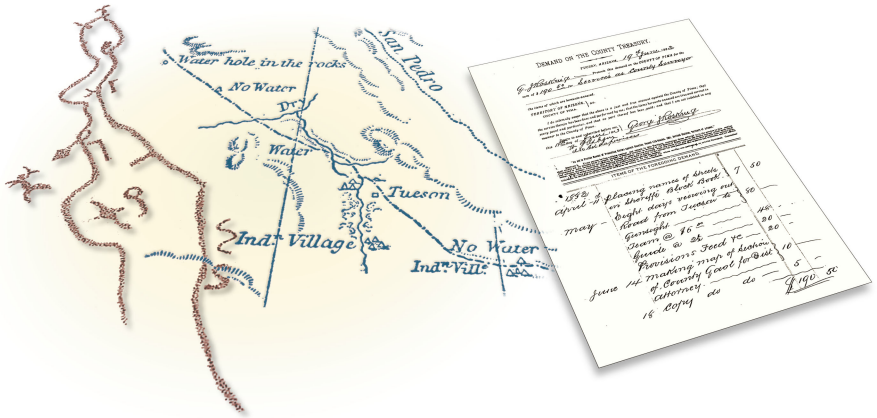
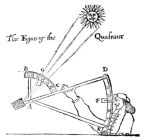

Mapping
Pima County, AZ
Sonoran Desert Conservation Plan
2002
Pima County
Arizona
Board of Supervisors
Ann Day, District 1
Dan Eckstrom, District 2
Sharon Bronson, Chair, District 3
Raymond J. Carroll, District 4
Richard Elías, District 5
County Administrator
Chuck Huckelberry
THE SEAL OF PIMA COUNTY ARIZONA
Official Map
OF THE
TERRITORY OF
ARIZONA
Compiled from Surveys, Reconnaissances
and other Sources
BY E. A. ECKHOFF AND P. RIECKER,
CIVIL ENGINEERS.
1880.
PIMA COUNTY, ARIZONA
LAS CRUCES
ORO VALLEY
MESA
UNITED STATES OF AMERICA
APACHES
YUMAS
COCOMARICOPAS
PAPAGOS
PIMERIA
THE SONORAN DESERT CONSERVATION PLAN TEAM
AUGUST 2002

MAPPING PIMA COUNTY, ARIZONA



Prepared by
Members of the
Sonoran Desert Conservation Plan Team



August, 2002

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I. INTRODUCTION

This book presents a very broad overview of the history of mapping of Pima County and surrounding areas. It includes representative samples of maps of the area but is not intended to be an atlas of all the maps made of Pima County. Such as book would be many hundreds of pages long because so many maps have been made from the sixteenth century to the present. This book is not intended to be a history of cartography. Many excellent books that examine this topic are listed in Chapter V.

For many years the main purpose of maps was to indicate how to get from one place to another. As new lands were explored, an important purpose was to delineate discoveries, often for the purpose of claiming sovereignty over a territory. For example, the Spaniards and Portuguese divided up discovered lands in North America so it was important to them to decide which lands belonged to which country. By the twentieth century mapping techniques had improved so much that new uses had been found for maps. Maps have been used for planning purposes, determining geological and hydrological features, planning infrastructure, delineating floodprone areas, predicting earthquakes and other hazards, mapping vegetation and wildlife, setting political boundaries and many other purposes as shown by the maps that follow.

Mapping is used today in the Sonoran Desert Conservation Plan (SDCP) for a multitude of purposes. The ability to create many information layers, which can then be superimposed on each other, plays an important role in decision making for the SDCP.

Fig. 1-1 One mapper's view of the world in 1483 before Europeans knew about what is now Pima County. Other mapmakers of this period knew much more about the outline of places such as Africa.

The Development of Mapping Techniques

The sophisticated mapping techniques that are at the core of the Sonoran Desert Conservation Plan have their origins far back in history. In addition to gaining information from exploration of lands, cartographers and explorers had to solve problems of determining and depicting distance and direction, and portraying the curved surface of a nearly spherical earth on a 2-dimensional surface.

We are so accustomed to aerial and satellite photography today, that it is difficult to imagine how the early explorers mapped their world entirely from observations from the surface of the earth and sea. Many early maps were conjectured from theories of what ought to be according to factors such as religious dogma. Gradually, however, exploration clarified many of the unknowns and speculation, leading to modern, highly accurate maps.

Explorers and mapmakers usually worked under very difficult conditions and could only carry the most necessary equipment.

The development of mapmaking also depended on the invention of the printing press and later computers as well as the modern printer that utilizes electronic files.

The products of the Sonoran Desert Conservation Plan would not be possible without the contributions of hundreds of unknown mappers and inventors in the past.

Art work was an important element of many of the European maps of the 16th to 19th centuries. Mapmaking was an art more than a science and where geographic knowledge was limited, art work assumed great importance.

Fig 1-3 Decorative detail and title block from a Spanish map made in the 18th century.

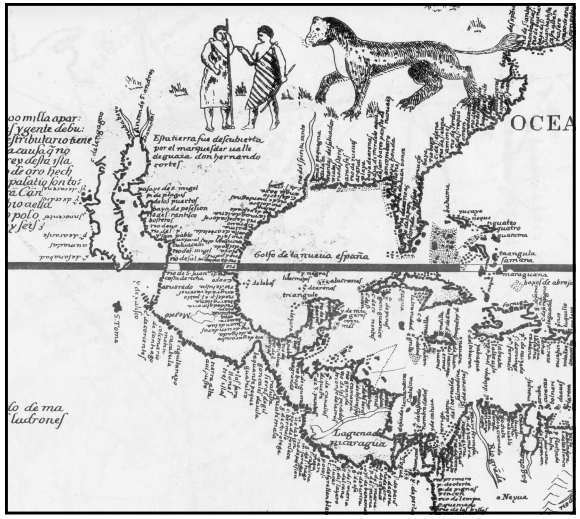

Fig. 1-2 Decorative artwork from a Spanish map made in 1654.

Fig. 1-4 Elaborate artwork filling the entire lower left corner of a 19th century map of North America by H.S. Tanner.

Showing elevation depended both on determining the elevation and on portraying that to the viewer. The modern map in Fig. 1-8, while perhaps less artistic, is far more precise than the earlier versions, although the inexperienced map reader may find it more difficult to decipher.

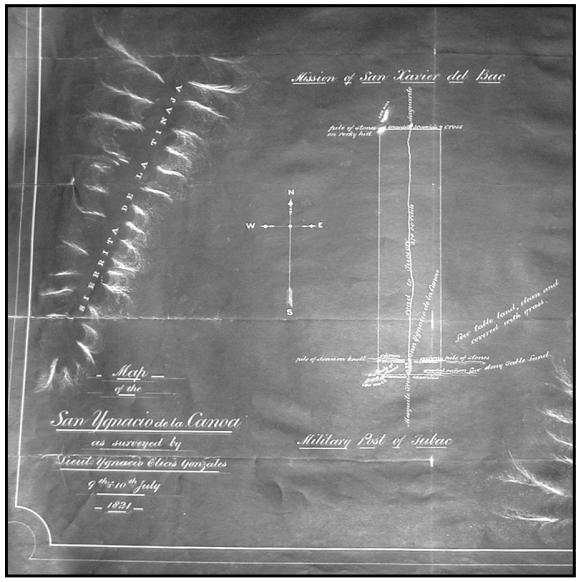

Fig. 1-5 A depiction of mountains in a 19th century map of Canoa.

Fig. 1-6 Depiction of mountains in an early Spanish map of Mexico.

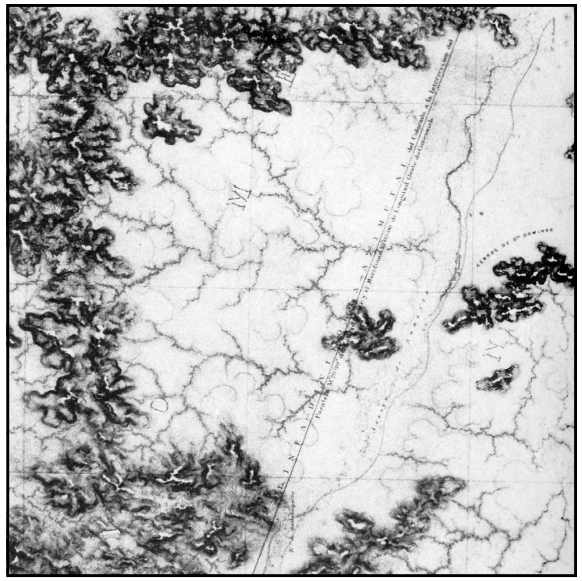

Fig 1-7 Depiction of mountains in a map of the Mexican survey of the U.S.-Mexico boundary in the 1850s.

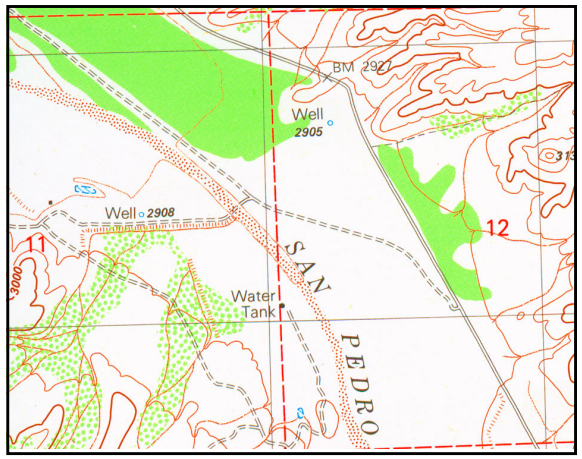

Fig. 1-8 Depiction of elevation change in a 20th century U.S.G.S. topographic map of the San Pedro River near Redington.

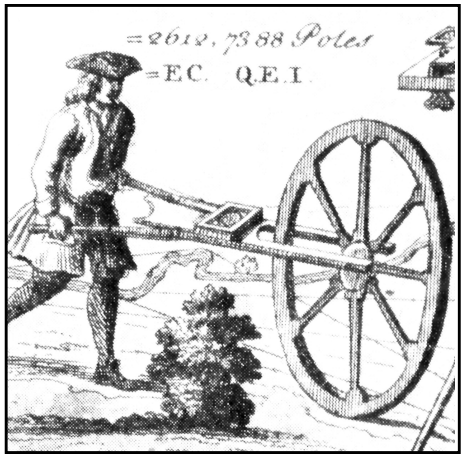

Fig. 1-9 A simple way of measuring distance in 18th century England.

Fig. 1-11 John Regan using a GPS system to determine distance and location in 21st century Arizona.

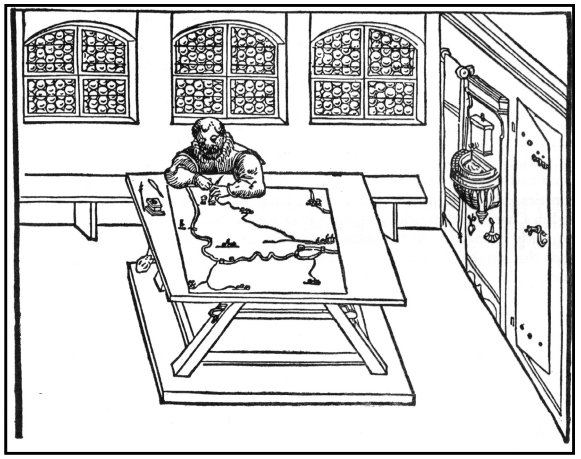

Fig. 1-12 A 16th century mapmaker at work in Germany.

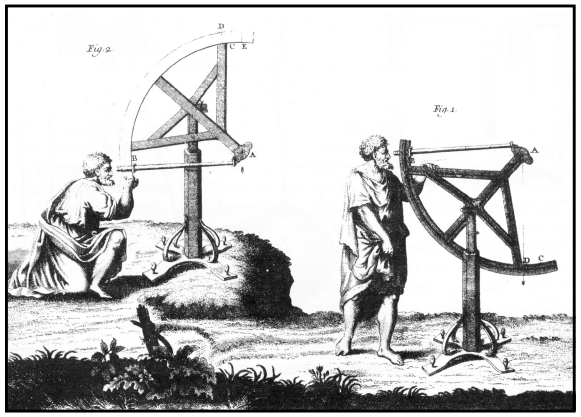

Fig. 1-10 Determining location in 18th century Holland.

Mapping Then and Now

The powerful mapping tools available today make it possible to produce a great variety of detailed maps for specific purposes. Aerial photography and now satellite photography present views unimaginable to the historic cartographers. Anyone equipped with a GPS system can immediately determine his/her precise location. How modern tools are used for SDCP is discussed in Chapter IV.

Fig. 1-13 A 21st century mapmaker at work in Arizona, John Regan making SDCP maps.

Determining latitude and longitude posed real problems for early explorers and sea captains. Once the compass was invented latitude became relatively simple to determine and direction could be determined by watching celestial bodies such as the North Star on a clear night. Longitude–distance east and west–was much more difficult. Sea captains often had difficulty knowing just how far they had gone, especially with cross winds and waves and under cloudy skies. The English government offered a large prize to anyone who solved this problem and many ingenious solutions were proposed. The true solution ultimately depended on invention of an accurate clock. In an interesting book, Ava Sobel tells of the many attempts and John Harrison's 40-year search for the true solution to the longitude problem.

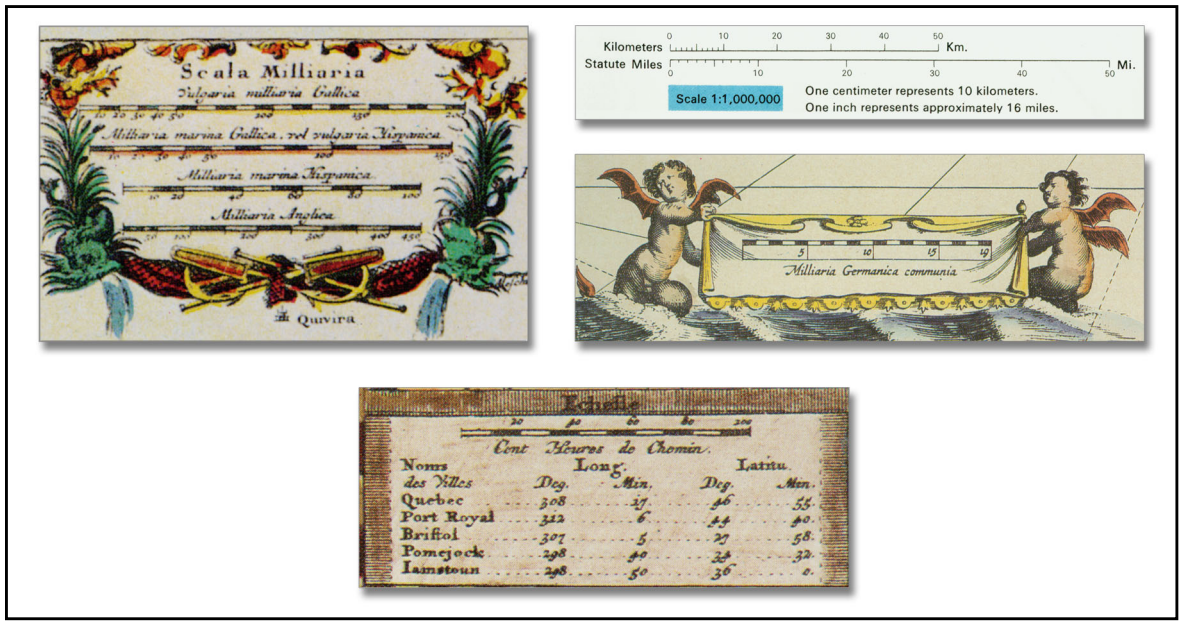

Fig. 1-14 The earliest maps did not indicate the scale to show the distance on the earth that is represented by a distance on the map. The first is from a 1660 French map, the second from a modern atlas, the third and fourth from 1757 and 1730 German maps. Note the need to state measurements from several countries in the bottom map, while in the modern map, there are only two types needed. Note that all the maps in this report have been much reduced from the scale of the original maps.

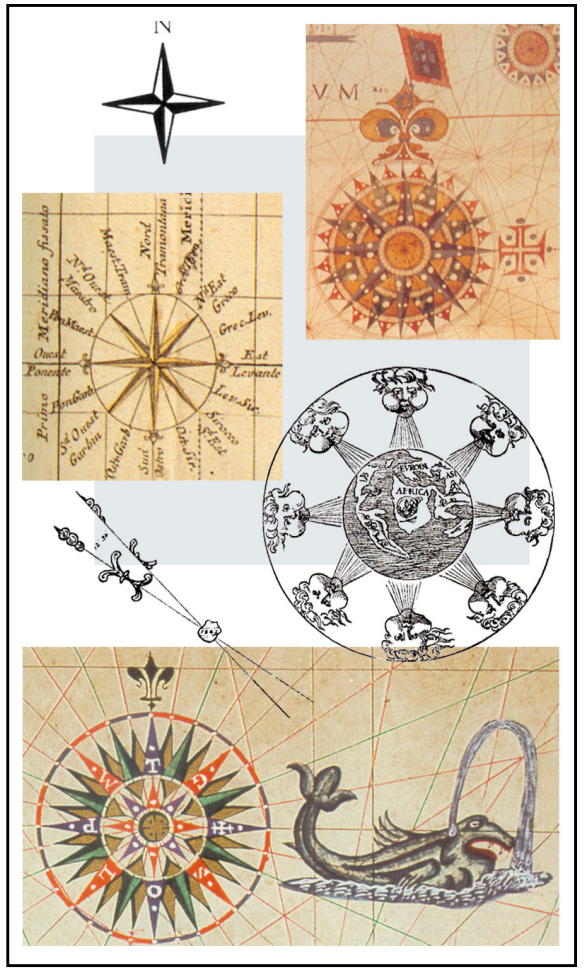

Fig. 1-15 On the earliest maps, north could be anywhere on the map. By the 16th century, north was generally up and the location of north indicated. The map roses above are examples of ways of doing this. On modern maps, north is usually indicated by an arrow.

How to show a nearly spherical 3-dimensional world on a 2-dimensional surface was a major challenge for cartographers. The first is used frequently in atlases and by the U.S.G.S. for certain purposes. Shapes are correct along parallels but increasing distorted at the poles. The second is a projection developed by Mercator in 1569 and is most accurate in the equatorial regions and most distorted at the poles. It is commonly used in maps today. The third projection was invented in 1820 and was in common use until the 1950s but is considered obsolete today. It is best suited for large areas with a north-south orientation. The bottom projection is increasingly in use today by groups such as the National Geographic Society. It reduced distortion at the poles considerably but has some distortion. For further information see the U.S.G.S. Poster Map Projections.

