facilities it becomes convenient to practice open burning as a method of volume reduction for accumulated materials. This practice not only occurs at the disposal site, but also at the point of origin. Backyard burning of household refuse, usually in a barrel type incinerator, is commonplace in the area with little regulation.

Future Needs

McNary residents should be provided with adequate garbage collection services and the region with a properly operated sanitary landfill. Mean capital costs for collection equipment in rural areas of Arizona are estimated at about $0.52 per capita per year. Operation and maintenance amounts to $5.14 per capita per year. Rural sanitary landfills have estimated capital, operating and maintenance costs of $1.47 per capita per year, excluding land acquisition.

The first step in formulating the detailed equipment needs and sanitary landfill size and location would be development of a regional solid waste disposal plan.

In essence the plan can be applied on a regional basis as it could include the adjacent communities of Pinetop, Lakeside and Show Low.

SCALE 1:62500

SOURCE: U.S. Department of the Interior
Geological Survey 1969

ENVIRONMENTAL SERVICES NEEDS STUDY

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Mc NARY, ARIZONA

TOPOGRAPHIC FEATURES

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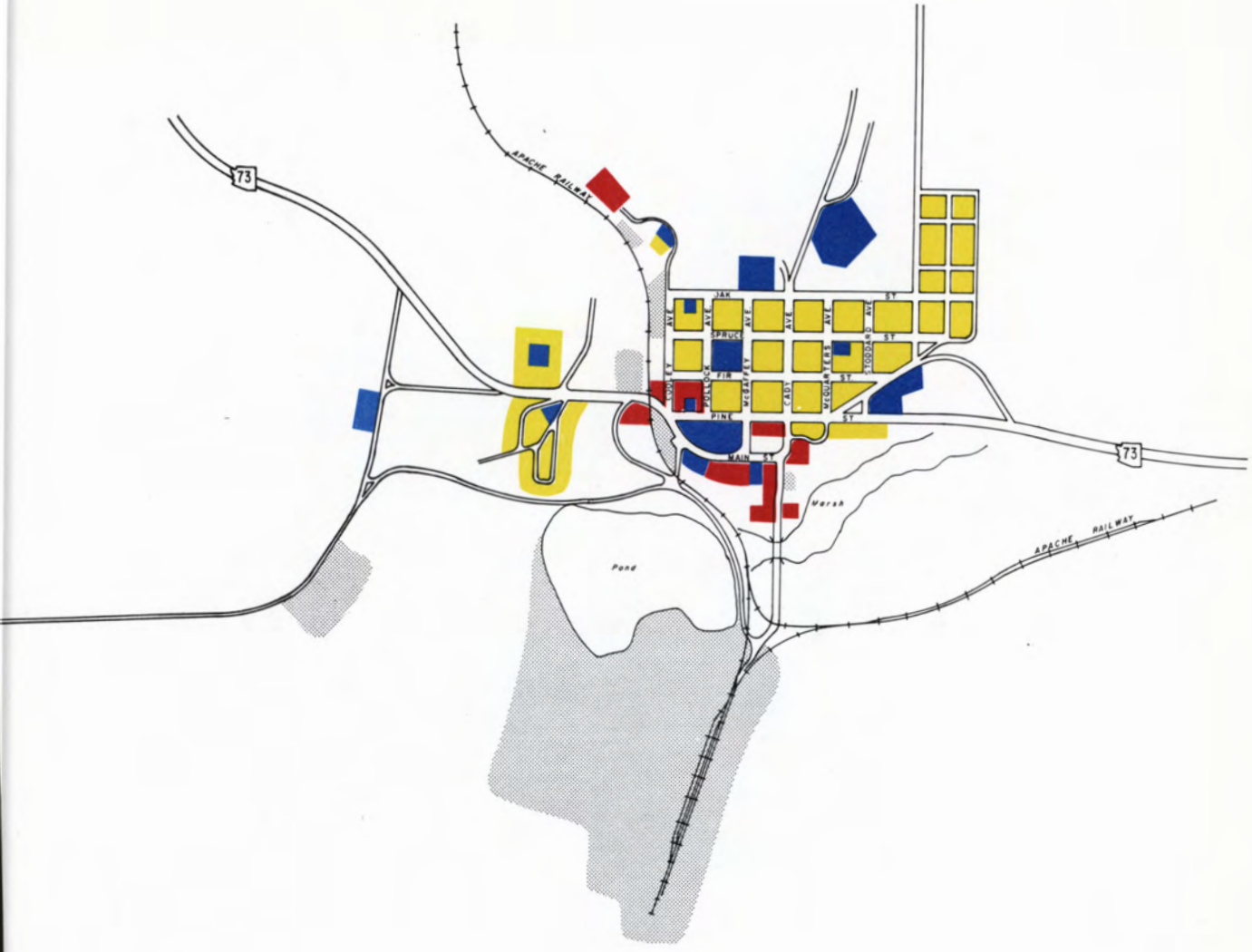
PLATE 14



LEGEND

- RESIDENTIAL
- COMMERCIAL
- PUBLIC/QUASI-PUBLIC
- INDUSTRIAL

SOURCE: Century Systems Division; Century Geophysical Corp.

SCALE—FEET

800 400 0 400 800 1200 1600 2400 3200 4000

ENVIRONMENTAL SERVICES NEEDS STUDY

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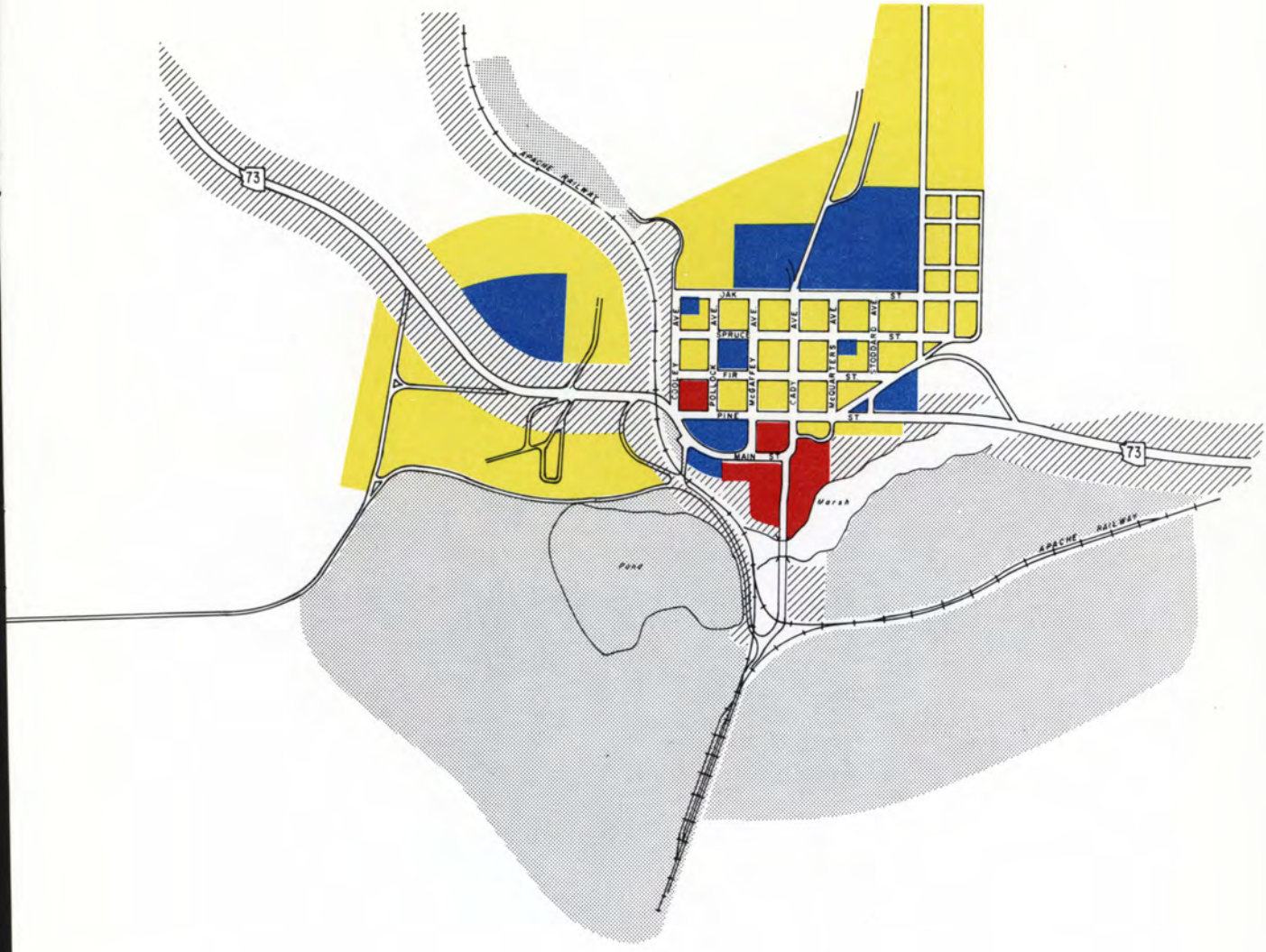
McNARY, ARIZONA

LAND USE

N

PLATE 15



LEGEND

- BUFFER
- RESIDENTIAL
- COMMERCIAL
- PUBLIC/QUASI-PUBLIC
- INDUSTRIAL

SOURCE: Ft. Apache Indian Reservation Comprehensive Plan by Century Systems Division; Century Geophysical Corp.

SCALE—FEET

800 400 0 400 800 1200 1600 2400 3200 4000

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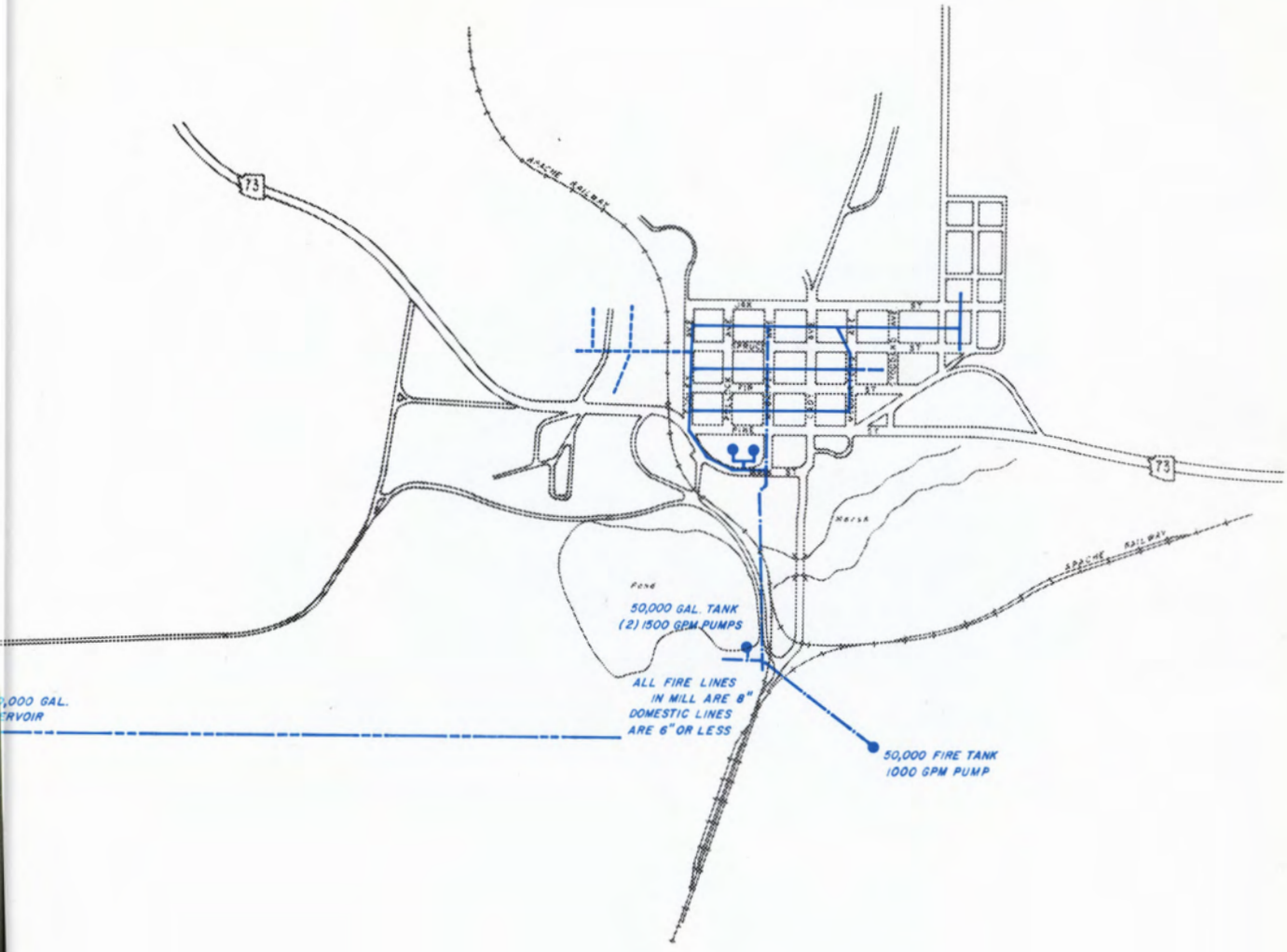
McNARY, ARIZONA