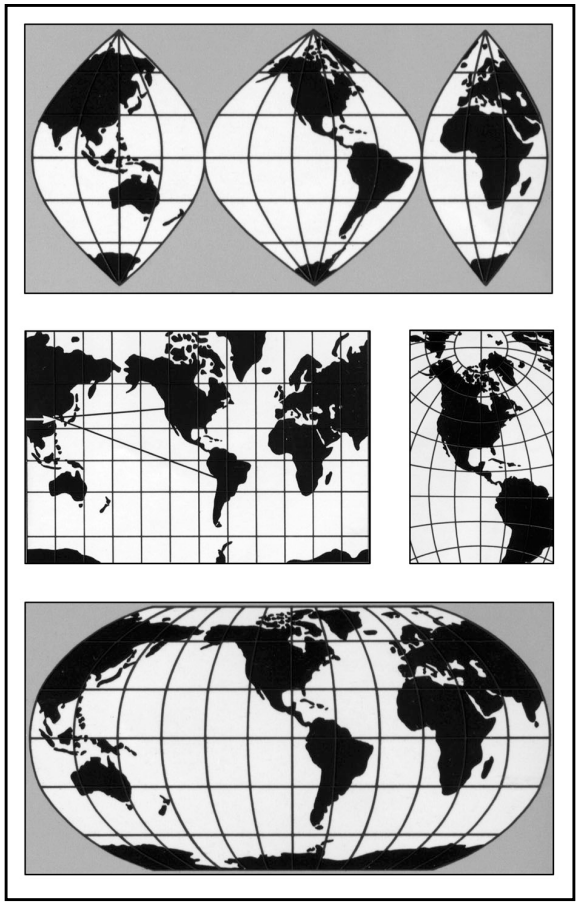

Fig. 1-16 Several ways of projecting a curved world on a flat surface from the 2002 U.S.G.S. Map Projections Poster .

Note the use of various projections in the maps in this report, especially that in some of the maps, lines of latitude and longitude are straight while in others they are curved.

II. HISTORIC MAPS

Spanish discoveries and maps

New Views of the World

For most of human life on earth, people's view of the world was limited to what they could experience personally by traveling on foot or later horseback or boat. Some early civilizations used rock art to depict places. More extensive mapping came along with the invention of writing and expansion of geographic horizons. The Mediterranean civilizations began to map their explorations into other lands. Greek, Roman, and Arabic travelers mapped the coast of Africa and Europe and explorations in the interior of the continents. Europeans knew little or nothing of the world beyond the great oceans, and people on the other side of the ocean knew virtually nothing about Europe.

Period of the Conquistadors

When the first Spanish explorers reached Pima County from the south they were entering what was for them unknown territory. The natives who lived in the area, of course, were quite familiar with their homeland, but as far as we know did not make maps, although Native Americans in other areas did. The earliest Spanish maps show how knowledge of the region gradually progressed. Spanish ships sailed along the coast of what is now Mexico and California and up the Gulf of California.

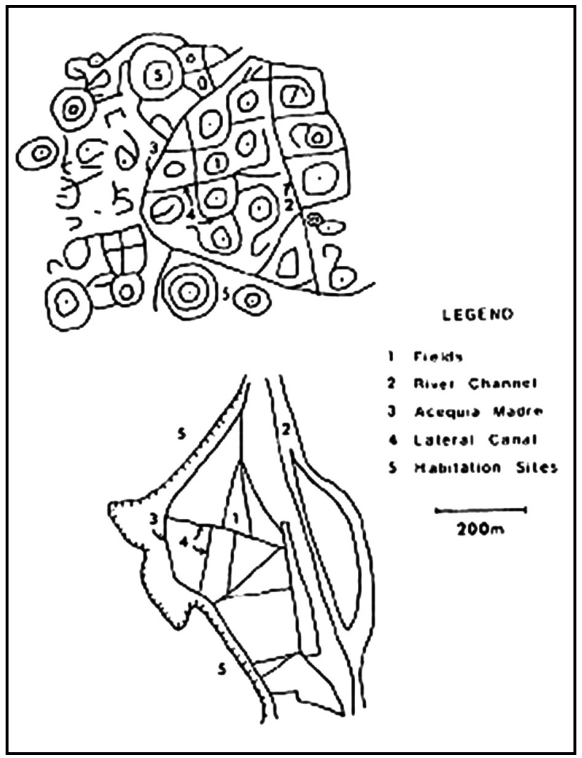

Fig. 2-1 This prehistoric rock art map from Sonora depicts a village, farm fields, and canals. The map (top) corresponds to an archaeologist's map of the site itself (bottom).

It was apparent to some of these explorers that what is now Baja and California up to San Francisco Bay was one large island. Father Kino's explorations ultimately determined that Baja was a peninsula.

The earliest maps show confusion about the Colorado and Gila Rivers, some showing just one river extending eastward into Arizona. What is now Pima County was at that time the northernmost extent of Pimeria Alta, which extended far into Mexico. The major roads were north and south and as far as possible followed the rivers. The Camino Real extended from Tucson Presidio into the interior of Sonora. The Camino del Diablo went across what are now the Tohono O'odham Nation and the Cabeza Prieta National Wildlife Refuge. Along this route water sources were far apart and knowledge of where to find water was crucial to survival.

After the Mexican revolution what is now Pima County became a part of Mexico. Knowledge of the region had expanded greatly and the Gila and Colorado Rivers were fairly accurately placed. After Mexico ceded and later sold parts of Arizona to the United States mapping the international boundary became an important goal.

Much more information about historic trails and exploration of Pima County is available in Suzanne Bott's SDCP report *Trails, Rails, and Roadways in Pima County*.

Fig. 2-2 America Septetrionalis 17th century. Note in this map that the coasts of Baja and California are mapped but the notion persists that that area is an island all the way to San Francisco Bay. This notion lasted in maps long after Baja was shown to be a peninsula. Courtesy Arizona State Library map collection.

Fig. 2-3 America Septetrionalis 18th century. Note that Baja and California are no longer depicted as an island. The entire unexplored northwest is left totally blank. Courtesy Arizona State Library map collection.

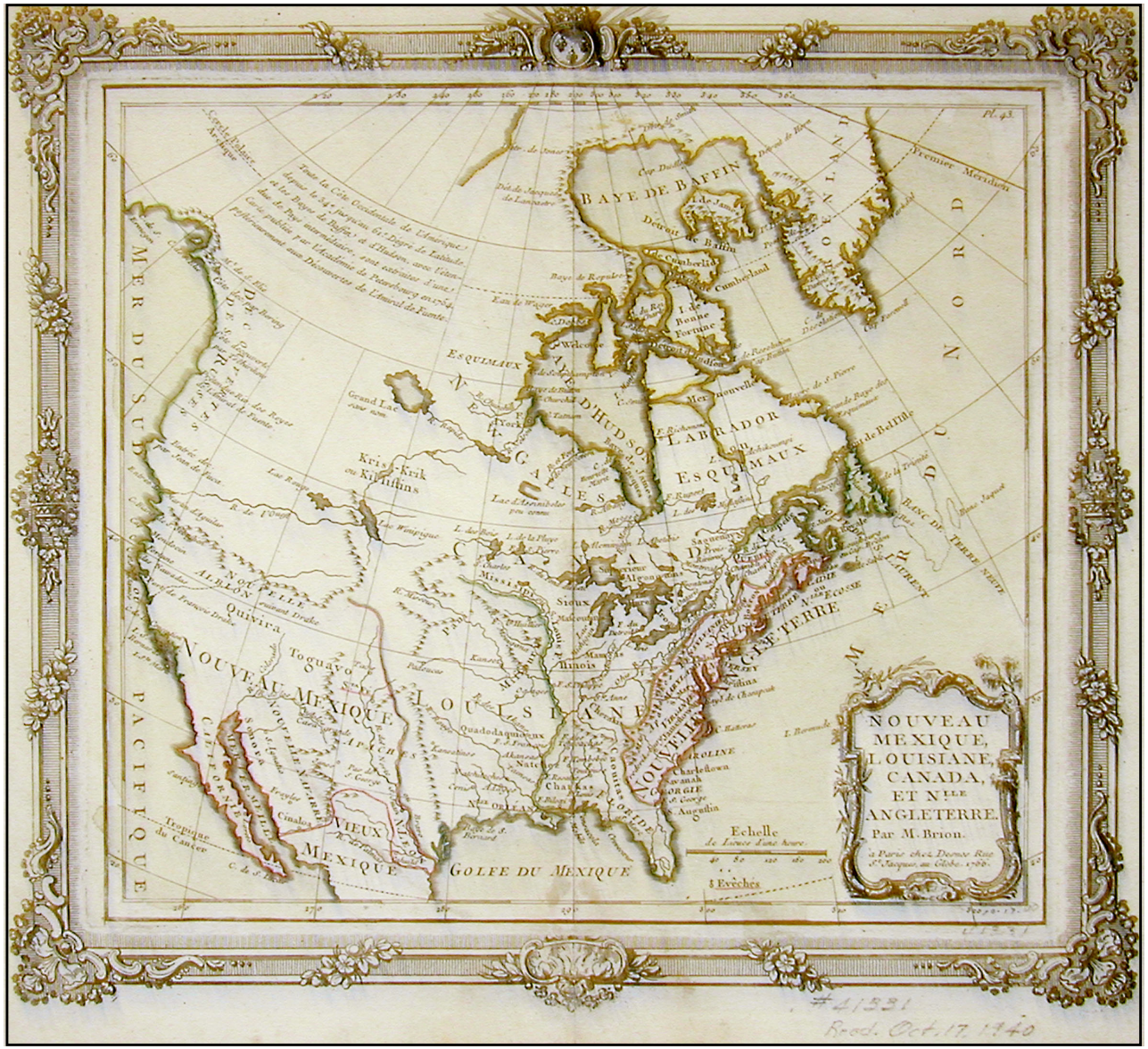

Fig. 2-4 A French map from 1740 showing much more coastal detail than other maps, but still indicating the lack of knowledge of the American Southwest or unexplored areas inland. Courtesy Arizona State Library map collection.

Fig. 2-5 An 18th century English map of North and South America. Longitude is measured from London.

Fig. 2-6 Partie de Mexique ou de la Nouvle Espagne by the French mapmaker, Roubert de Vaugondy, 1749. Courtesy the University of Arizona Library.

Fig. 2-7 A map based on Father Kino's explorations. His depiction of the Santa Cruz and San Pedro rivers were quite accurate because they were based on personal observation.

"I spoke to them of the Word of God and on the map of the world I showed them the lands, the rivers, and the seas over which we fathers had come from afar to bring them the saving knowledge of our Holy Faith. …And I showed them on the map of the world how the Spaniards and the Faith had come by sea to Vera Cruz, and had gone into Puebla and to Mexico, Gaudalaxara, Sinaloa, Sonora, and now …the land of the Pimas…" Father Kino speaking to the residents of Bac (which later became San Xavier del Bac). In Kino, Historical Memoirs 122-123.

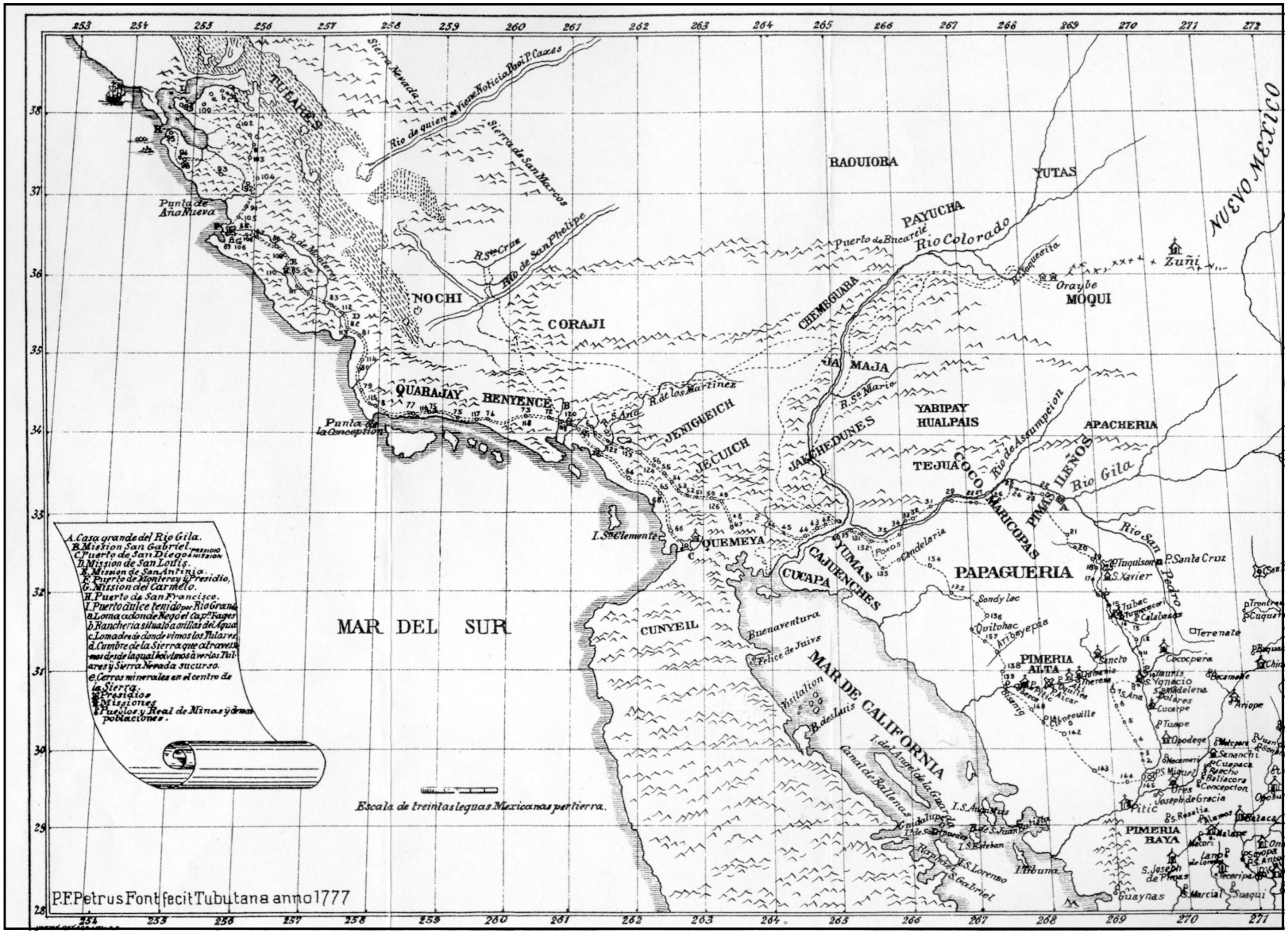

Fig. 2-8 Mapa Correspondiente al Diario que Forme E.L. P.E. Pedro Font del Viace que Hizo a Monterrey y Puerto de San Francisco y del Viage que Hize El. P. Garces al Moqui 1775. From Hinton's Handbook to Arizona. 1878.

Fig. 2-9 Mapa de los Estados Unidos de Mexico. 1847. Courtesy Arizona State Library map collection.

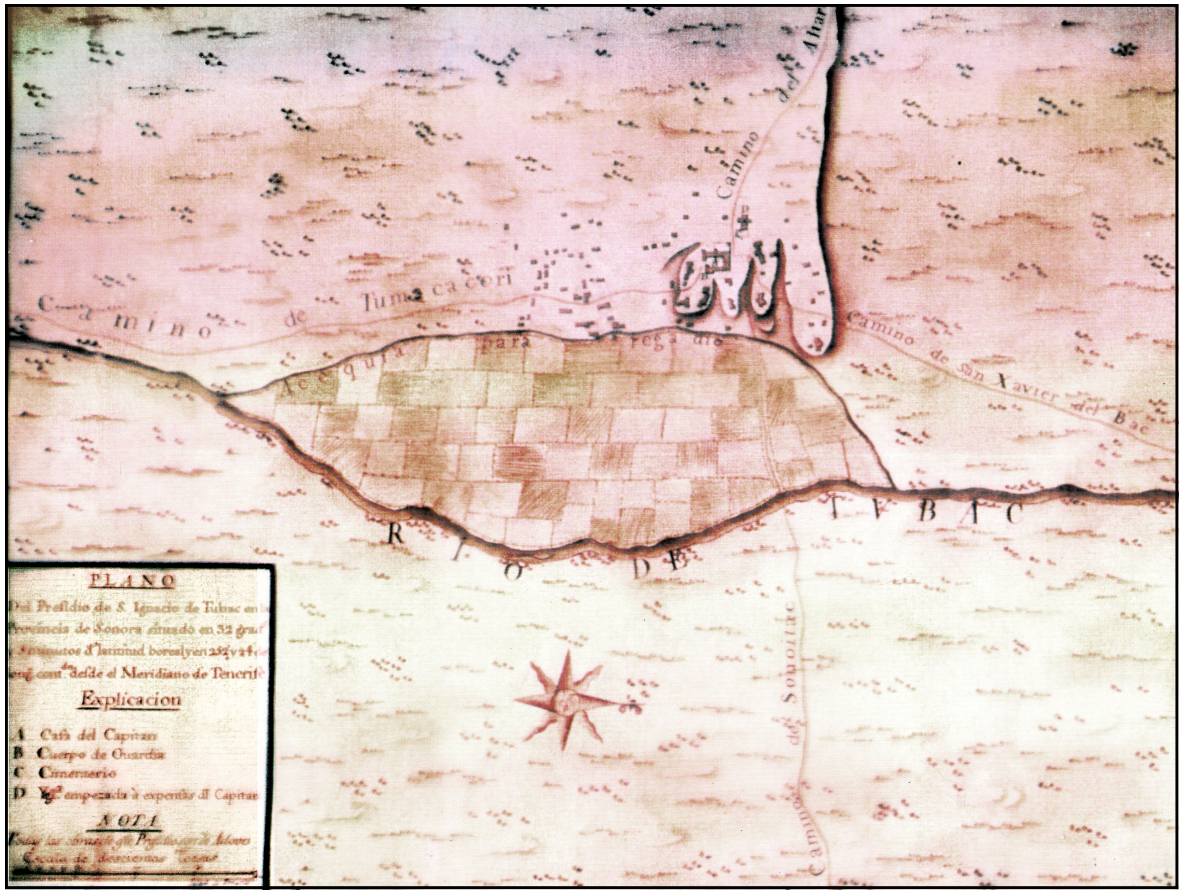

Fig. 2-10 The Presidio of Tubac and farm fields. This is one of a series of maps made by Spanish cartographers and is amazingly accurate. The channel of the Santa Cruz River is very similar to today's channel and many of the buildings indicated by black squares have been found in archaeological excavations in the places marked.

Fig. 2-11 The United States of Mexico in the 1840s. Courtesy Arizona State Library map collection.

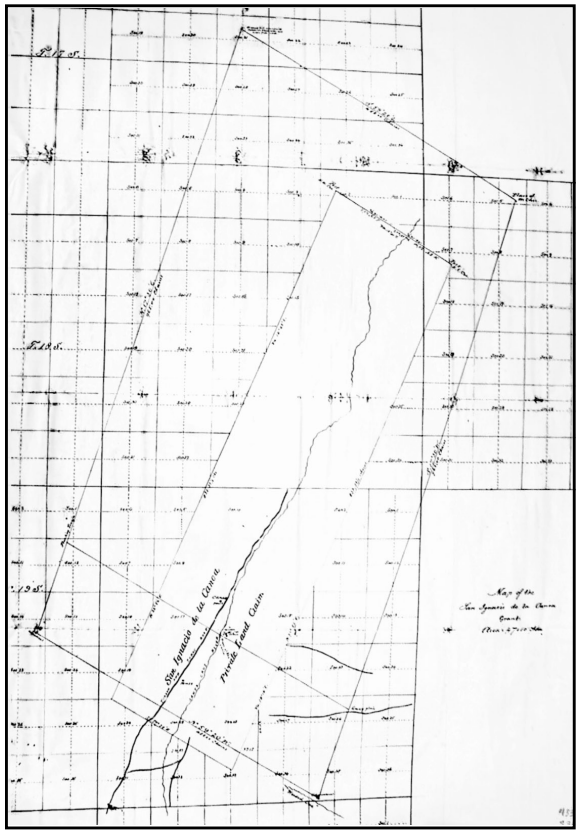

Fig. 2-12 San Ignacio de la Canoa Land Grant. The exact boundaries of the Spanish and Mexican land grants were tested in courts to determine land ownership claims into American times. While some of the grants were legitimate, in other cases, wildly exaggerated claims were discounted in court. Maps played an important role in determining who had the right to specific lands. Canoa is in the Green Valley area and preservation of the historic ranch is an element of SDCP. Courtesy Arizona State Library map collection.