LAND USE PLAN

N

PLATE 16



LEGEND

10" LINE
8" LINE
6" LINE
4" LINE
2" LINE
STORAGE TANK

SCALE—FEET

800 400 0 400 800 1200 1600 2400 3200 4000

ENVIRONMENTAL SERVICES NEEDS STUDY

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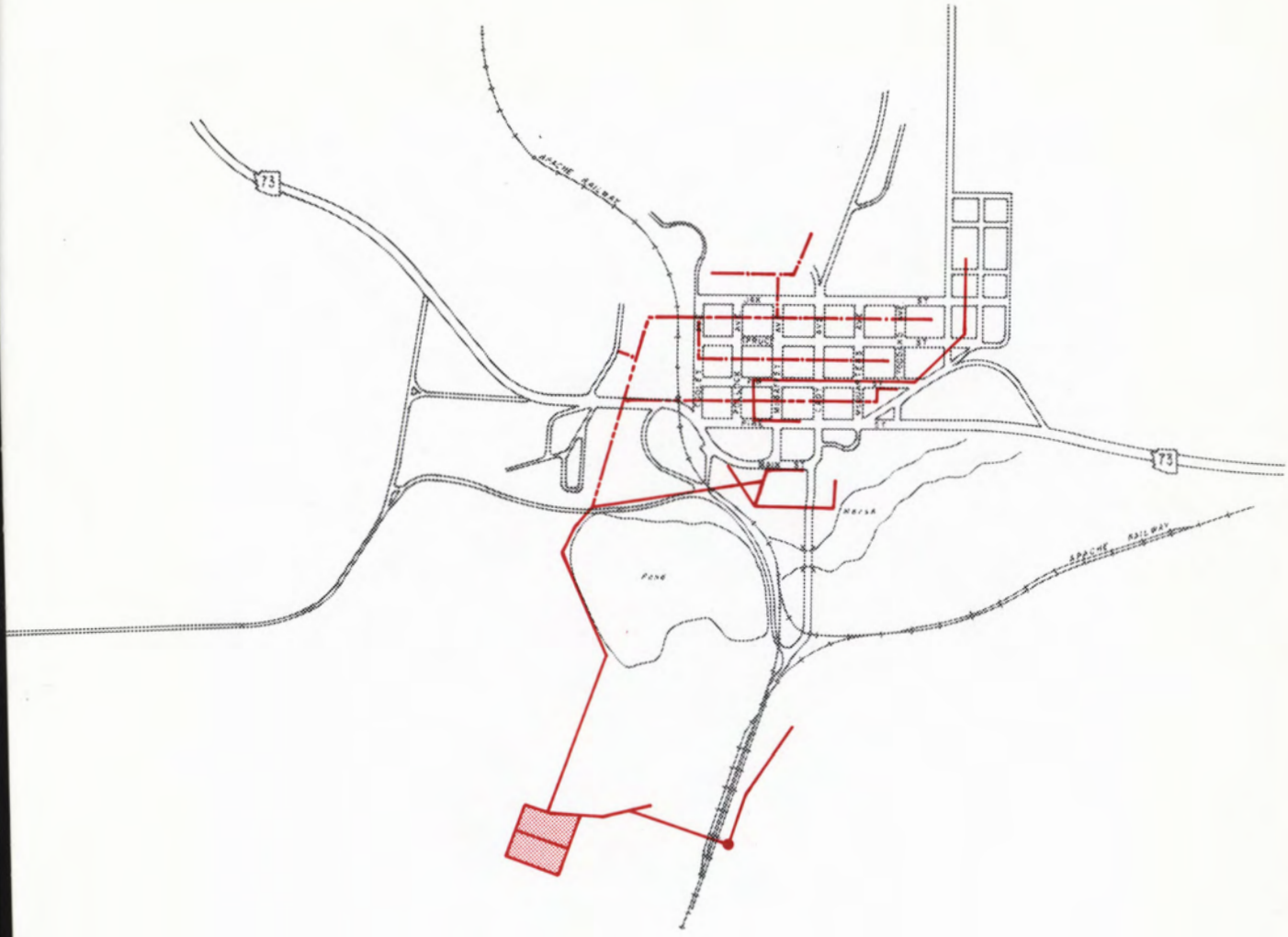
McNARY, ARIZONA

WATER SYSTEM

N

PLATE 17



LEGEND

15" LINE

8" LINE

6" LINE

LIFT STATION

LAGOONS

SCALE—FEET

800 400 0 400 800 1200 1600 2400 3200 4000

ENVIRONMENTAL SERVICES NEEDS STUDY

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PLANNING AND DEVELOPMENT

McNARY, ARIZONA

SEWER SYSTEM

N

PLATE 18

COMMUNITIES OF ALPINE, GREER CONCHO AND NUTRIOSO

The above community developments are small rural areas with permanent estimated populations ranging from 50 to 300. The general features of each area are presented in PLATES 19, 20, 21 and 22.

The Alpine and Nutrioso areas are located 25 miles south of Springerville-Eager in the Escudillo Mountains on US 666.

Greer, situated within the Apache National Forest, is about 10 miles west and seven miles south of the Springerville-Eager area. All three of these areas have ideal summer climates resulting in extensive development of cottages and homes used for summer vacations and/or recreational activities. Residency swells during the summer season to nearly 10 times the permanent based populations.

Concho is located approximately 14 miles west of St. Johns at the junction of highways US 180 (Alternate) and Arizona 61. Concho is known as the earliest non-Indian settlement in Apache County. It was established in the late 1860's and taken over in 1879 by Mormon settlers who called the town Erastus for a short time, but returned to the name Concho in 1890.

WATER SUPPLY AND DISTRIBUTION SYSTEMS

Existing Facilities

Domestic water supply services are provided by franchised water companies. These companies are outlined briefly by area in the following paragraphs and Tables III-20 through III-24.

Permanent and summer residents of the Alpine Area are served by six water supply companies; Alpine Water Company, Alpine Water System, Chapache Water Co-Op, Meadow View Cottages; Aspen Lodge; and Tal-Wi-Wi Water Company. The first two noted above are the largest of the systems.

The Alpine Water System consists of two wells (120 and 200 feet in depth) and 10 springs. The distribution network contains 3 storage tanks with a total capacity of 140,000 gallons and 12,320 feet of pipeline. Representative water quality for wells and springs in the area are noted in Table III-20.

Customers for the Alpine Water System are noted in Table III-21.

The Chapache Water Company has one well 260 feet in depth and for 1970 had 29 customers.

The Pinecrest Water Company serves residents of Nutrioso from a well source. Water quality data is noted in Table III-22.

TABLE III-20

REPRESENTATIVE WATER QUALITY DATA
FOR WELLS AND SPRINGS IN ALPINE AREA
APACHE COUNTY

Chemical Species	Concentration, mg/liter Wells	Springs
Total Dissolved Solids (TDS)	234.0	165.0
Total Hardness	14.0	12.0
Calcium	4.0	4.0
Magnesium	1.0	1.0
Sodium	68.0	56.0
Alkalinity (P/Total)	2.0/168.0	10.0/126.0
Chlorides	4.0	4.0
Fluorides	0.0	0.0
Nitrates	1.0	1.0
Sulfates	6.0	6.0

Source: Arizona State Department of Health, Water Supply Division.

TABLE III-21

WATER SERVICES - ALPINE WATER SYSTEM
APACHE COUNTY

Year	Residential	Commercial
1973	115	22
1972	113	22
1971	112	21
1970	110	21
1969	112	20
1968	112	19
1967	110	19
1966	108	19
1965	111	18
1964	108	10
1963	108	-

Source: Arizona Corporation Commission.

TABLE III-22

WATER QUALITY DATA
PINECREST WATER COMPANY
NUTRIOSO, ARIZONA

Chemical Species	Concentration, mg/liter
Total Dissolved Solids	338.0
Total Hardness	220.0
Calcium	62.0
Magnesium	15.0
Sodium	37.0
Alkalinity	264.0
Chlorides	4.0
Fluorides	0.3
Nitrates	1.0
Sulfates	12.0

Source: Arizona State Department of Health, Water Supply Division.

Water supply in the Greer areas is provided by private lodge, ranch well, spring fed systems and the Greer Water Company.

The water company has a spring source of supply which discharges to a 47,500 gallon steel storage tank and an older stonetank that has a capacity of about 61,000 gallons. The distribution network consists of three mains which serve approximately 50 customers. Water quality data is noted in Table III-23.

Residents of Concho are served by the Concho Water Supply Company. Presently the system has 25 customers on approximately 8,000 feet of distribution main. The network has a single storage tank of 4,000 gallons capacity. Water quality data is presented in Table III-24.

Future Needs

The preceding water supply systems are small in terms of the numbers of customers and extensiveness of the distribution networks. Water supply sources for these systems appear adequate to meet future needs. The number of systems in the Alpine and Greer area suggest the consideration of consolidation of systems which would allow for more economic operation and more effective delivery of services.

It is difficult to assess which of these systems will feel the greatest demand for expansion or modification in the next twenty year period. Increasing recreational activity trends and moderate summer climate will possibly result in increased development activity to meet the demand. Under these conditions it is projected that all areas will need a community type water supply and distribution facilities.

TABLE III-23

WATER QUALITY DATA
GREER WATER COMPANY
GREER, ARIZONA

Chemical Species	Concentration, mg/liter
Total Dissolved Solids	109.0
Total Hardness	62.0
Calcium	16.0
Magnesium	5.0
Sodium	10.0
Alkalinity	--
Chloride	3.0
Fluoride	0.1
Nitrates	1.0
Sulfates	9.0

Source: Arizona State Health Department.

TABLE III-24

WATER QUALITY DATA
CONCHO WATER SUPPLY COMPANY
CONCHO, ARIZONA

Chemical Species	
Total Dissolved Solids	294.0
Total Hardness	144.0
Calcium	34.0
Magnesium	14.0
Sodium	45.0
Iron	0.1
Alkalinity (P/Total)	4.0/180.0
Chlorides	21.0
Fluorides	0.7
Nitrates	1.0
Sulfates	46.0

Source: Arizona State Department of Health,
Water Supply Division.

SEWERAGE AND WASTEWATER TREATMENT

Existing Facilities

The Alpine, Nutrioso, Concho and Greer areas of Apache County utilize the septic tank system for sanitary disposal of sewage wastes in addition to pit privies. The use of septic tanks for rural areas is possibly the most economical means of waste disposal. Except in areas where soils are incompatible with septic tank systems, this form of disposal is justified. Densities of less than one septic tank per acre are not uncommon.

Significant problems have occurred in the Greer area due to the lack of sufficient topsoil within which a leach field can be expected to work satisfactorily. Recent sampling of the Little Colorado River by the Arizona State Department of Health indicated that septic tank effluents were contaminating the surface waters passing through the area.

In addition to lack of top soil, soils present have high clay contents which makes the situation more complex.

Soils in the Alpine area are also high in clay content even though there is a soil mantle in which a leach field could be constructed.

Future Needs

Septic tank sewage disposal facilities will continue to be the predominant means for adequately disposing of sewage wastes in rural areas. However, in the areas of Greer and Alpine, community collection and disposal facilities should be developed. The area of Alpine has formed a non-profit sewer company to act as a vehicle for financing needed facilities. To date a successful program has not been implemented.

SOLID WASTES DISPOSAL PRACTICES AND TECHNIQUES

Exising Facilities

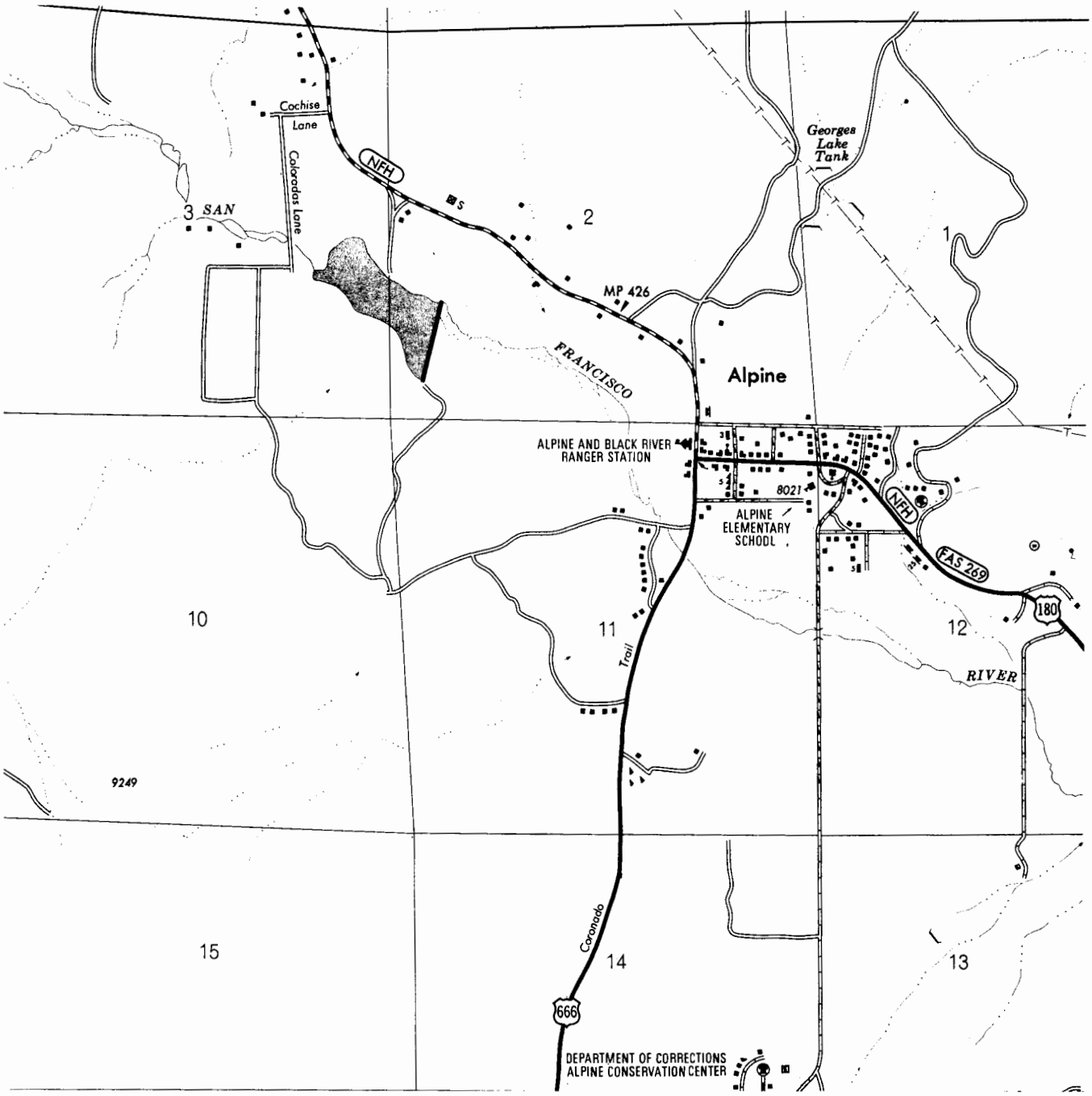
All areas of development discussed are without services for collection and disposal of solid waste materials. Individual responsibility prevails for disposal of collected wastes at area dumpsites or by burning. Open dumps are periodically maintained by County Highway Department or the U.S. Forest Service. However, burning of accumulated materials is a common practice by those who utilize the dumpsites. Sanitary landfills are non-existent in the county, except in the Eager-Springerville area.

Future Needs

The county should conduct a detailed study of waste production levels in all areas of development to support the formulation of a detailed study on the location of regional sanitary landfills. Such facilities would serve all areas of present and future development.

Recreation Area Needs

There is little need for any immediate or near-future changes in water supply systems, sewage, or solid waste disposal facilities for the recreation areas of Apache National Forest. Recreation and camping accommodations are served by a spring-fed distribution system and wells. Campgrounds are served by vault privies. No problems have arisen with these facilities. The remoteness of some of the recreation sites presents a problem in collecting and disposing of solid waste.