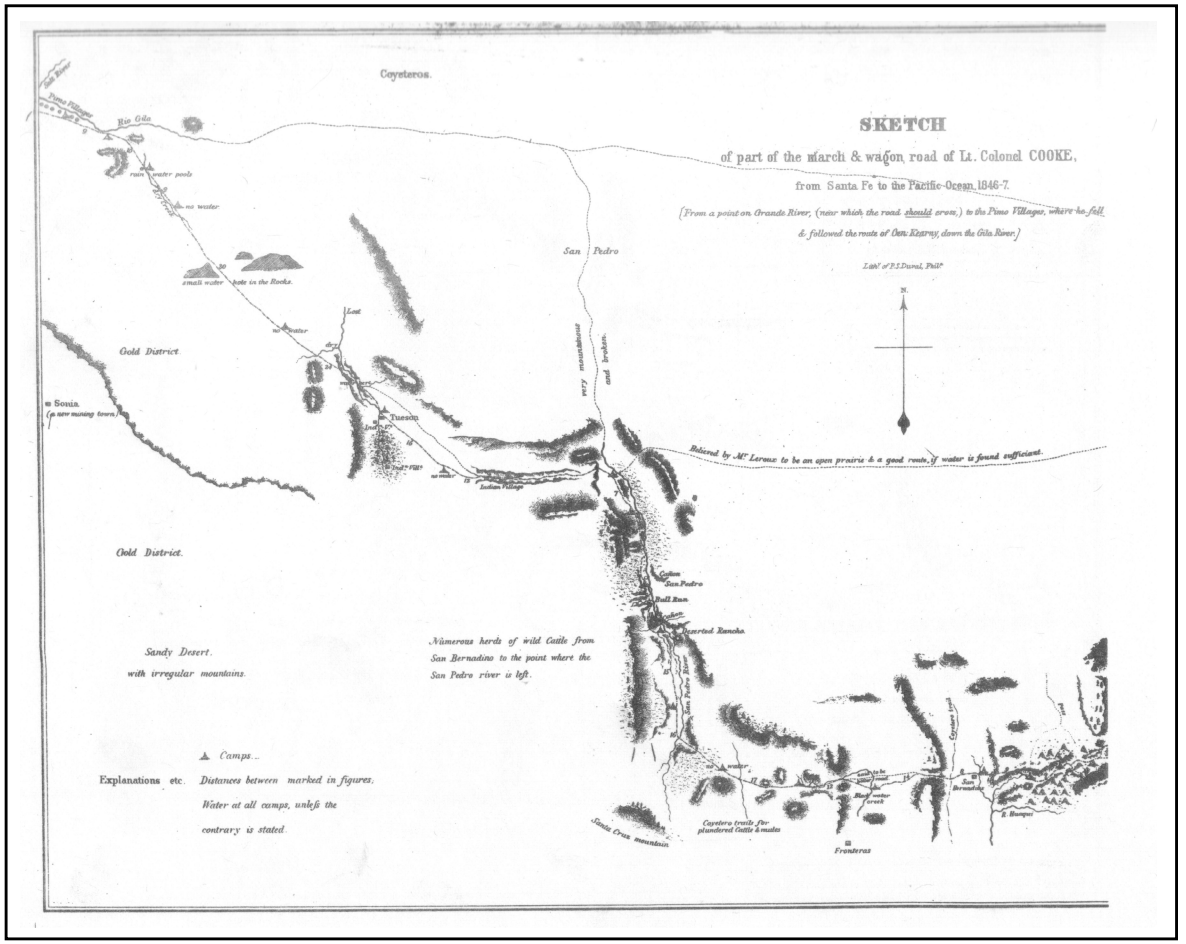

Fig. 2-13 The route of the Mormon Battalion led by Lt. George Cooke in 1846-47 under the military command of Gen. Stephen Watts Kearny. One charge of this group was to map out a wagon road to California.

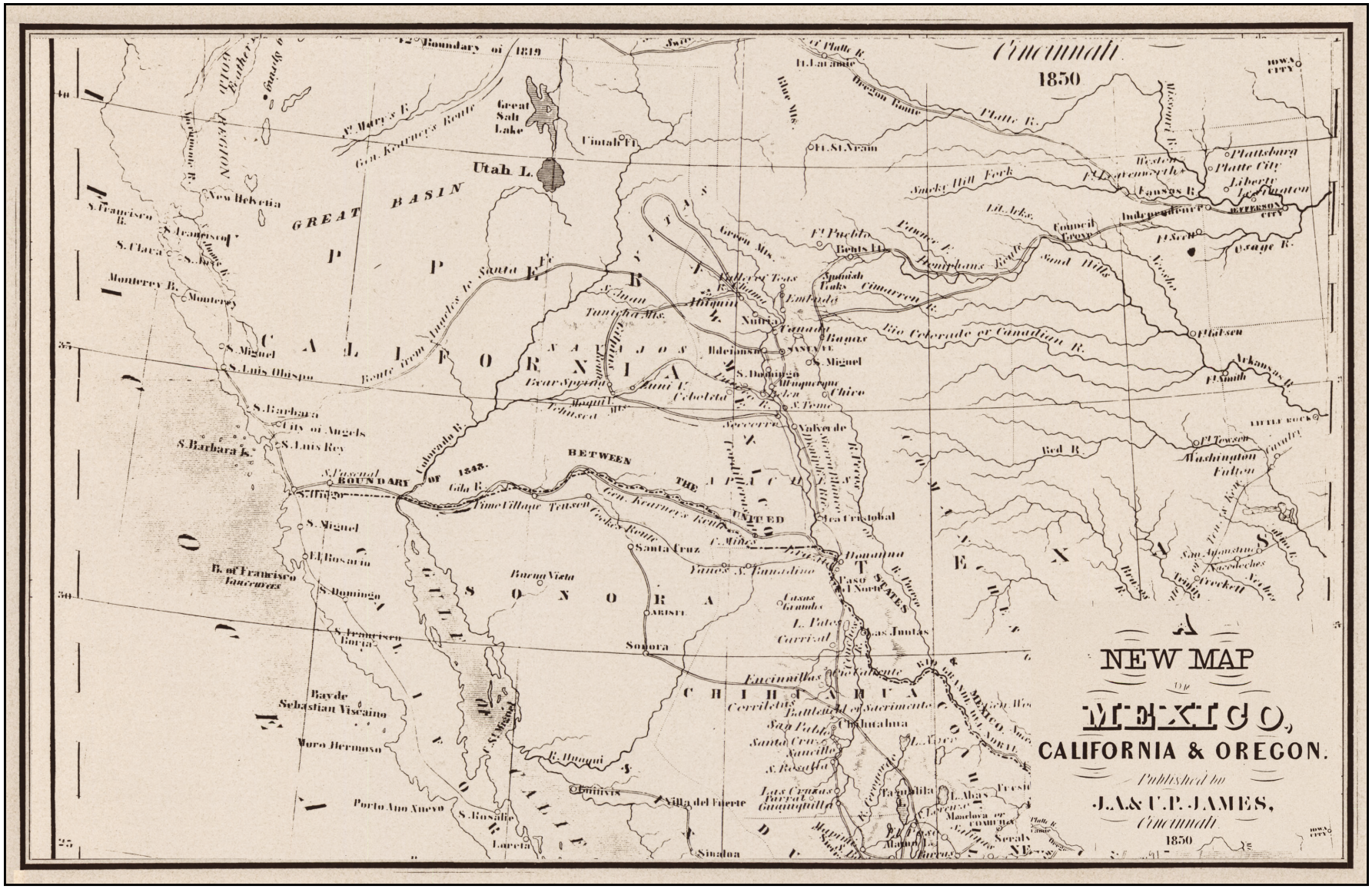

Fig. 2-14 A New Map of Mexico, California & Oregon by A.M. and E.P. James 1850. Note that Pima County is in Sonora. Courtesy Arizona State Library map collection.

Fig. 2-15 A New Map of Nebraska, Kansas and the Indian Territories. Courtesy Joy Mehulka.

Mapping in the Early Territorial Period

The United States acquired parts of Arizona by treaty in 1848, but Pima County was still in Mexico. In 1854 the U.S. purchased lands south of the Gila River to what is now the international border and Pima County changed from a Mexican territory to an American one. Even before this, however, travelers were crossing Pima County to get to the California gold fields and groups such as the Mormon Battalion gathered useful geographic information.

Accurate surveys of the border were needed and both Mexico and the U.S. appointed official surveyors to do the job. Politicians had determined the boundary with little geographic information or concern for natural boundaries such as mountains, although parts of the boundary followed the center of rivers such as the Rio Grande. While geographically meaningful, since rivers move around in their channels, the boundary itself could move. This is an issue today for the boundary between Arizona and California that is based on the Colorado River which has changed in places so that what should be Arizona is now in California and vice versa. Paula Rebert describes mapping the boundary in detail in *La Gran Linea*.

As more and more people settled in the area the U.S. General Land Office, later the Bureau of Land Management, conducted systematic surveys of the state.

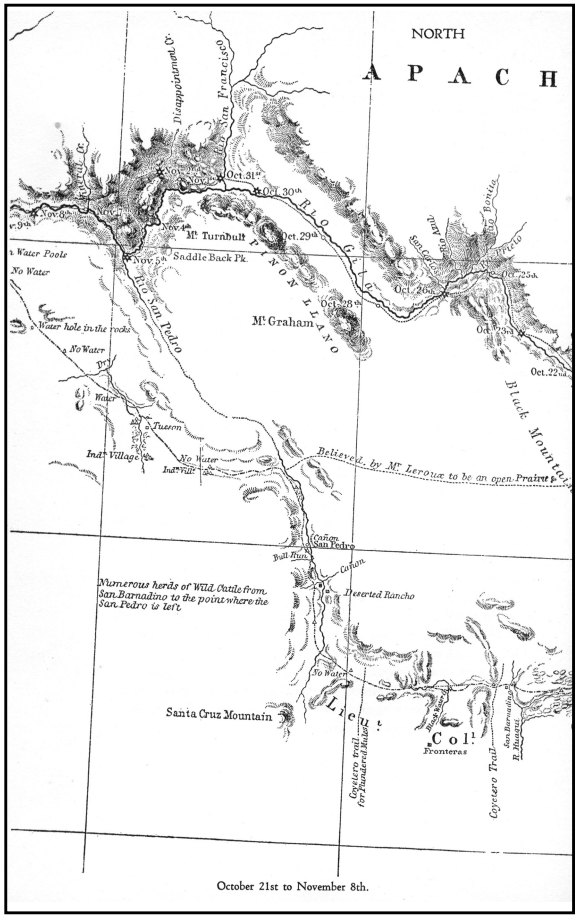

Fig. 2-16 Emory's map of the journey Oct. 21st - Nov. 8th, 1846. Note the similarities to Cooke's map. Emory had traveled with the Mormon Battalion as surveyor and scientist. From W. Emory *Report on the U.S. and Mexico Boundary Survey* 1859.

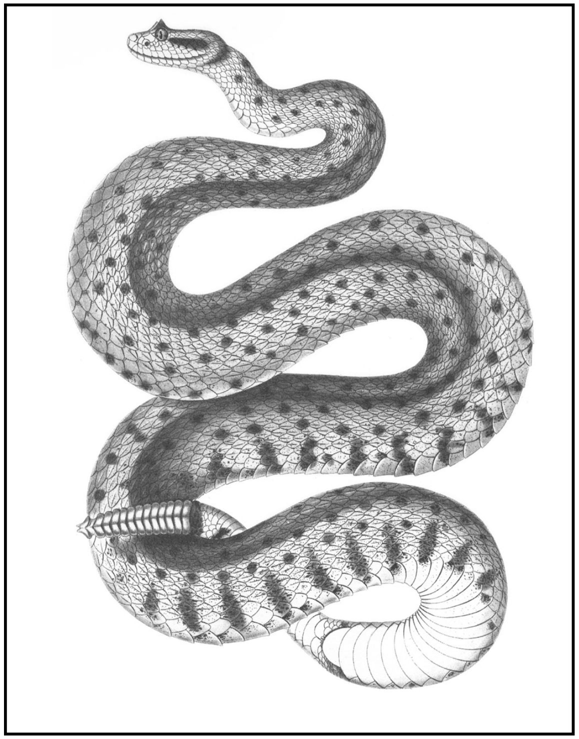

Fig. 2-17 Scientists and artists were an important part of the official U.S. boundary survey. This is one drawing from Emory's *United States and Mexican Boundary Survey.*

Fig. 2-18 A portion of John G. Parke's *Survey for A Railroad* of 1854-55.

The Treaty of Guadalupe Hidalgo specified a vague boundary line that needed to be mapped by Mexican and U.S. surveyors for the details. Here is a section of the treaty indicating what the surveyors were to determine. The boundary line was to continue from the Rio Grande "…thence westwardly along the whole Southern Boundary of New Mexico (which runs north of the town called Paso) to its western termination; thence northward along the western line of New Mexico until it intersects the first branch of the river Gila (or it should not intersect any branch of that river, then, to the point on the said line nearest to such branch, and thence in a direct line to the same) thence down the middle of said branch and of the said river, until it empties into the Rio Colorado, thence, across the Rio Colorado, following the division line between Upper and Lower California, to the Pacific Ocean…"

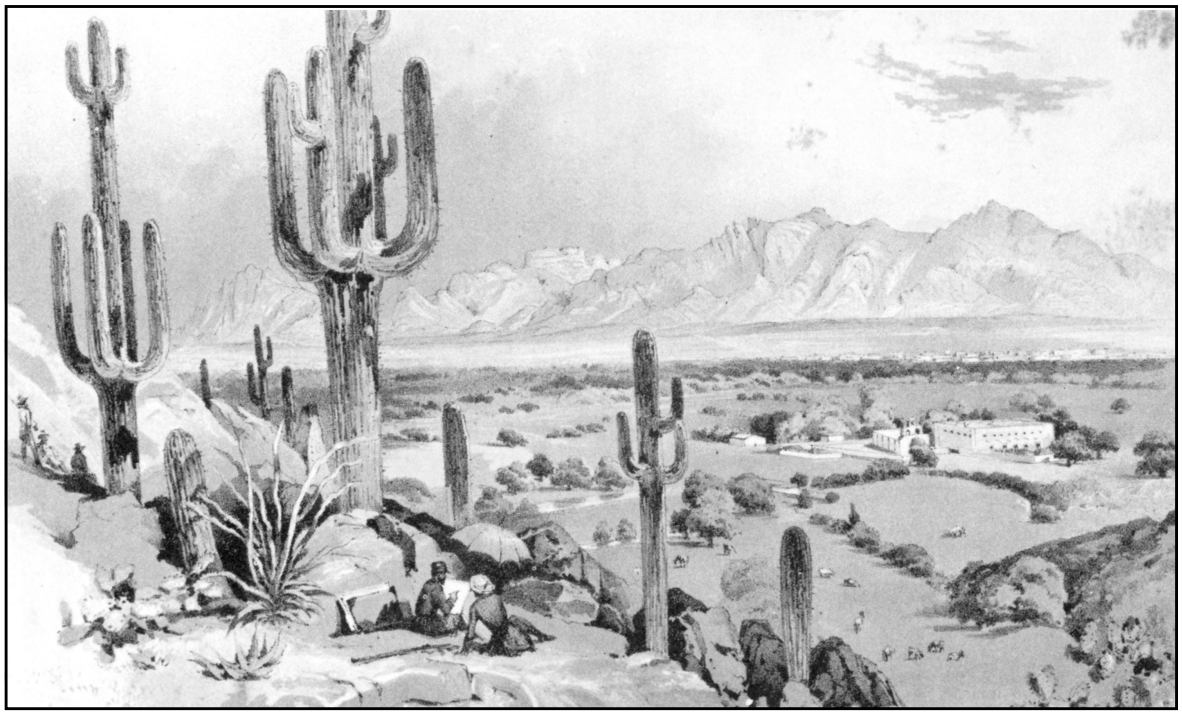

Fig. 2-19 An artist accompanied Bartlett on his survey and depicted unusual sights such as this saguaro-studded hill overlooking the small town of Tucson. *Narrative of Explorations and Incidents.* 1854.

1687-1710 . Father Eusebio Kino
1774-76 ..... Juan Batista de Anza
1775-76 ..... Francisco Garces
1846-47 ..... Lt. Cooke and the Mormon Battalion
1852 ..... John Bartlett
1854-55 ..... John G. Parke
1849-57 ..... U.S.-Mexico Boundary Commissions
1854 ..... Andrew B. Gray
1860s on ... Land Office Cadastral Surveys
1891-94 ..... Boundary Resurvey

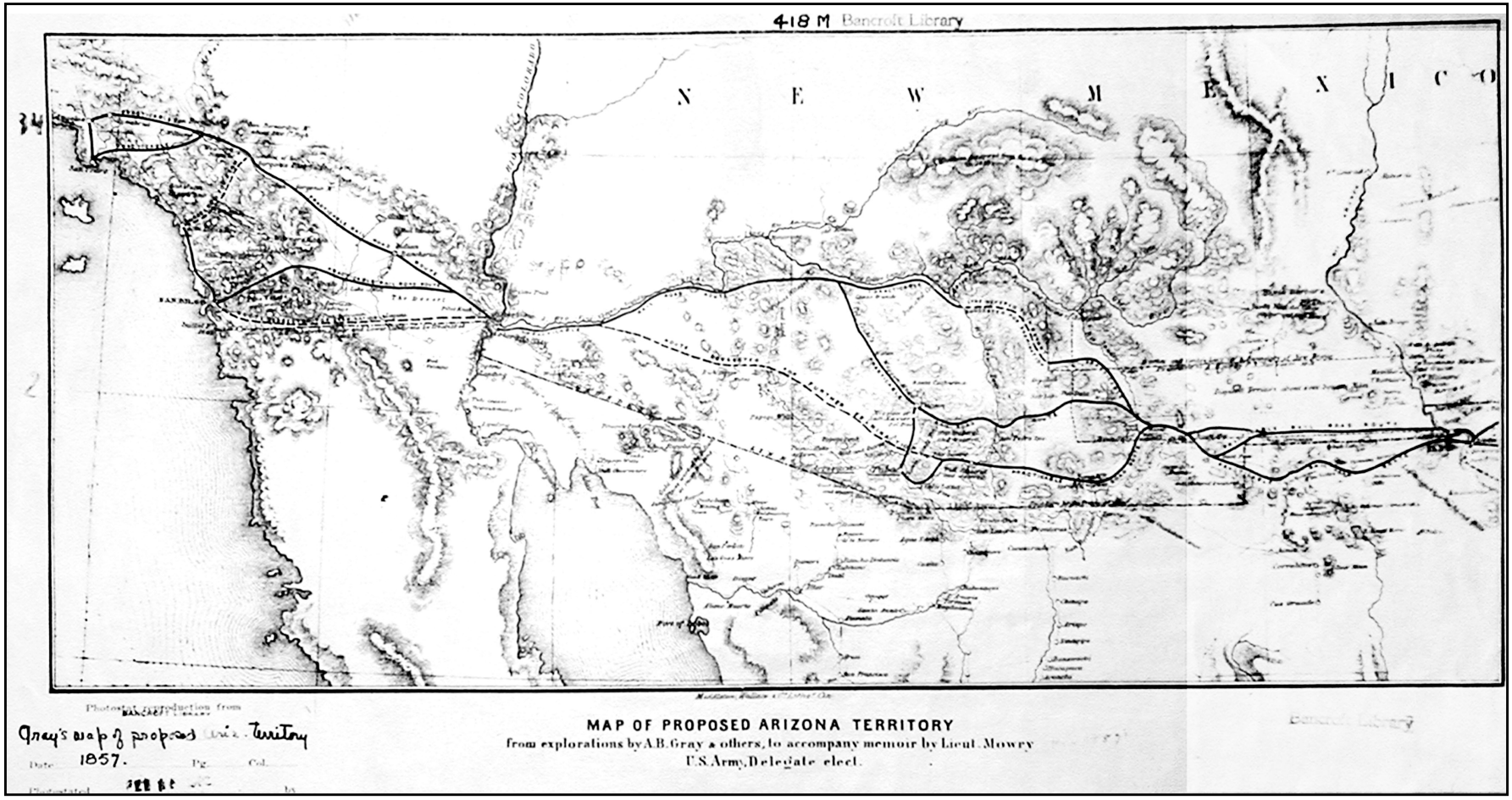

Fig. 2-20 Map of the Proposed Arizona Territory in 1857 by A.B. Gray.