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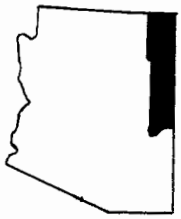

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GENERAL FEATURES

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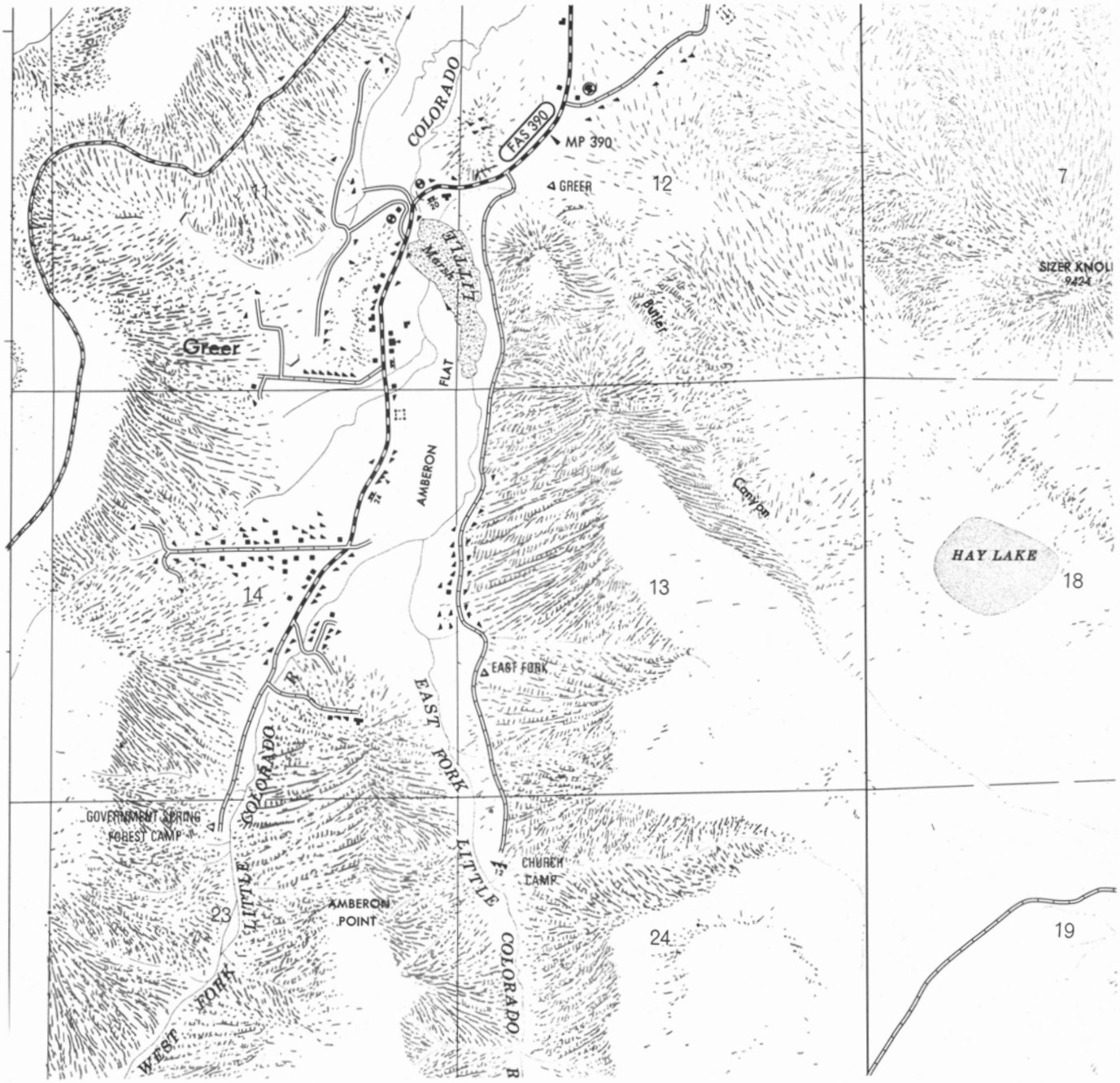
PLATE 19



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GENERAL FEATURE

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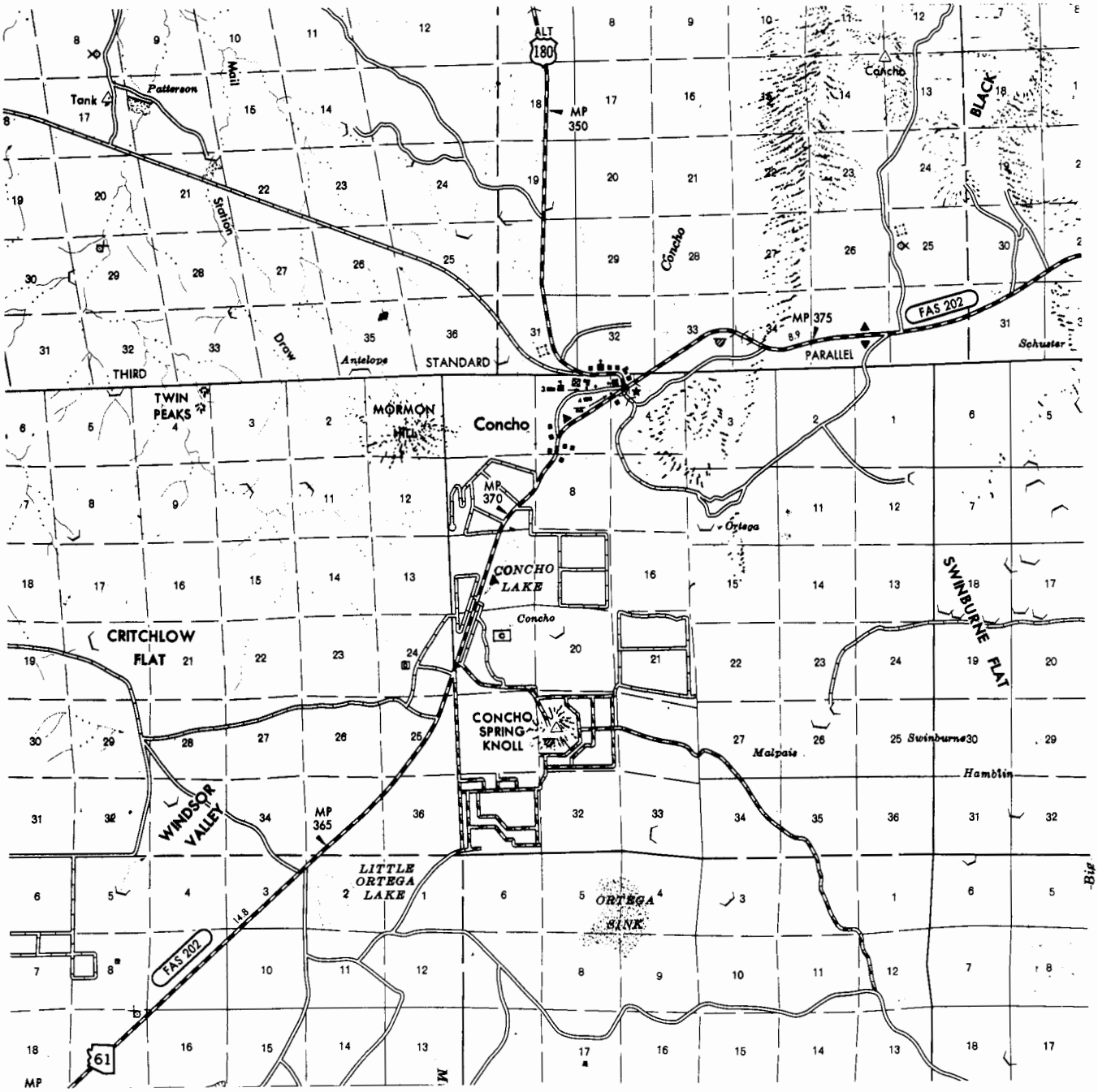
PLATE 20