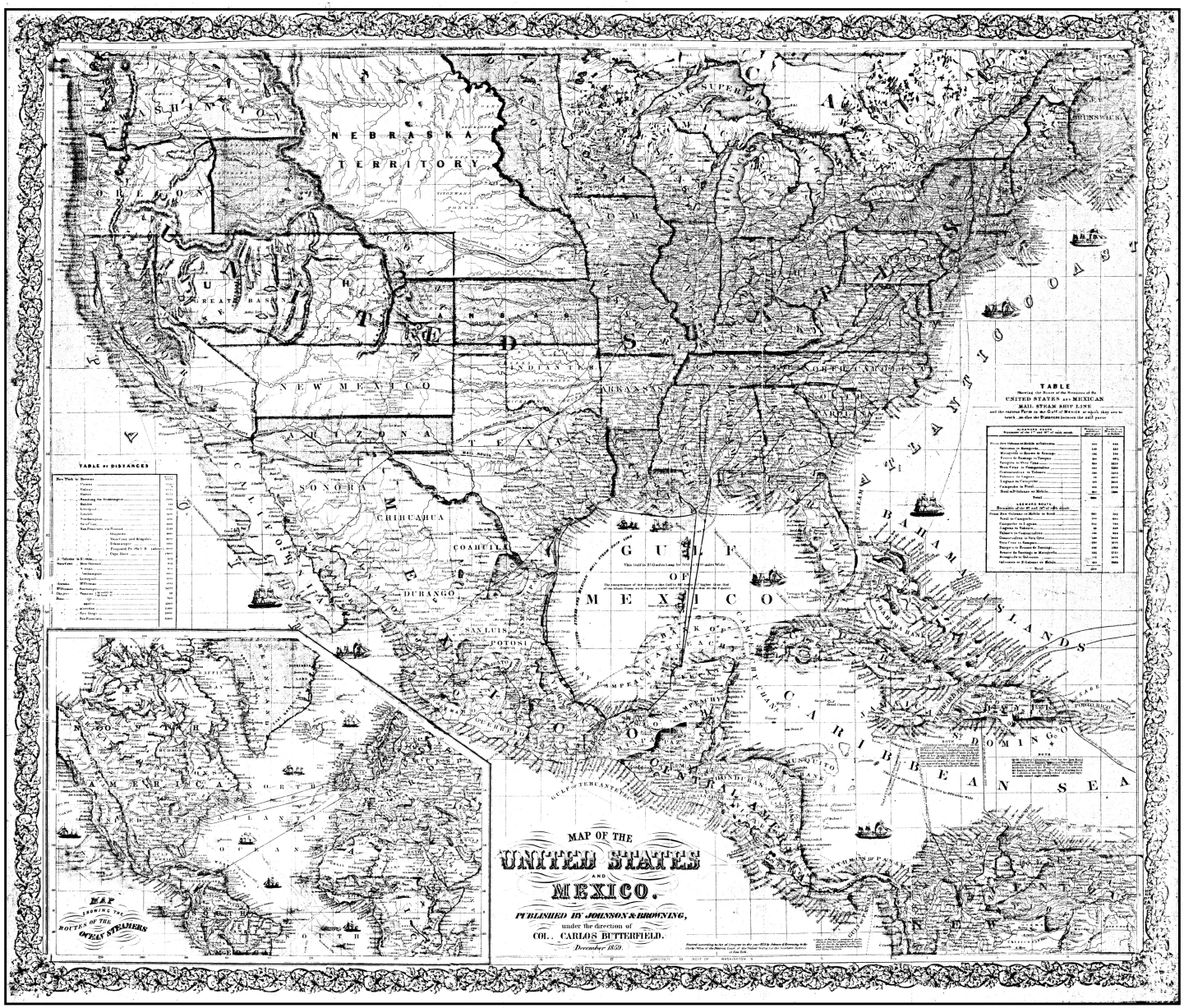

Fig. 2-21 1859 map of the United States and Mexico, showing Arizona as a separate territory south of the New Mexico Territory. Although this division was proposed, it never happened.

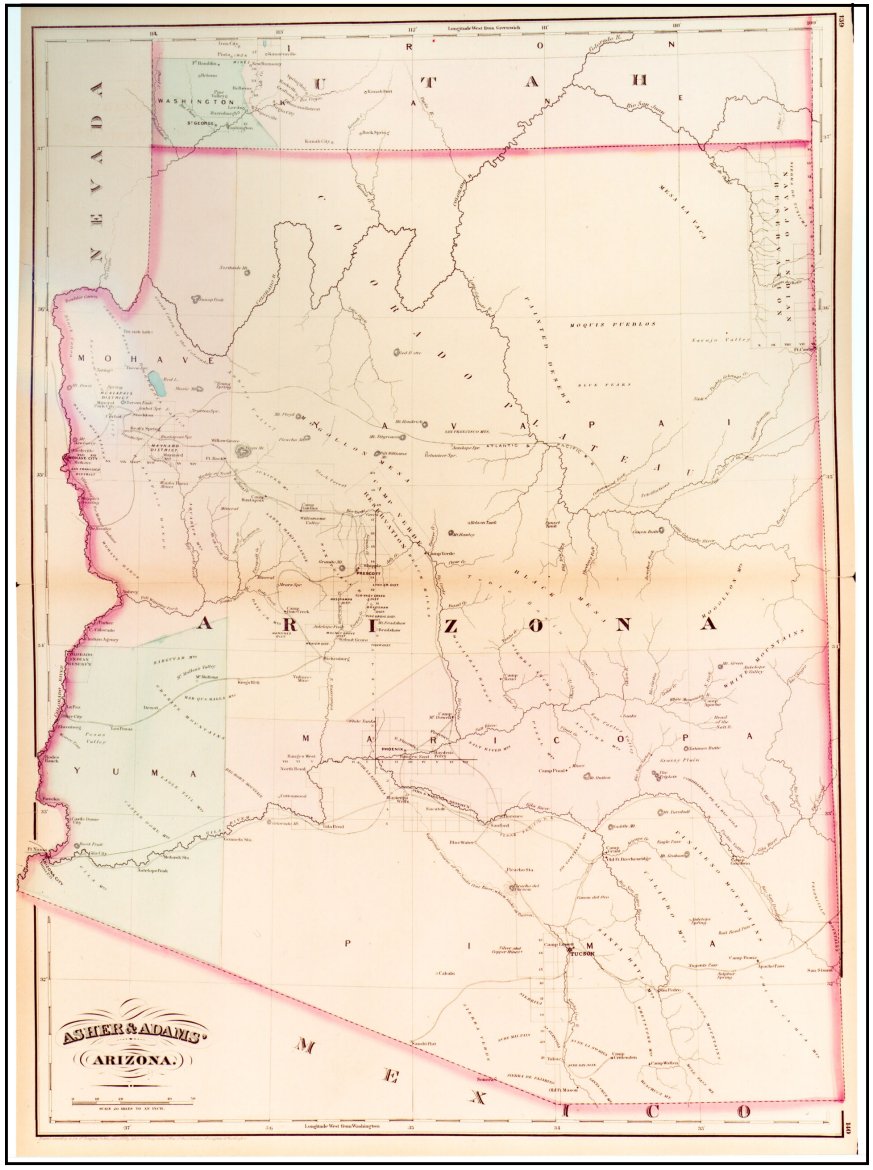

Fig. 2-22 Asher and Adams 1873 map of Arizona. Courtesy Joy Mehulka.

Fig. 2-23 The eastern Pima County portion of the Asher and Adams map.

Fig. 2-24 George Roskruge was Pima County's preeminent surveyor in the last quarter of the 19th century. He later became Surveyor General of the United States. He is shown here in full Free Mason regalia.

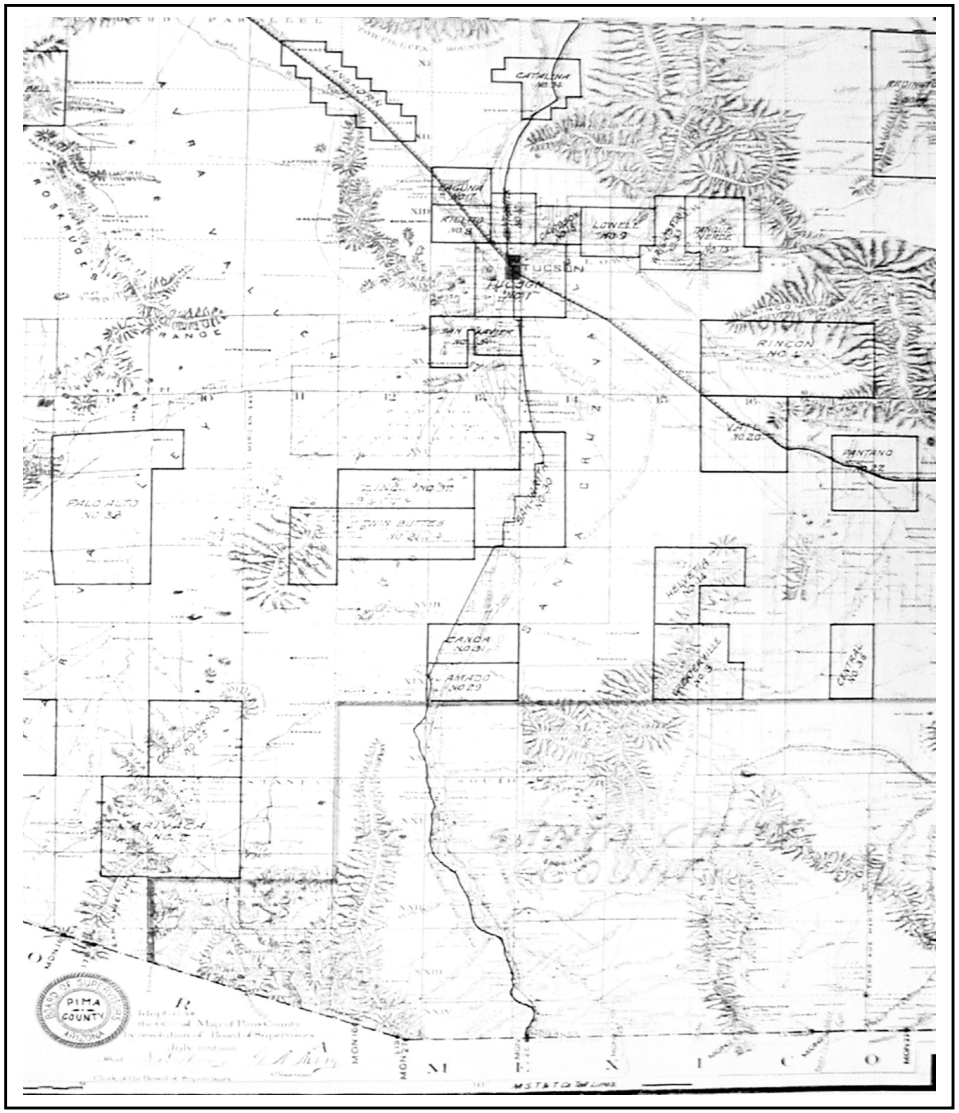

Fig 2-25 Detail of the 1888 Official Map of Pima County by George Roskruge. Mining districts are indicated by rectangles. Note that Santa Cruz County is now a separate county.

Fig. 2-26 1885 Geo. F. Cram map of Arizona. Both maps this page courtesy Ed Curley.

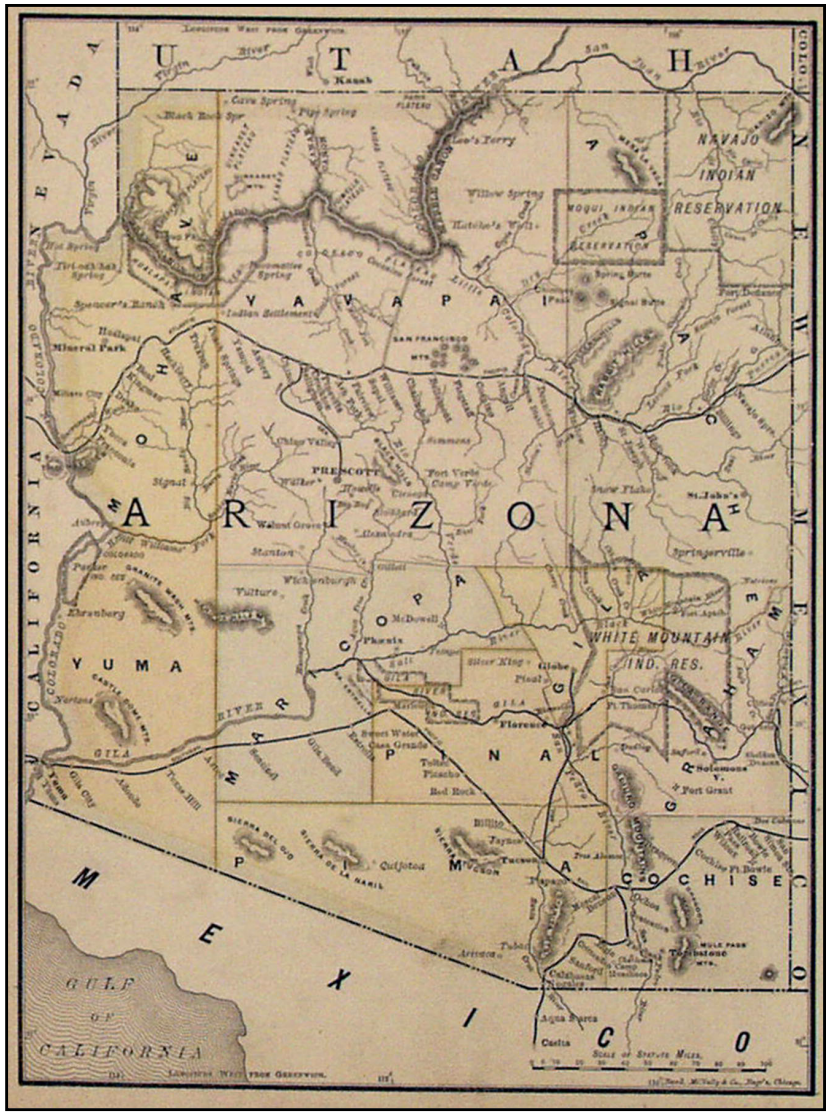

Fig. 2-27 1889 Rand, McNally & Co. map of Arizona.

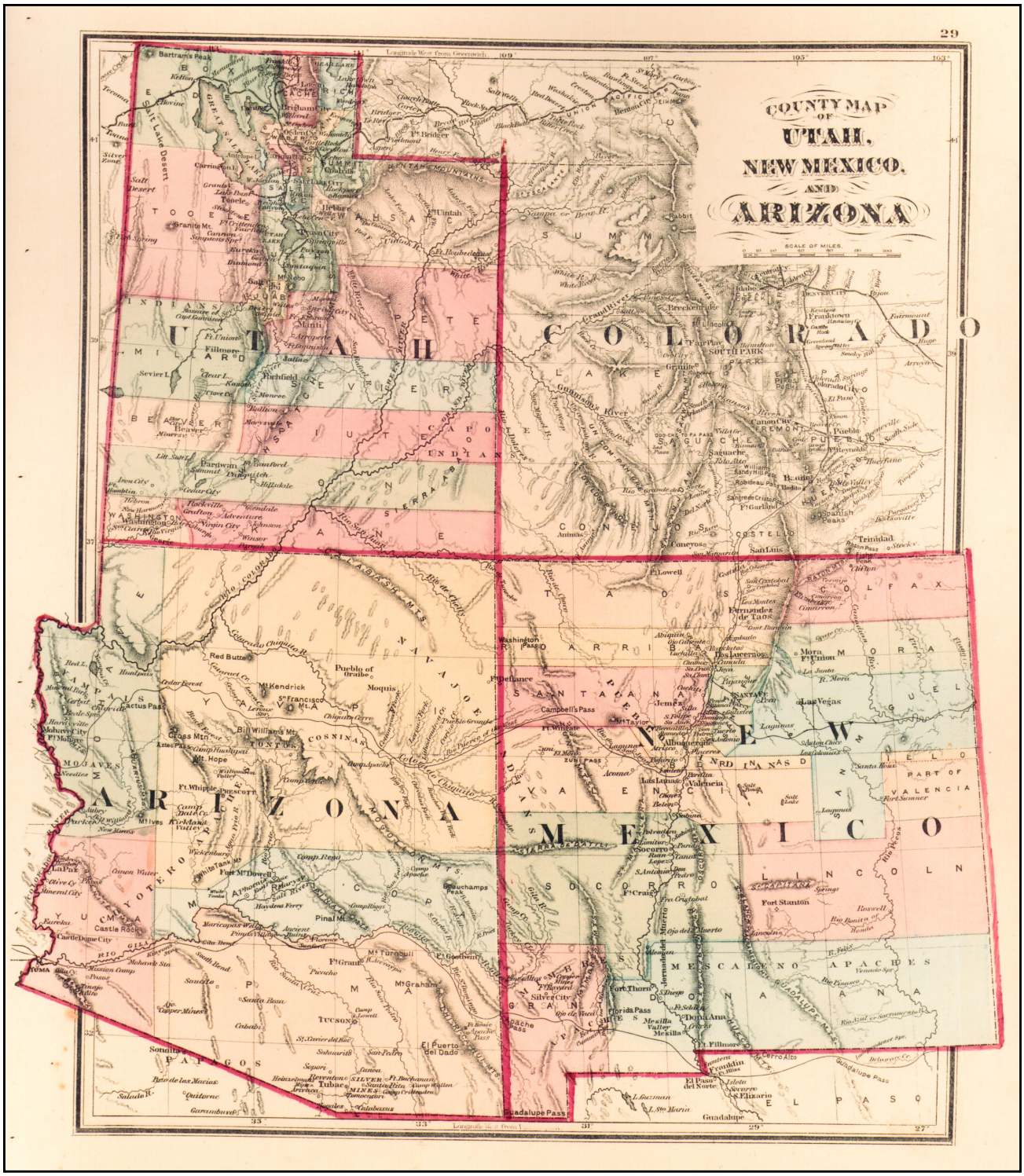

Fig. 2-28 The Four-Corners Region before 1881. Map courtesy Ed Curley.

Fig. 2-29 The Aribac (Arivaca) Land Grant as drawn by George Roskruge. Courtesy University of Arizona Library, Special Collections.

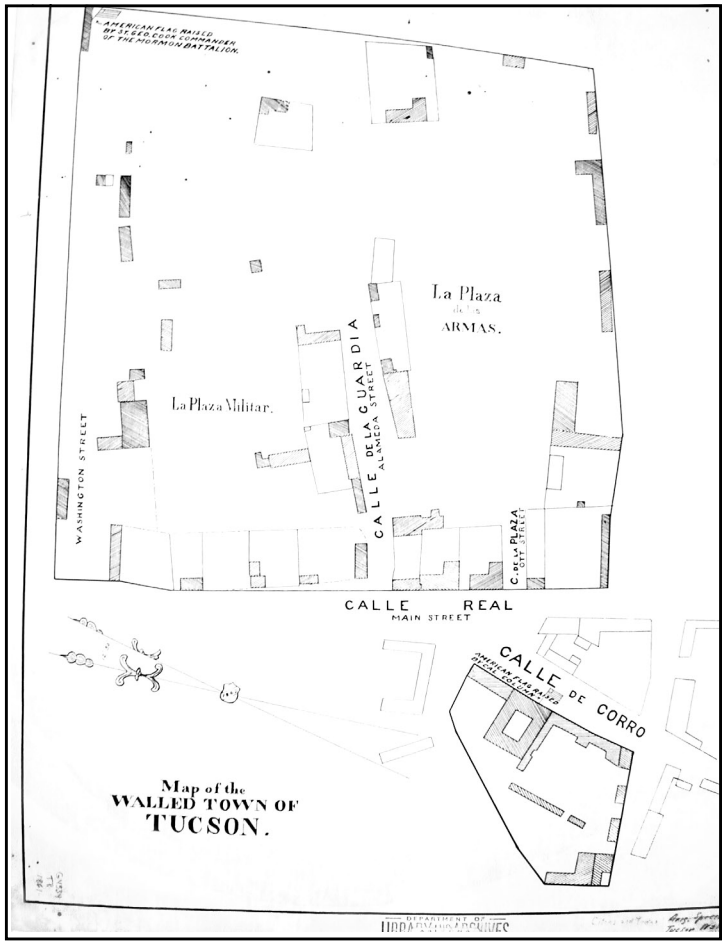

Fig. 2-30 The Walled Town of Tucson in the 1860s. Note that north is on the left. Courtesy Arizona State Library map collection.

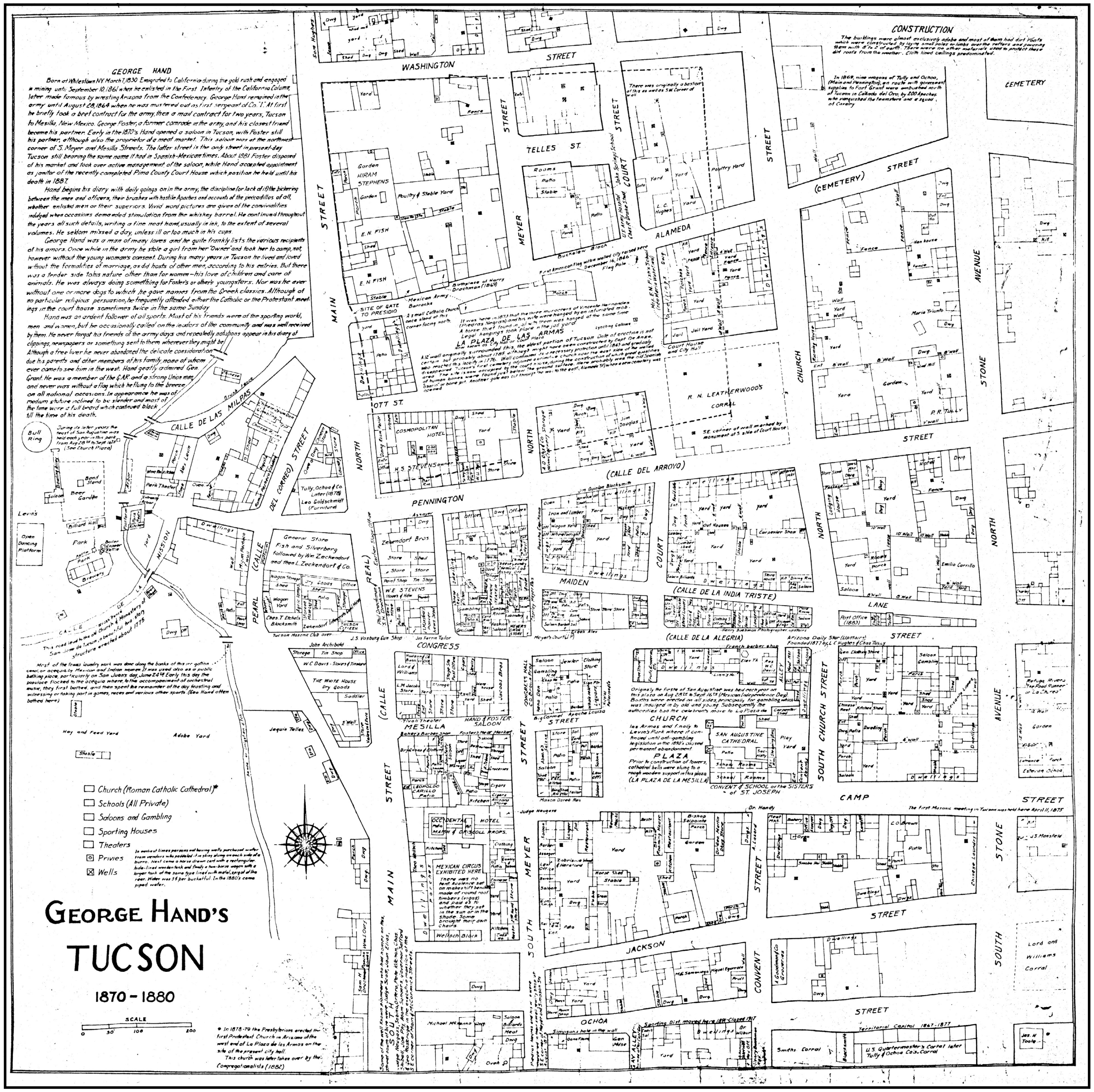

Fig. 2-31 George Hand's Tucson 1870-1880. Courtesy Arizona State Library map collection.

Fig. 2-32 The first official map of Tucson. Courtesy Arizona State Archives map collection.

Fig. 2-33 Surveyor's newspaper ad from the 1870s.

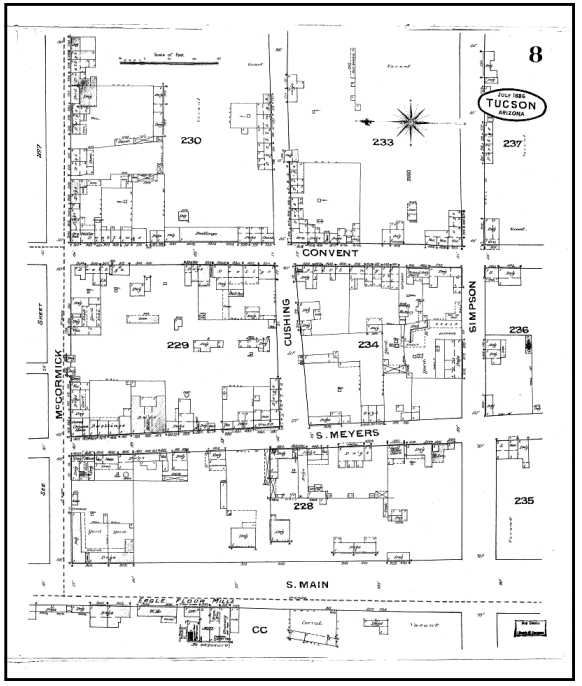

Fig. 2-34. One of the Sanborn Fire Insurance Maps of Tucson for 1886. Such maps were used for calculating fire insurance risks and rates.

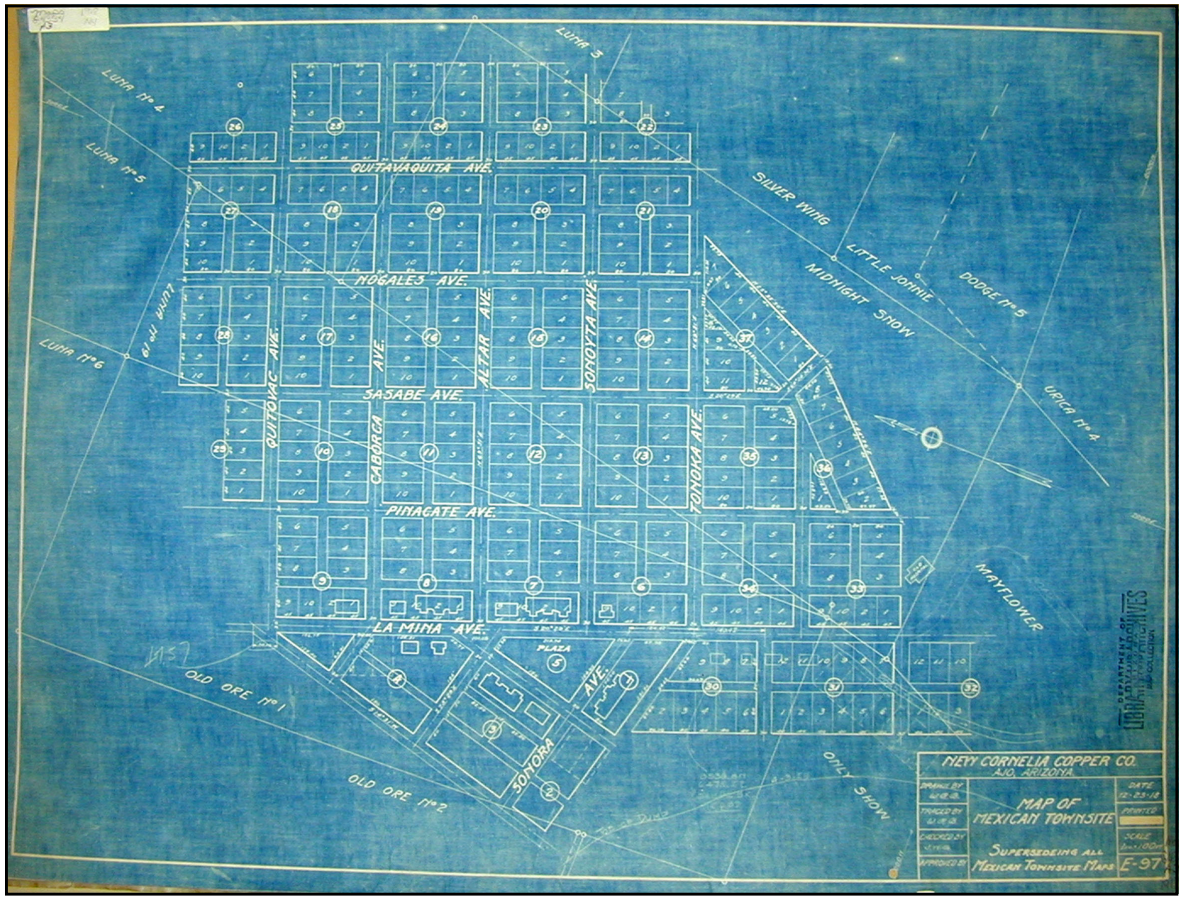

Fig. 2-35 Map of the Mexican townsite of Ajo made for the New Cornelia Copper Company in 1918. Courtesy Arizona State Library map collection.

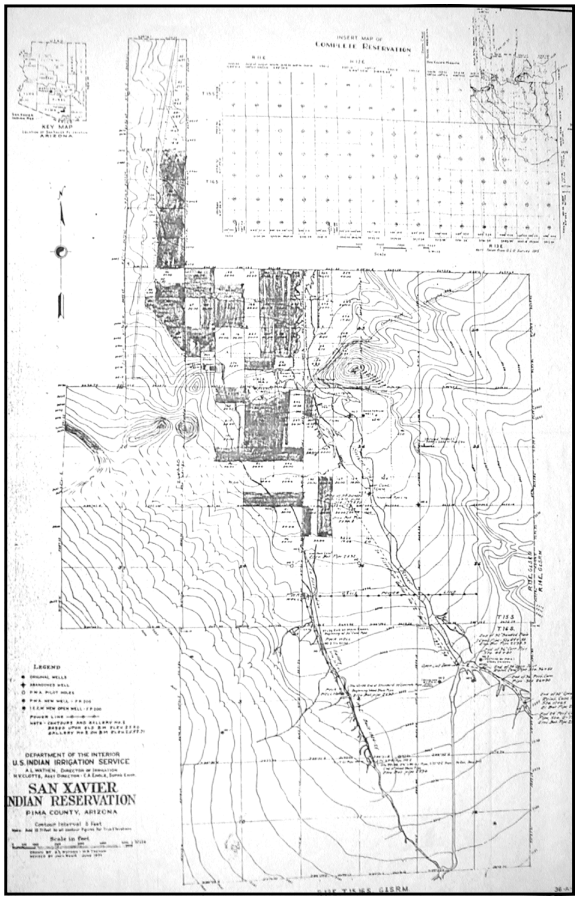

Fig. 2-36 San Xavier Indian reservation and cultivated lands. Produced by the U.S. Indian Irrigation Service in the early 1900s. Courtesy University of Arizona map collection.

III. USE OF MAPS FOR VARIOUS PURPOSES

There are many ways in which maps are used, only a few of which are explored in this chapter. They are used to depict, analyze and plan in areas such as:

- Agriculture and irrigation facilities
- Archaeological and historical features
- Communications systems
- Crime patterns
- Economics and business trends
- Future infrastructure demands
- Geology, hydrology, and soil types
- Health patterns and facility needs
- Land ownership
- Land use
- Military campaigns
- Mining claims
- Parks and recreation facilities
- Political boundaries
- Population distribution
- Racial and economic distribution
- School districts
- Tourism promotion
- Transportation routes
- Vegetation and wildlife
- Voting districts
- Water supplies
- Water quality
- Watercourses and floodplains
- Weather and climate

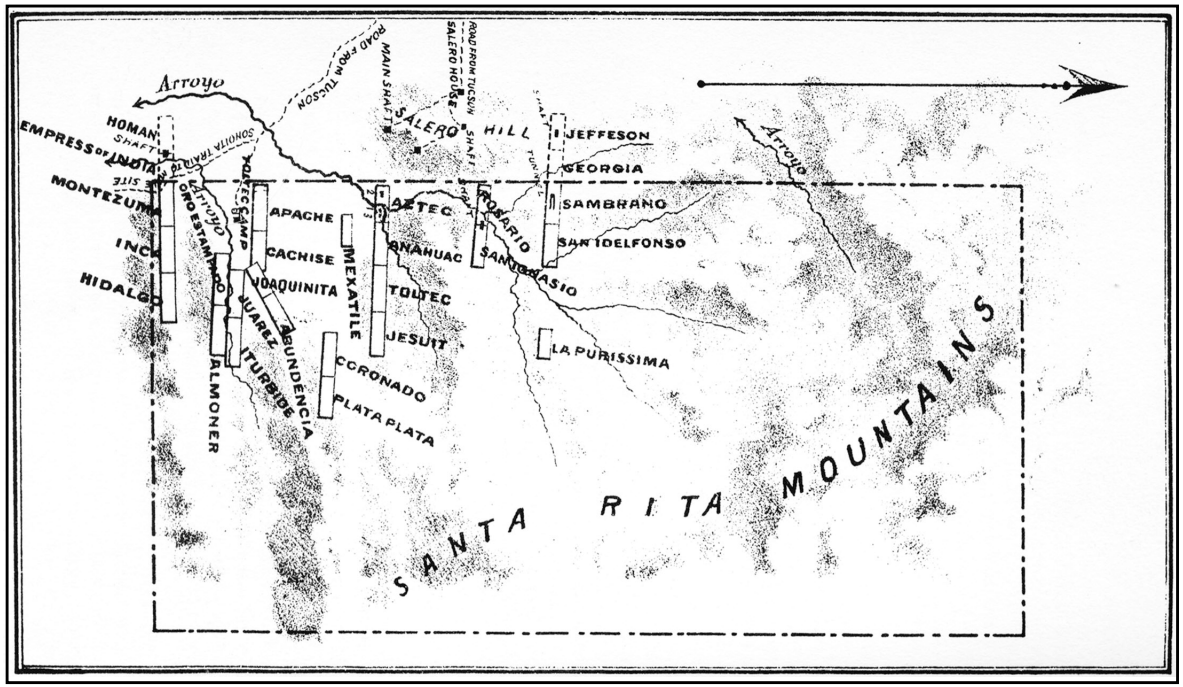

Fig. 3-1 One of the early territorial impetuses to making maps was establishing mining claims. Certain areas were declared mining districts and claims within those districts delineated. This map shows the Aztec Mining District in the Santa Rita Mountains in 1877. Courtesy University of Arizona map collection.

Military Campaigns

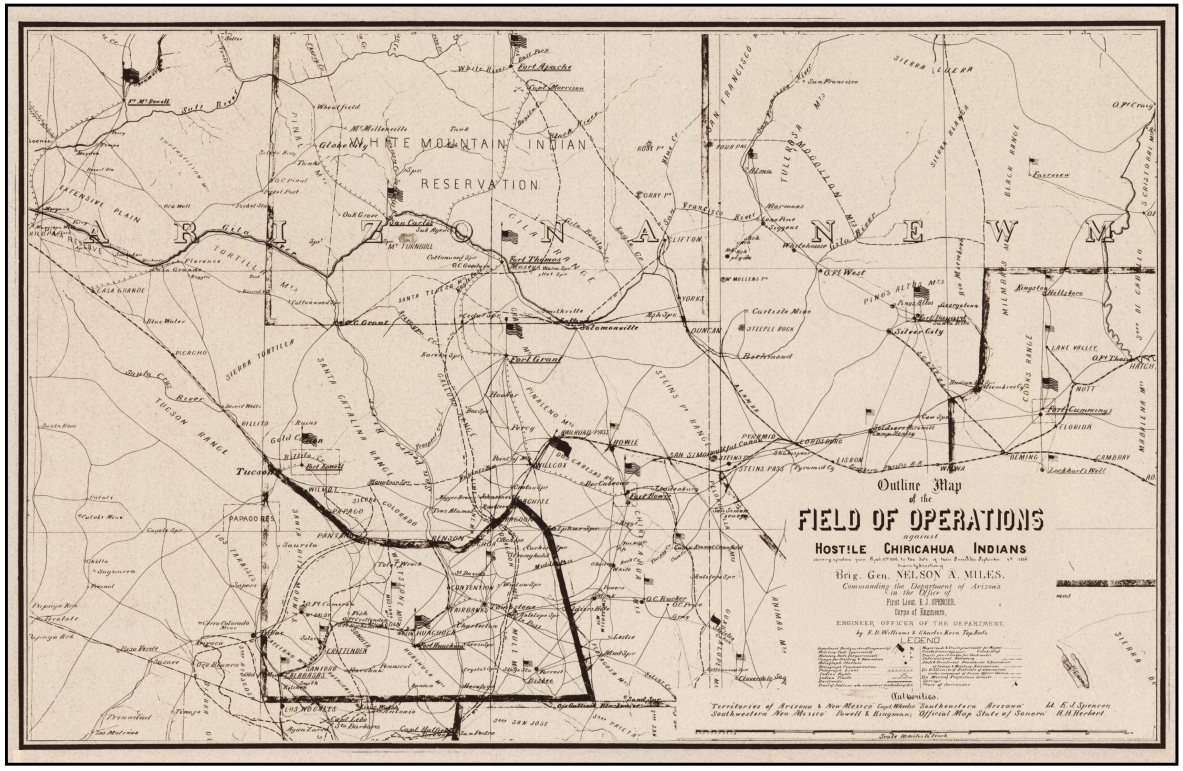

Fig. 3-2 Field of operations against the Hostile Chiricahua Indians prepared by the U.S. Army in the 1870s.