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STATUTE MILES

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GENERAL FEATURE

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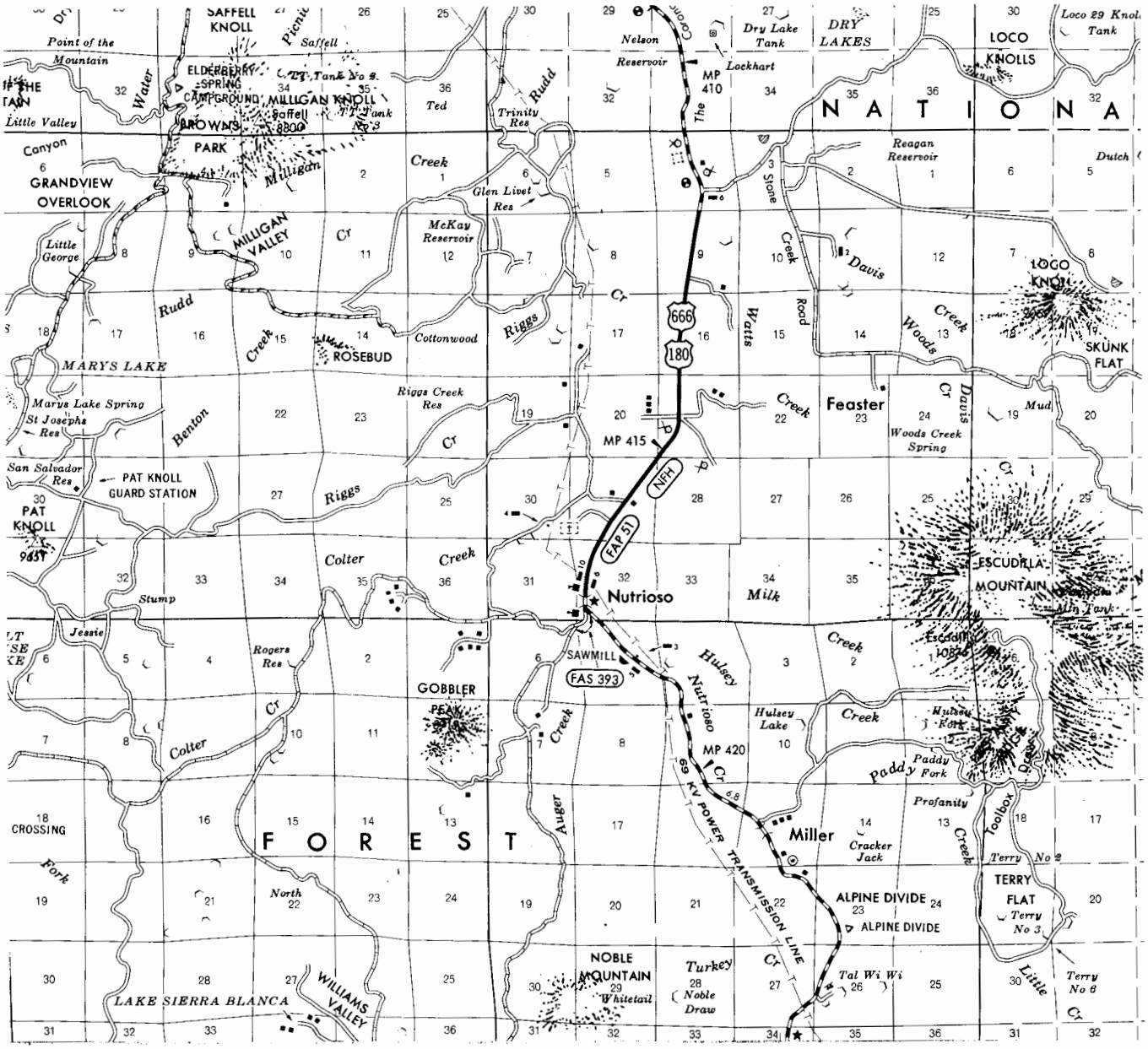
PLATE 21



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NUTRIOSO, ARIZONA
GENERAL FEATURES

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PLATE 22

REFERENCES

1. Mineral and Water Resources of Arizona, Arizona Bureau of Mines, Bulletin 180, University of Arizona, Tucson, 1969, P. 475.

2. National Forest Service Report - Region 3, June 30, 1971.

3. U.S.G.S. Water Supply Paper 1541-A, 1960.

4. Computed by C. W. Thornwaite method as reported in An Approach Toward a Regional Classification of Climate, 1948.

5. Little Colorado Plateau, RC&D, 1971.

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/

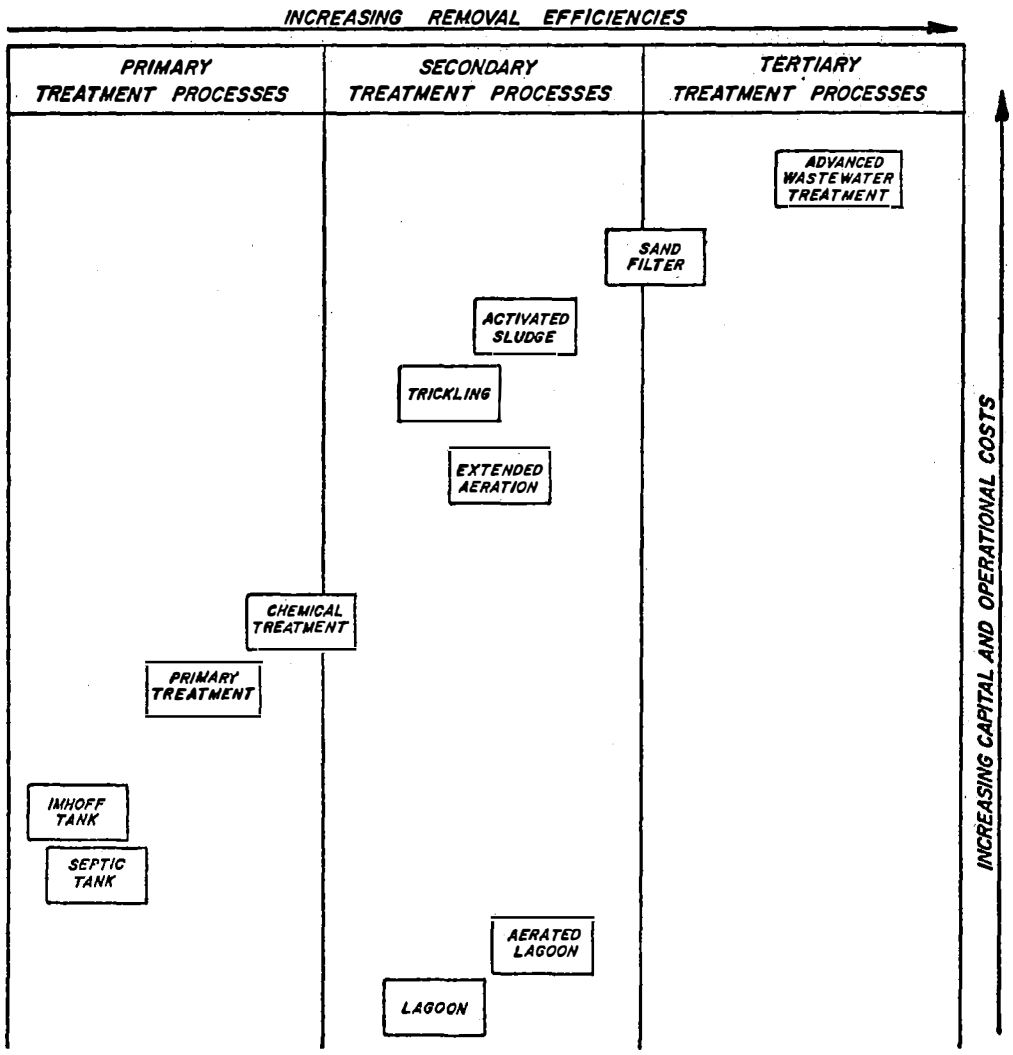


FIGURE I-1. GENERALIZED RANKING OF UNIT COST AND REMOVAL EFFICIENCIES OF CONVENTIONAL WASTE TREATMENT PROCESS.