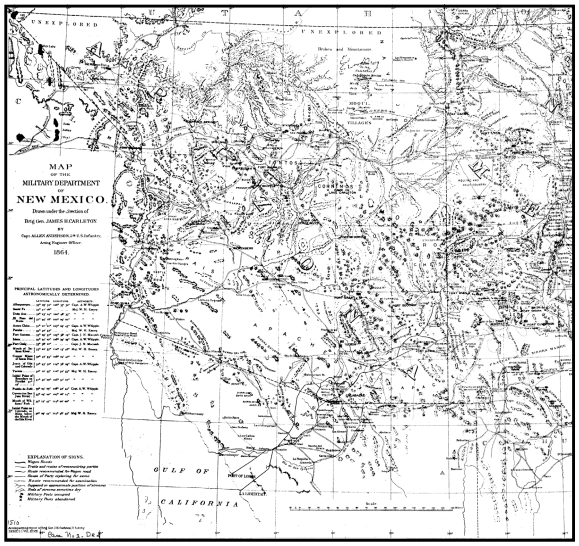

Fig. 3-3 Map of the Military Department of New Mexico, prepared by the U.S. Army in 1864.

Transportation Routes

Transportation maps either show the existing location of roads, trails, and railroads or are used for planning purposes to develop the best route for a new road or railroad. In the twentieth century, new mapping techniques led to map that analyze features such as traffic volumes in order to project future road needs.

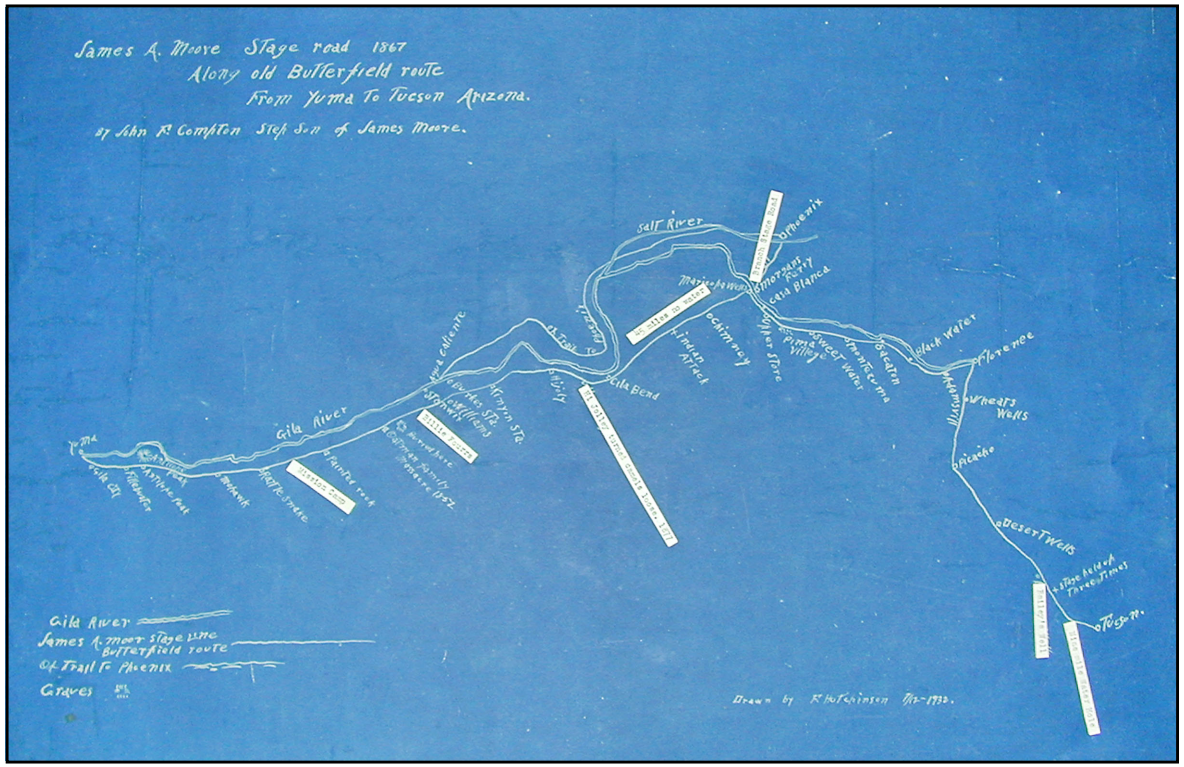

Fig. 3-4 An annotated map of the stagecoach road along the old Butterfield route between Tucson and Yuma in 1867. The annotations include notes such as "rattlesnake" and "no water." Note the importance of places to find water. Courtesy Arizona State Archives map collection.

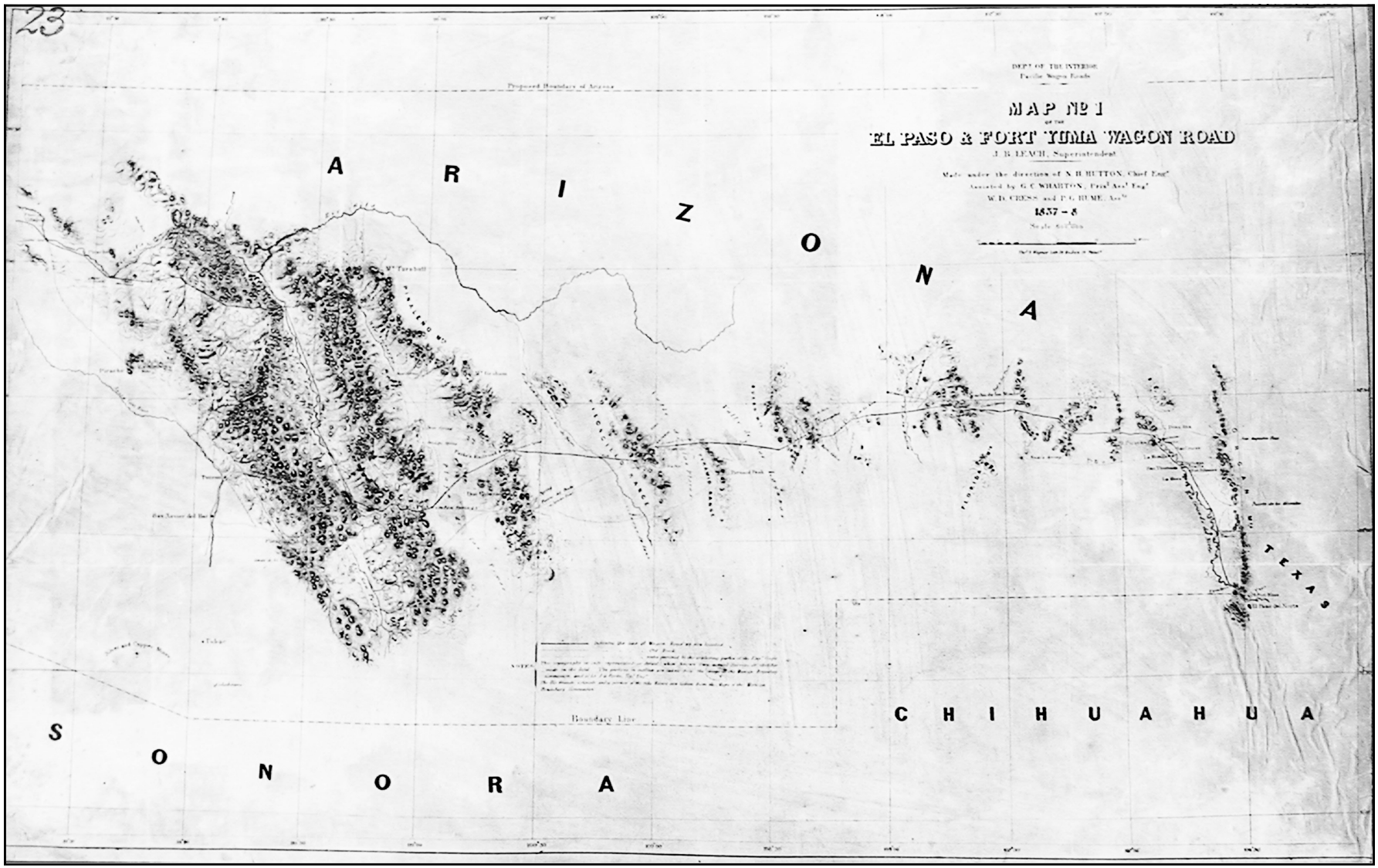

Fig. 3-5 The El Paso and Fort Yuma Wagon Road. The section from El Paso to Tucson in 1857-58. Courtesy of the Arizona State Archives map collection.

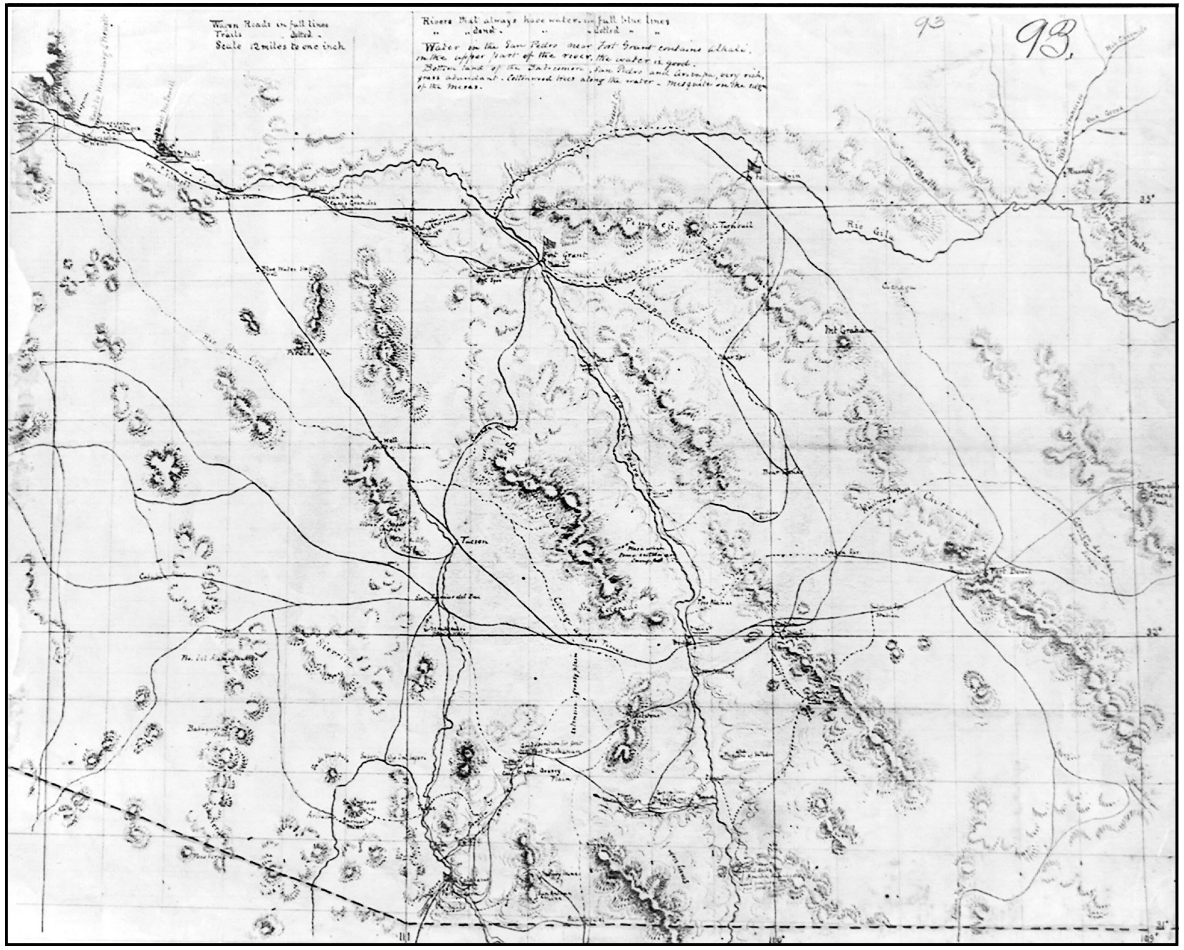

Fig. 3-6 Streams and trails in Southern Arizona in 1870. Courtesy Arizona State Library map collection.

Fig. 3-7 The proposed Tucson and Gulf of California Railroad in 1861. It was never built. Courtesy University of Arizona map collection.

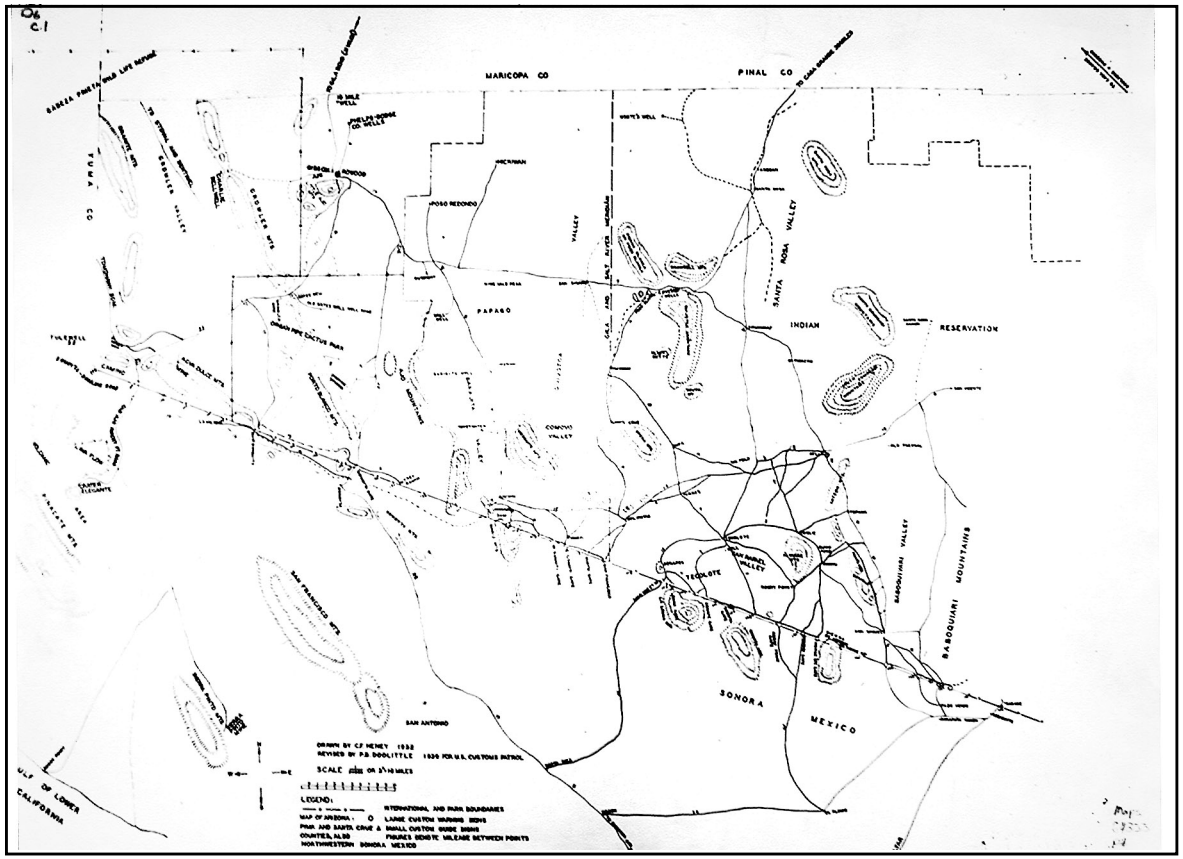

Fig. 3-8 Roads along the border in the early 1900s. Courtesy University of Arizona map collection.

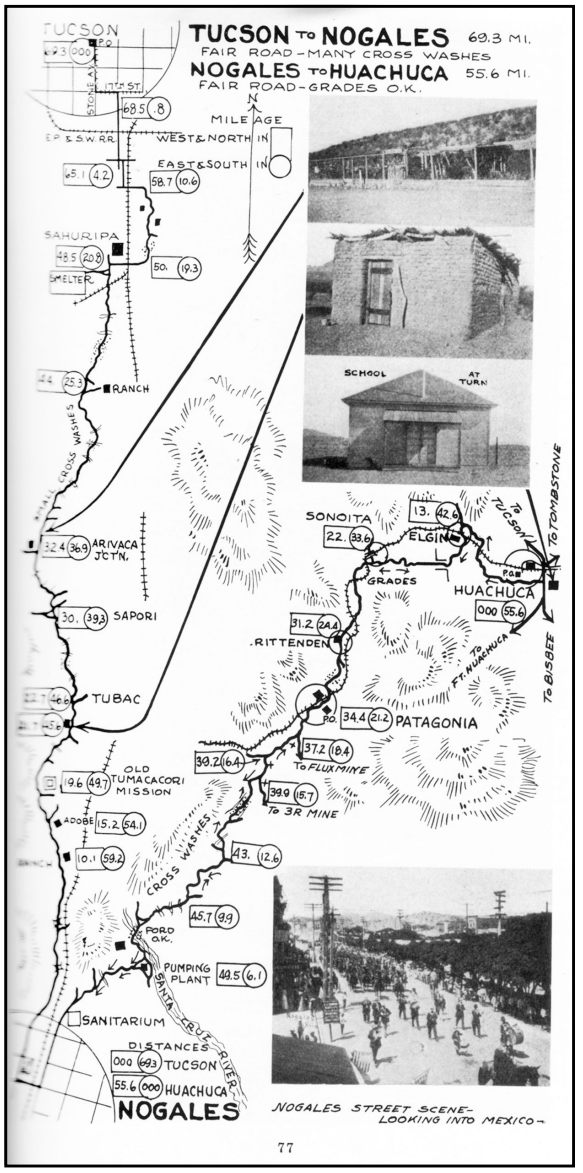

Fig. 3-9 The route between Tucson and Nogales in 1912 according to the Arizona Good Roads Association.

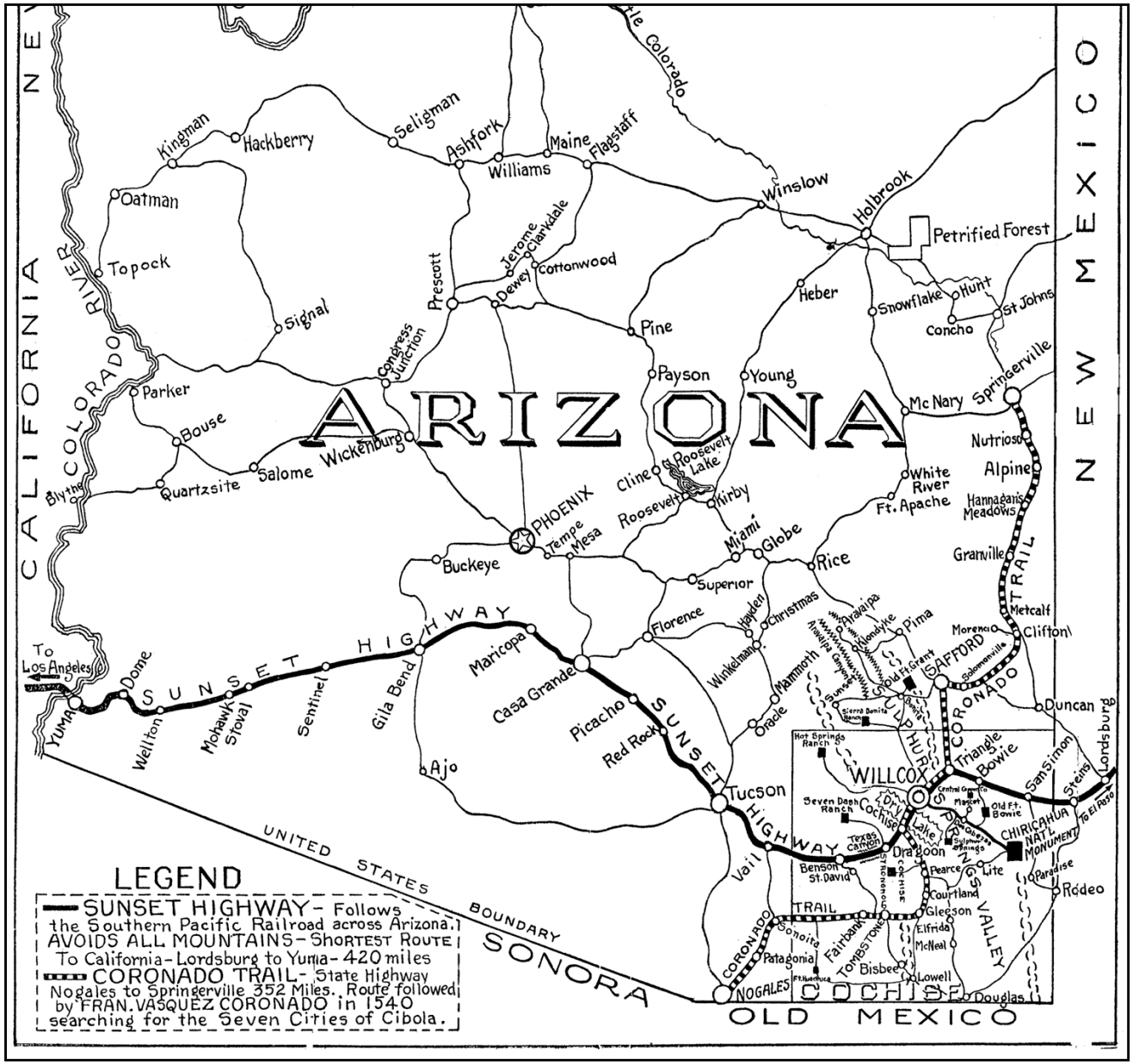

Fig. 3-10 Major routes in Arizona in the 1920s. Arizona Highway Department.

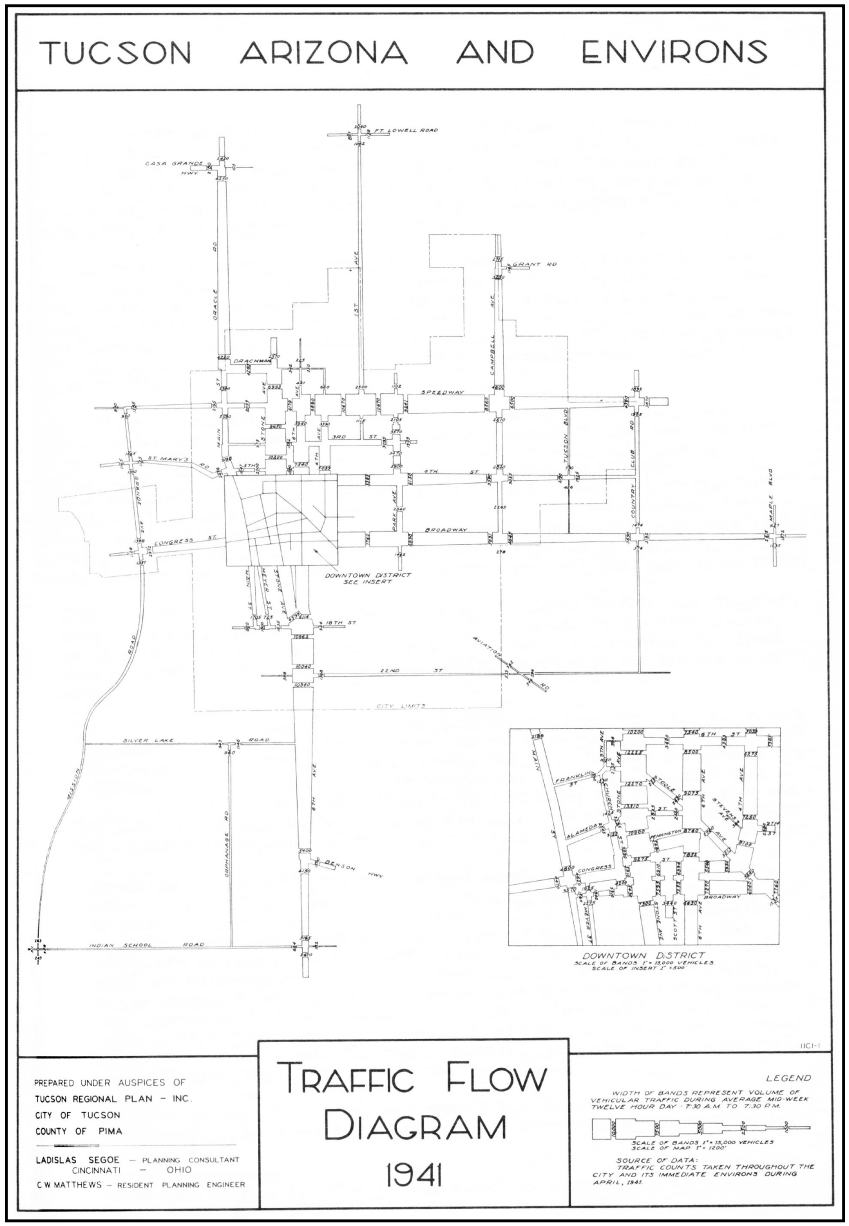

Fig. 3-11 Tucson traffic flow diagram 1941. Tucson Regional Plan.

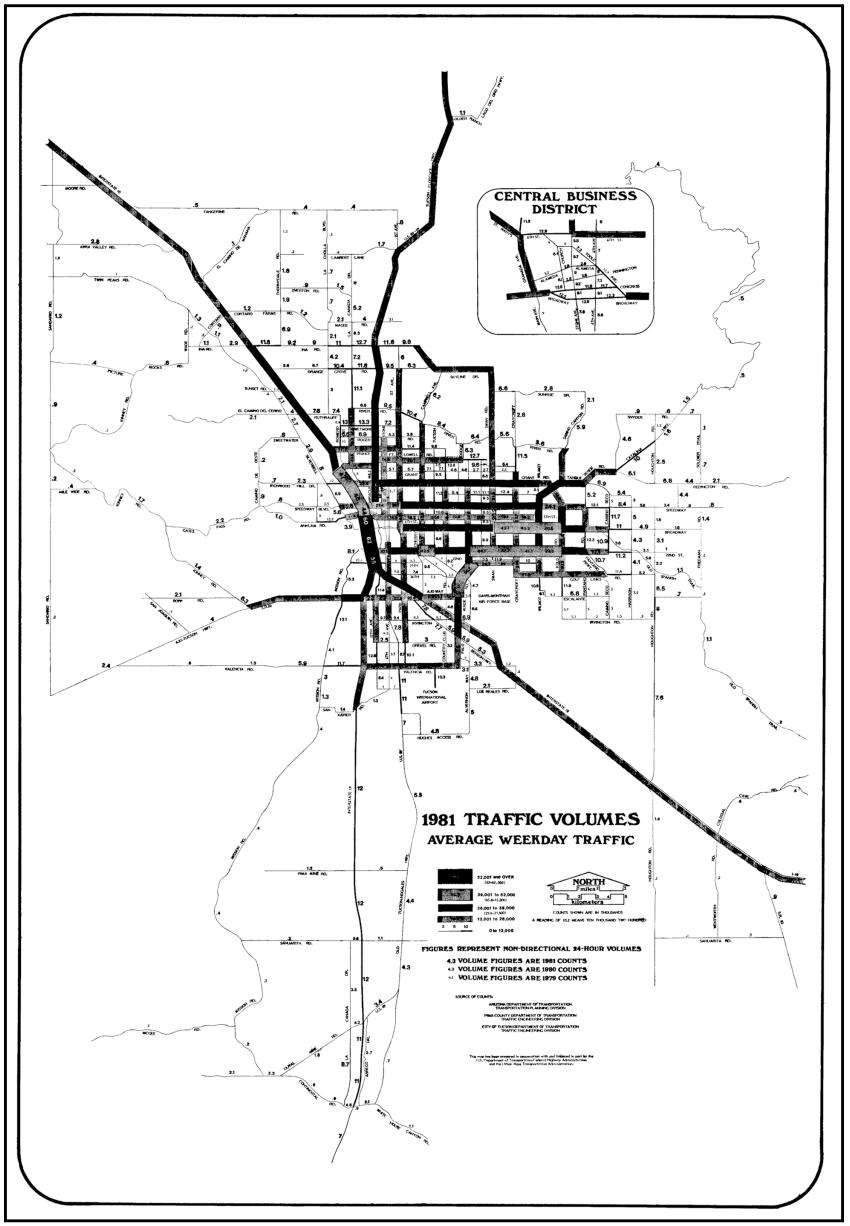

Fig. 3-12 1981 traffic volumes in Tucson. Pima Association of Governments.

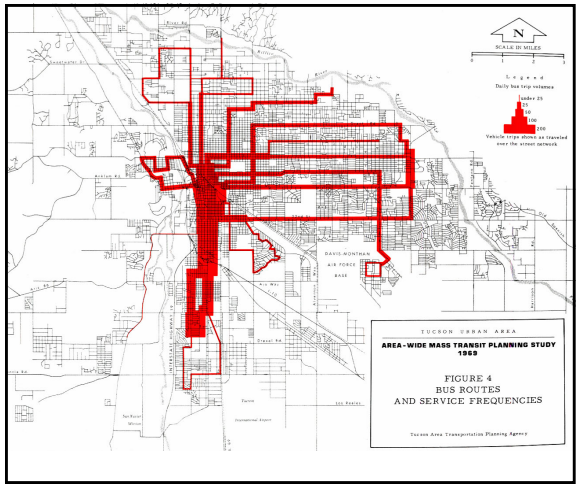

Fig. 3-13 Bus routes and service frequencies in 1969. Tucson Area Transportation Planning Agency.

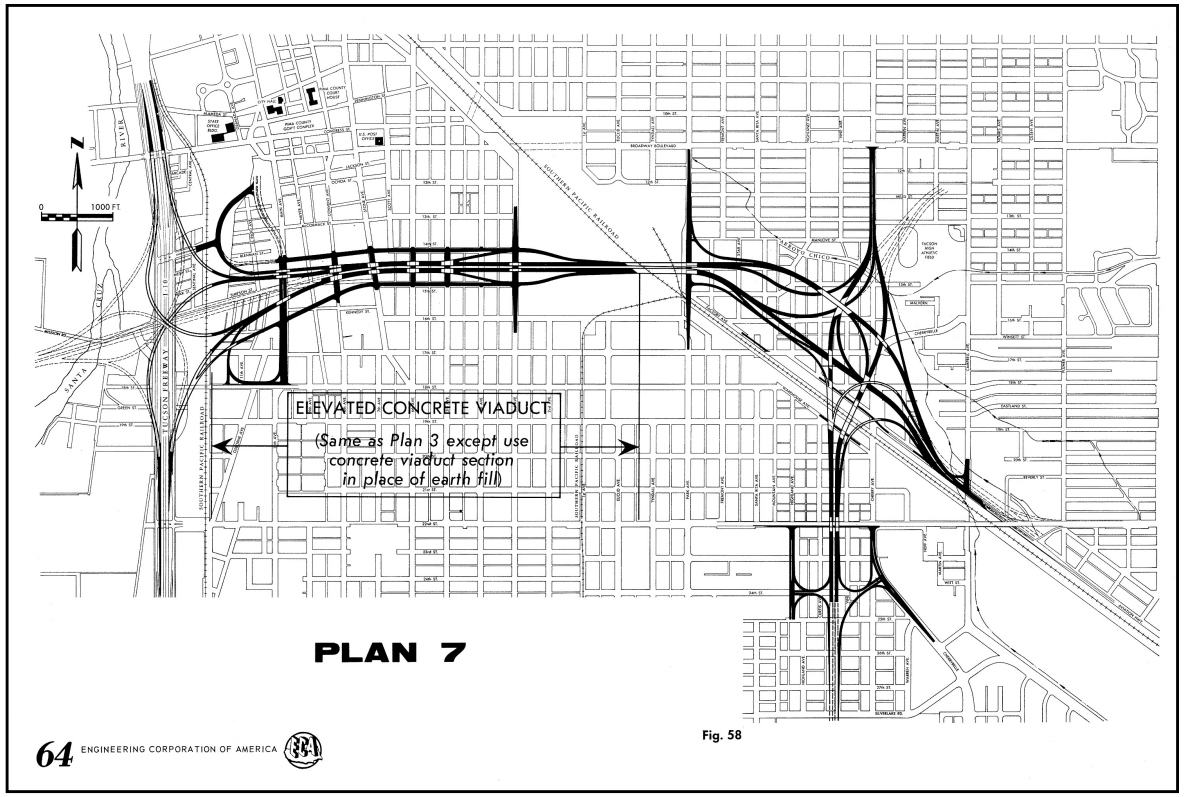

Fig. 3-14 One alternative design for freeway interchange construction in 1968. Arizona Highway Department.

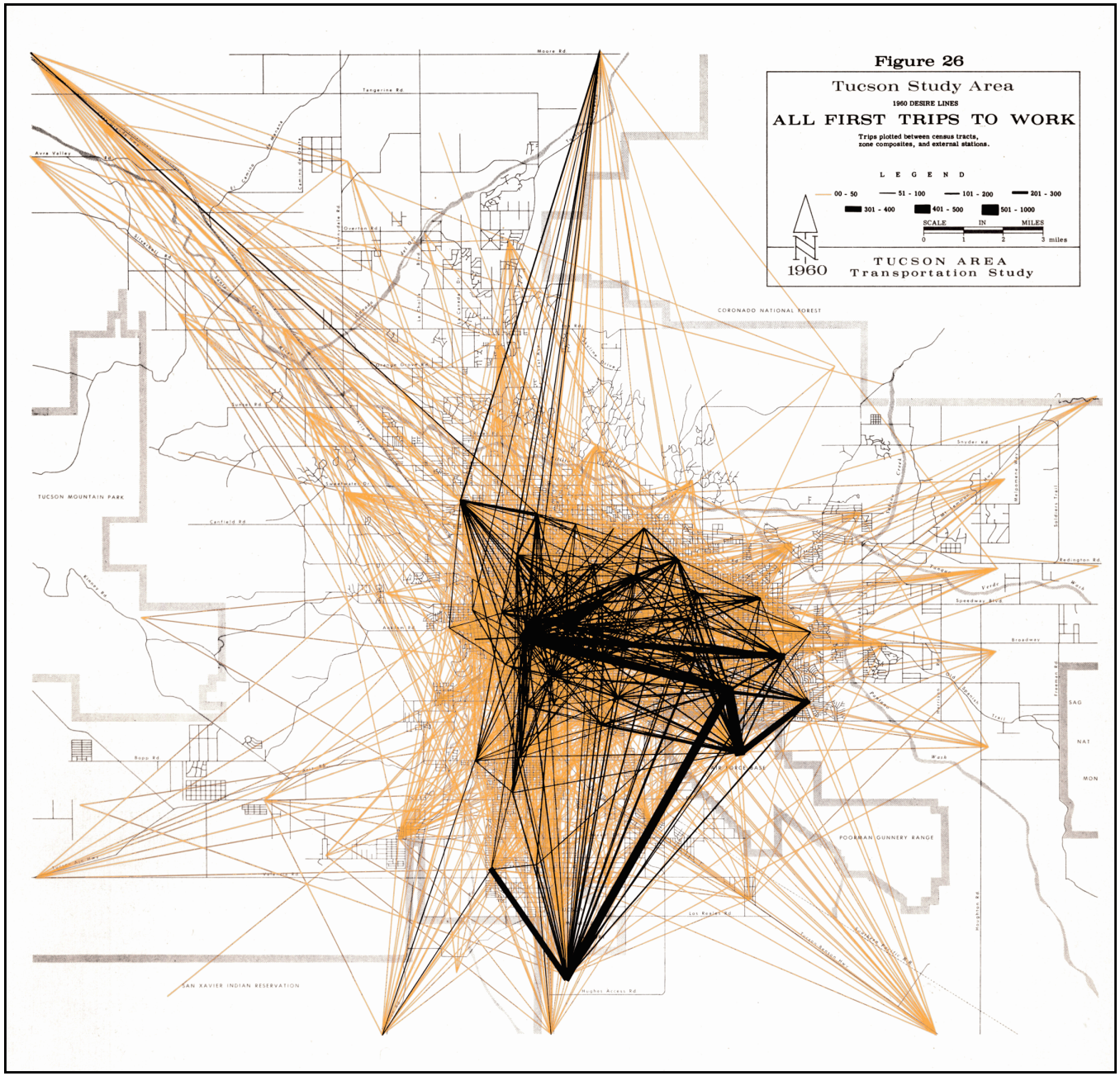

Fig. 3-15 Internal auto trips 1960. Tucson Area Transportation Planning Agency.