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.

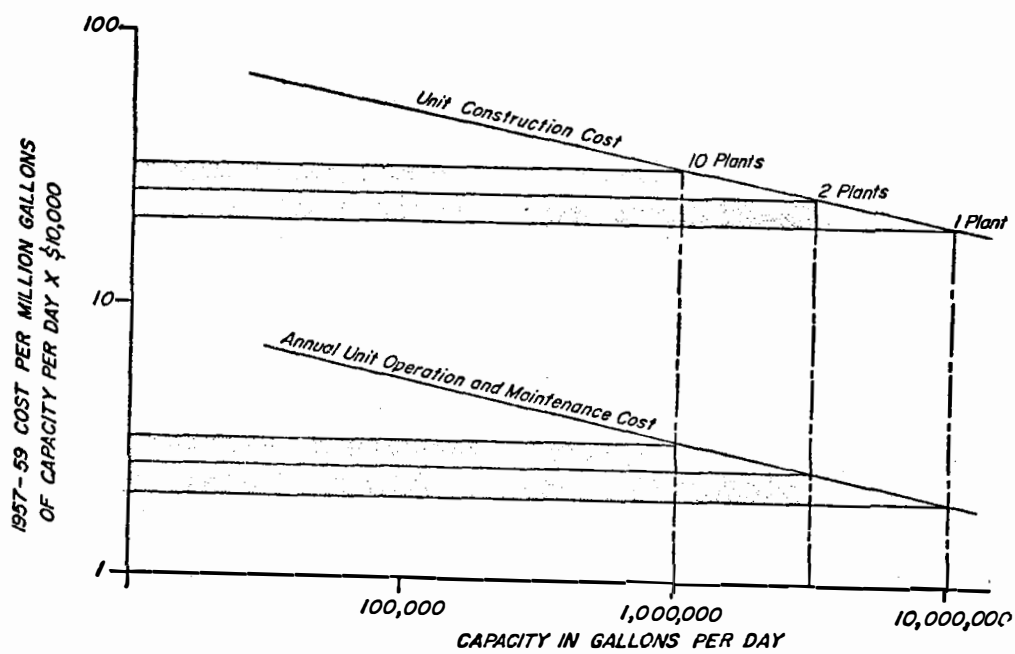


FIGURE I-2. APPLICATION OF ECONOMIES OF SCALE THROUGH CONSOLIDATION OF WASTE SOURCES PRODUCING 10 MILLION GALLONS PER DAY OF SEWAGE'.

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/

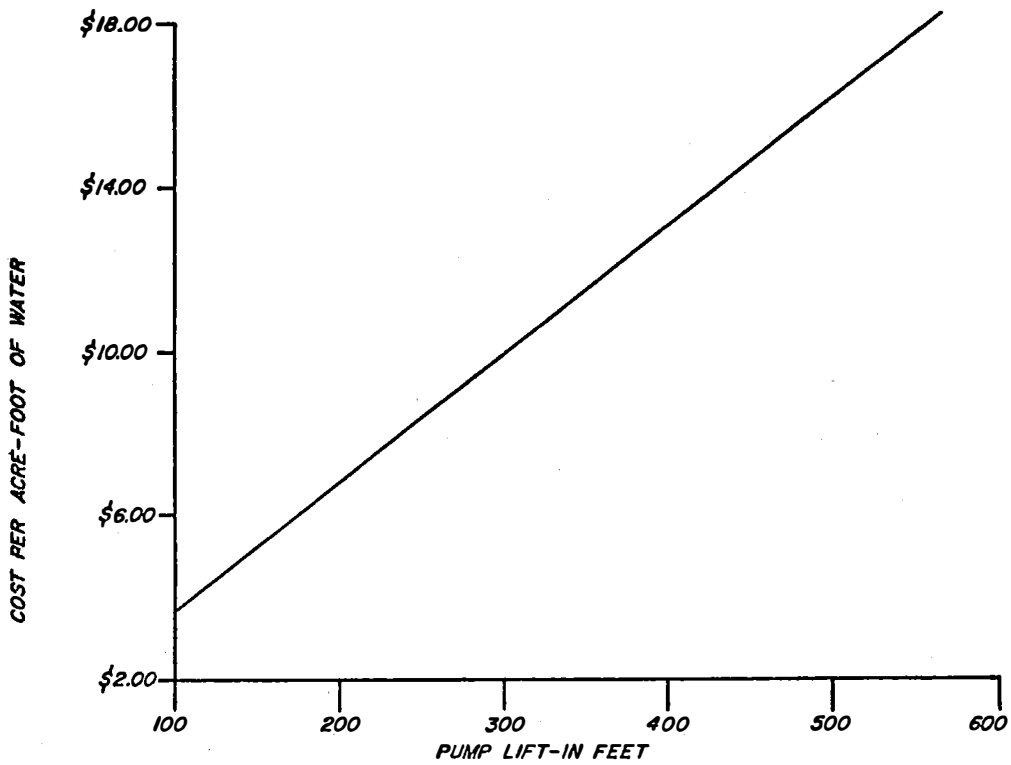


FIGURE I-3. RELATIONSHIP BETWEEN LIFT AND COST PER ACRE-FOOT OF GROUNDWATER PUMPED.

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	144
19	8.00	1946	1.6	33	125	0.702	0.925		o	1.93	½c	7.9	144
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†	0.354	o	1.49	o	26.6	66
29	8.00	1958	2.4	39	261	0.457	0.427		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 obtainab b. 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 1-4). 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.

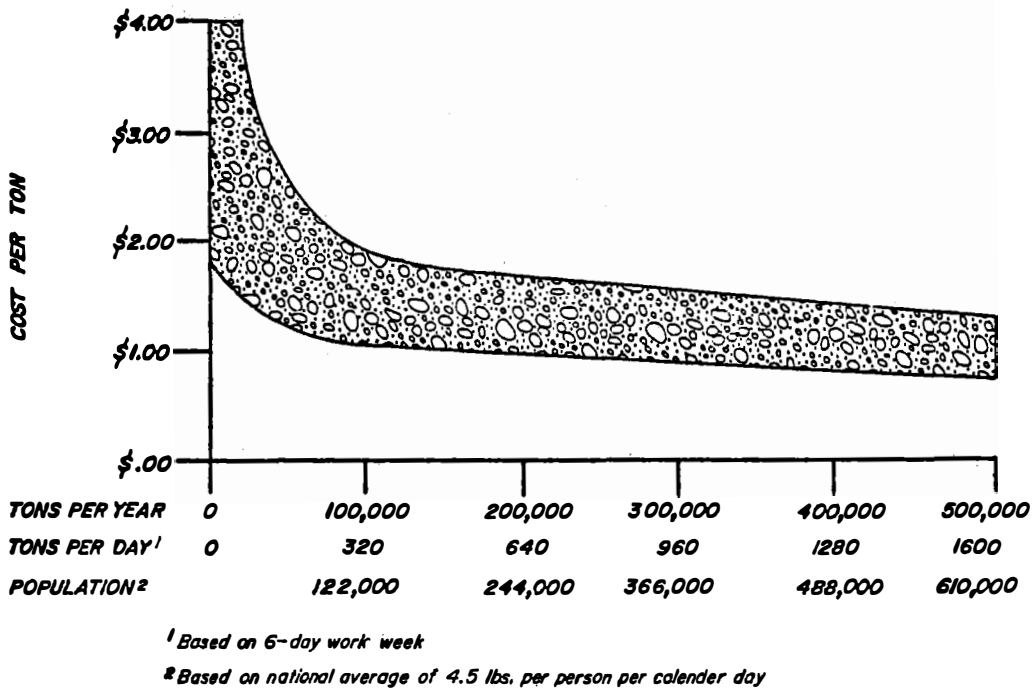


FIGURE I-4. SANITARY LANDFILL OPERATING COSTS

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., Dept. 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.

REFERENCES

1. U.S. Department of Interior, FWPCA, The Economics of Clean Water - Vol. I, April 1970.

2. Shah, K.L. and G.W. Reed. "Technique for estimating Construction Costs of Waste Treatment Plants," Water Pollution Control Federation Journal, May, 1970.

3. Nelson, A.G. and Busch, C.D., Cost of Pumping Irrigation Water in Central Arizona, University of Arizona, Technical Bulletin 182, April 1967.

4. U.S. Department of Health, Education and Welfare, Public Health Service Environmental Health Bureau of Solid Waste Management, Sanitary Landfill Facts, Publication 1792, Second Edition, 1970.

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

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

7. Arizona Revised Statutes 9-692 and 9-731.

8. "Cost of Conventional and Advanced Treatment of Wastewater," Smith, R. Water Pollution Control Federation Journal, September 1968.

9. "The Cost of Water Treatment by Coagulation Sedimentation and Rapid Sand Filtration." Koenig, L. American Water Works Association Journal, March 1967.

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 d 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

Class of Consumption	Quantity, gpcd* 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.

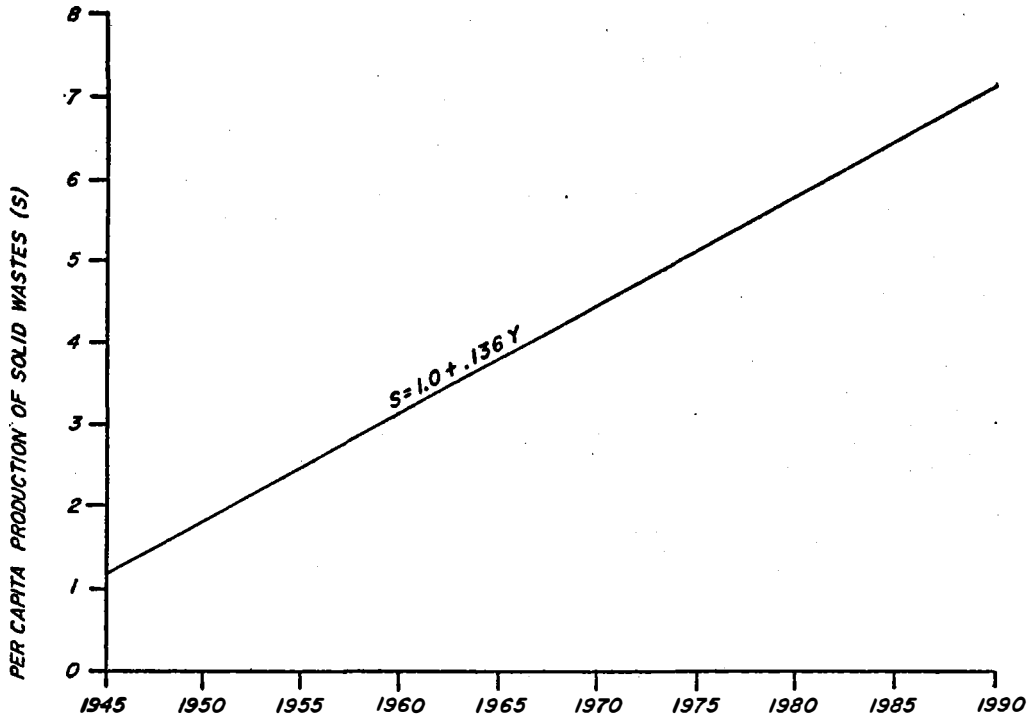
Generally solid wastes are defined as those materials that are solid or semi-solid consisting of refuse, garbage and rubbish. Solid wastes and by-products related to their breakdown constitute one of the forms of environmental pollution that is growing at an alarming rate. It is estimated that per capita 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.

REFERENCES

1. Proges, R. "Factors in Per Capita Water Consumption," Water and Sewage Works, Sept., 1958.

2. Anon "Present and Future Estimates of Water Consumption," Public Works, Dec., 1956.

3. Fair, G.M.; J.C. Geyer and D.A. Okun, Water and Wastewater Engineering, Volume 1. Water Supply and Wastewater Removal, 1966, John Wiley and Sons.

4. Sewage Treatment Plant Design, American Society of Civil Engineers, Manual of Practice No. 36, 1959.

5. Restoring the Quality of Our Environment, Report of the Environmental Pollution Panel Presidents Science Advisory Committee - 1965.

6. Future Solid Waste Accumulation, Report by the U.S. Department of the Interior, Bureau of Mines, Washington, D.C., 1968.

7. Anon "Plastics Pose a Solid Waste Disposal Problem," Environmental Science and Technology, 2:89, February 1968.

8. Anon "Per Capita Figure of 5.1 pounds of Matter Daily Indicated By National Survey," Solid Wastes Management - Refuse Removal Journal, 11:14, March 1968.

9. Eliot, G.F. "Garbage is a Nasty Word....But" Reprint - Suburbia Today, May 1961.

10. Mix, S.A. "Solid Wastes: Every Day Another 800 Million Pounds," Todays Health, p. 46, March 1966.

11. Anon "Refuse Quantities and Characteristics," In, Municipal Refuse Collection and Disposal, pp. 6-10, Issued by Office for Local Government, New York State Executive Department, 1964.

12. Rogus, C.A. "Refuse Collection and Refuse Characteristics," Public Works, 97:96, March 1966.

13. Kunsch, W.M. "Planned Refuse Vehicle Replacement: Better Service, Lower Maintenance," Public Works, 95:105, March 1964.

14. Hayden, I.L. "Incinerator Model Convinces Public," Public Works, 95:94, July 1964.

15. Gruenwald, A. and J.A. Reynolds, "Less than $3,000 Per Ton," The American City, 80:99, October 1965.

16. Kaiser, E.R., I. Halitsky, M.E. Jacobs, and L.C. McCabe, "Performance of a Flue Fed Incinerator," Air Pollution Control Association Journal, 9:85, February 1959.

17. Cohn, Morris M., "Effect of Food Wastes on Sewers and Sewage Treatment," Sewage Works Journal, 18:477, 1946.

18. Status of Solid Waste Management in California, California State Department of Public Health - 1970.

19. A Program Plan for Solid Waste Management in California, California State Department of Public Health - 1970.

20. Weaver, L. "Refuse and Litter Control in Recreation Areas," Public Works, 98:4, April 1967.

21. Munich, A.J., A.J. Klee, P.W. Britton, Preliminary Data Analysis; 1968 National Survey of Community Solid Waste Practices. Public Health Service Publication No. 1867, 1968.

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