Communications

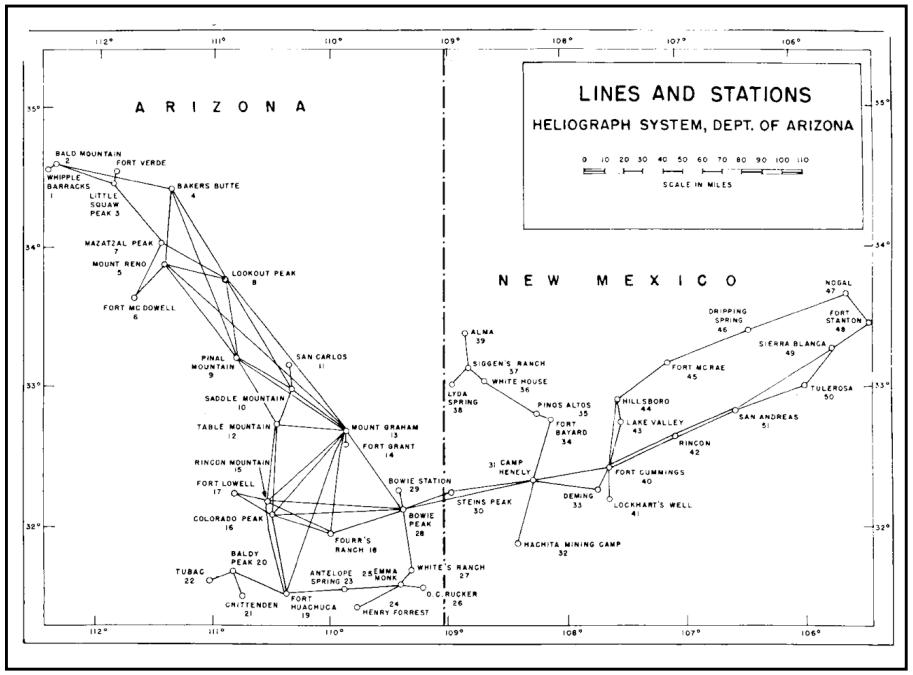

Fig. 3-16 Heliograph System Dept. of Arizona 1860s. Courtesy Fort Huachuca Military Museum.

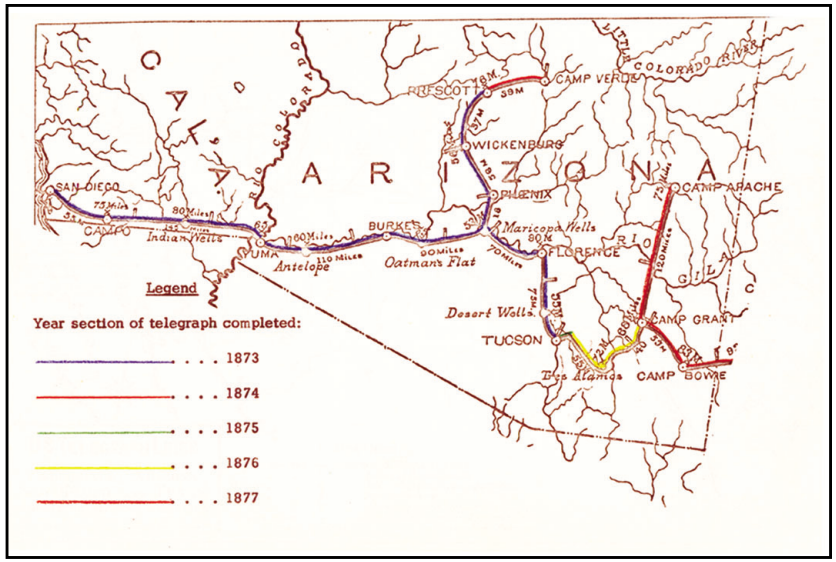

Fig. 3-17 Growth of the military telegraph in Arizona. Courtesy University of Arizona map collection.

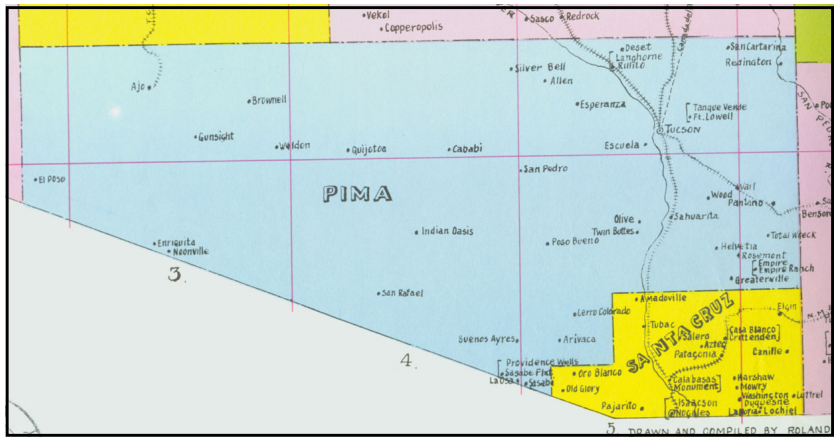

Fig. 3-18 Territorial post offices. Pima County section. Courtesy University of Arizona map collection.

Water Quantity and Quality

Water-related maps may show streams and other surface water features including diversions and planned dams. They may also show features related to groundwater, not visible to the surface viewer such as depth to water, contamination, or impacts of water withdrawal.

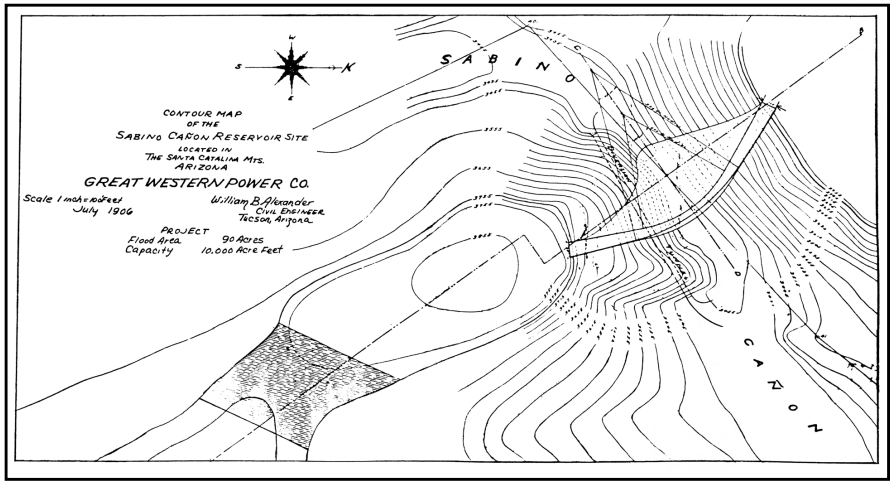

Fig. 3-19 Proposed Sabino Canyon Dam in 1906. This was one of several proposals to dam Sabino Canyon to provide water supplies for Tucson.

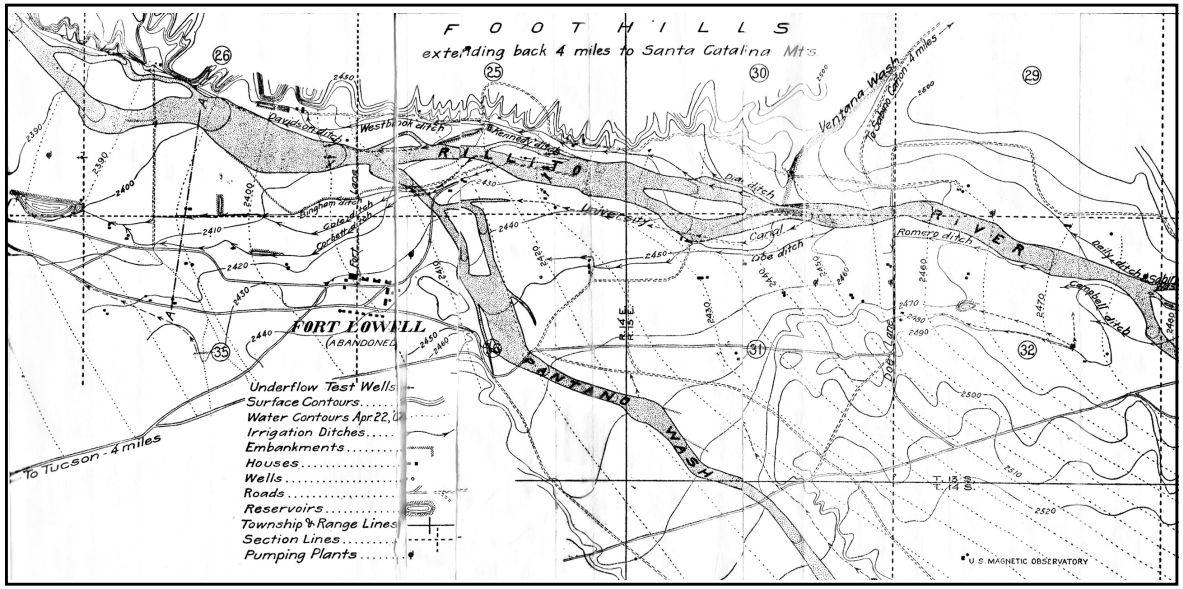

Fig. 3-20 The Rillito River and irrigation canals . From G.E.P. Smith's 1910 Groundwater supply and irrigation in the Rillito Valley. Agricultural Experiment Station, University of Arizona.

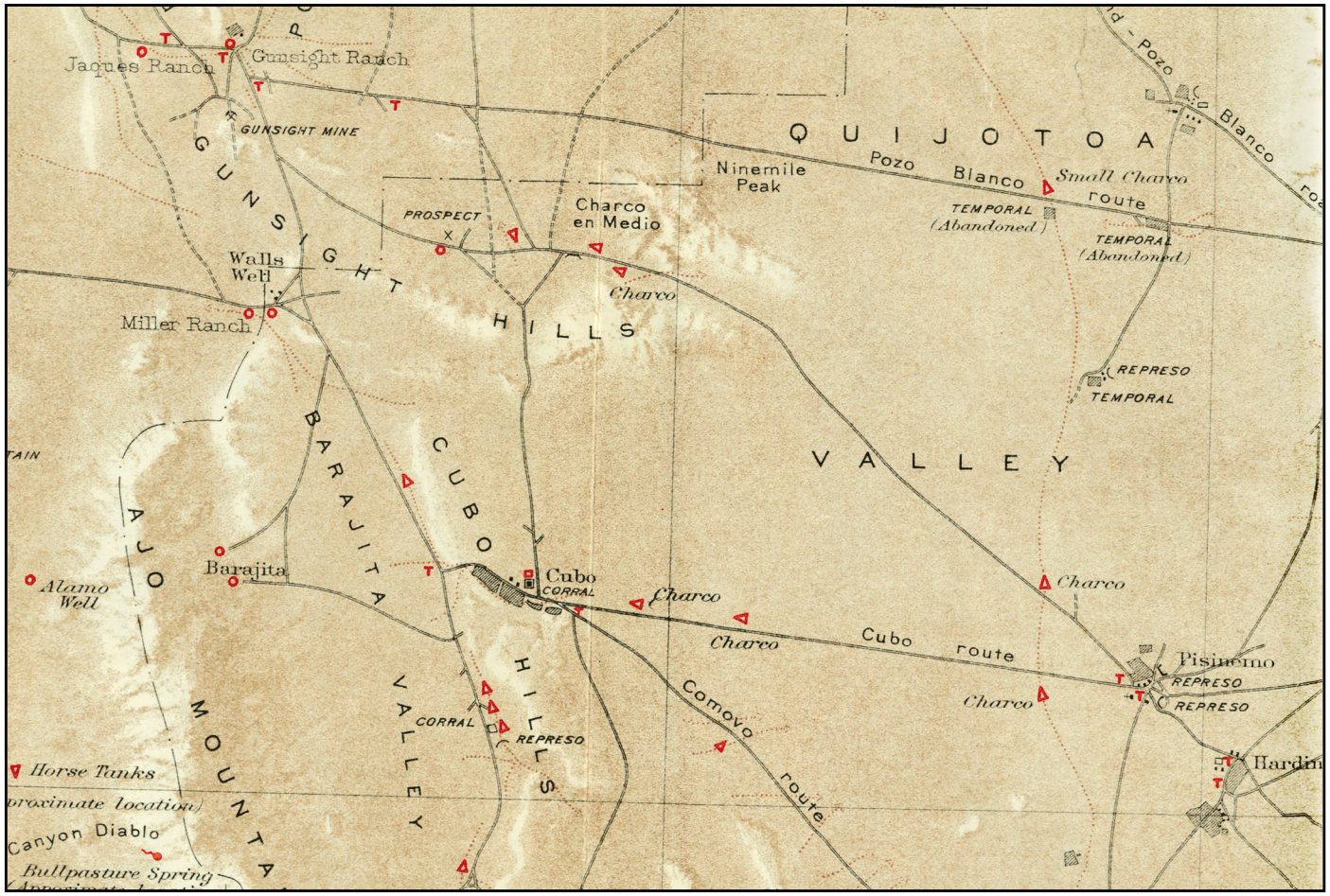

Fig. 3-21 Desert watering places. Detail from the Quijotoa Area. From Kirk Bryan's 1925 U.S.G.S study, The Papago Country, Arizona. Water Supply Paper 499.

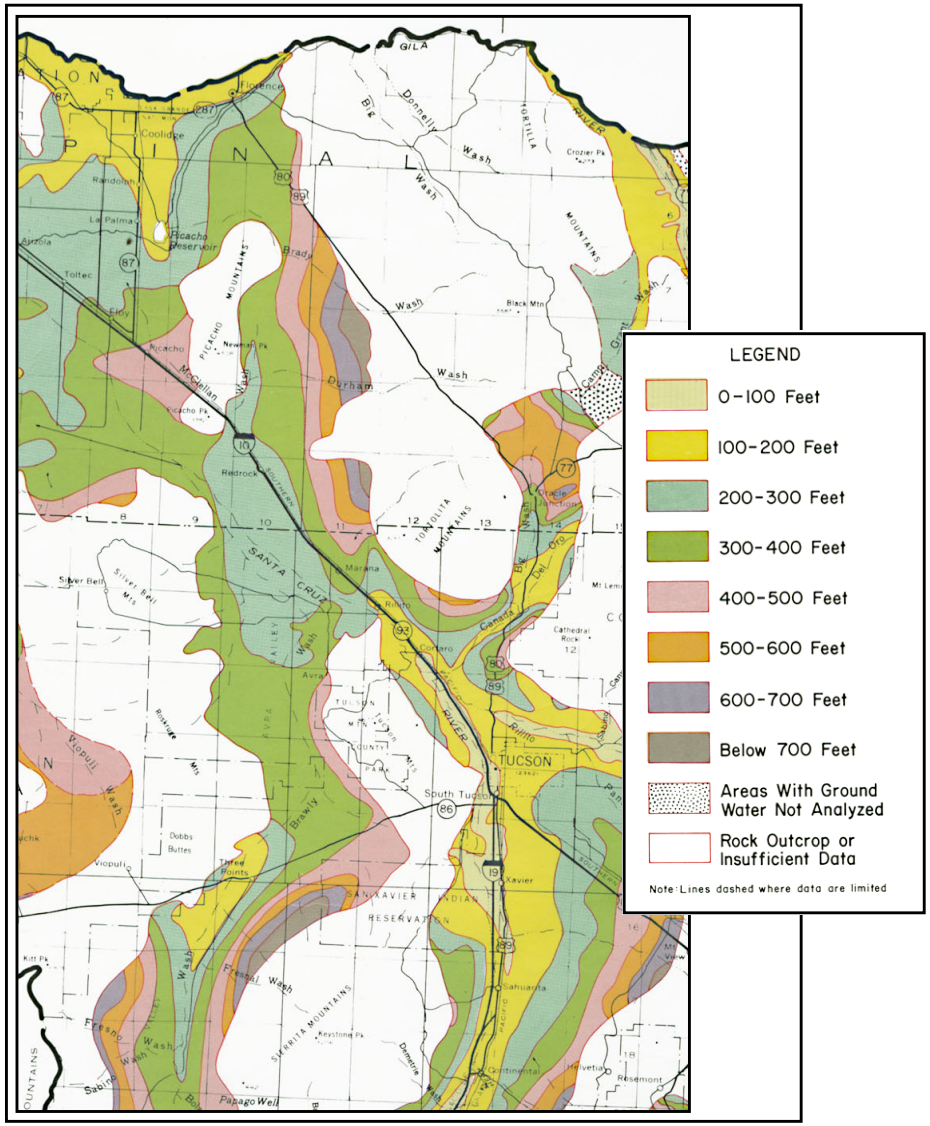

Fig. 3-22 Depth to water in the Tucson area, 1970 W. Osterkamp 1970. U.S. Geological Survey.

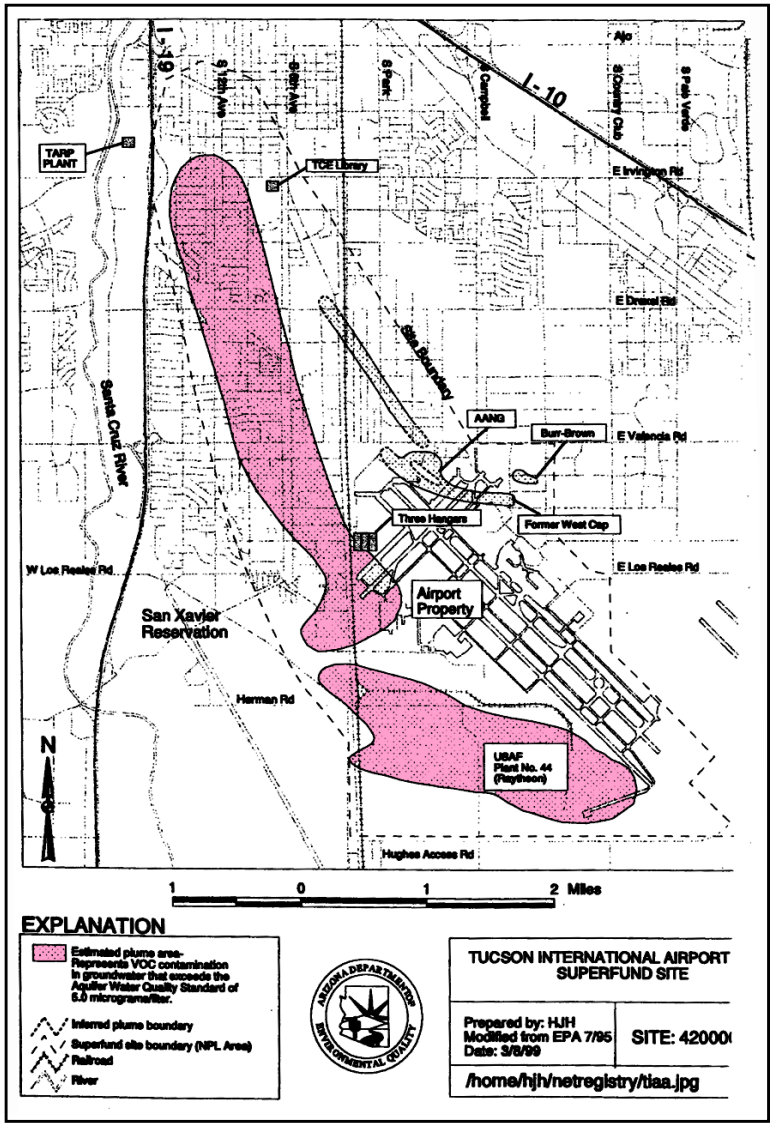

Fig. 3-23 The plume of groundwater contaminated with TCE on Tucson's south side in the 1980s, as determined by the Arizona Department of Environmental Quality and the Environmental Protection Agency.

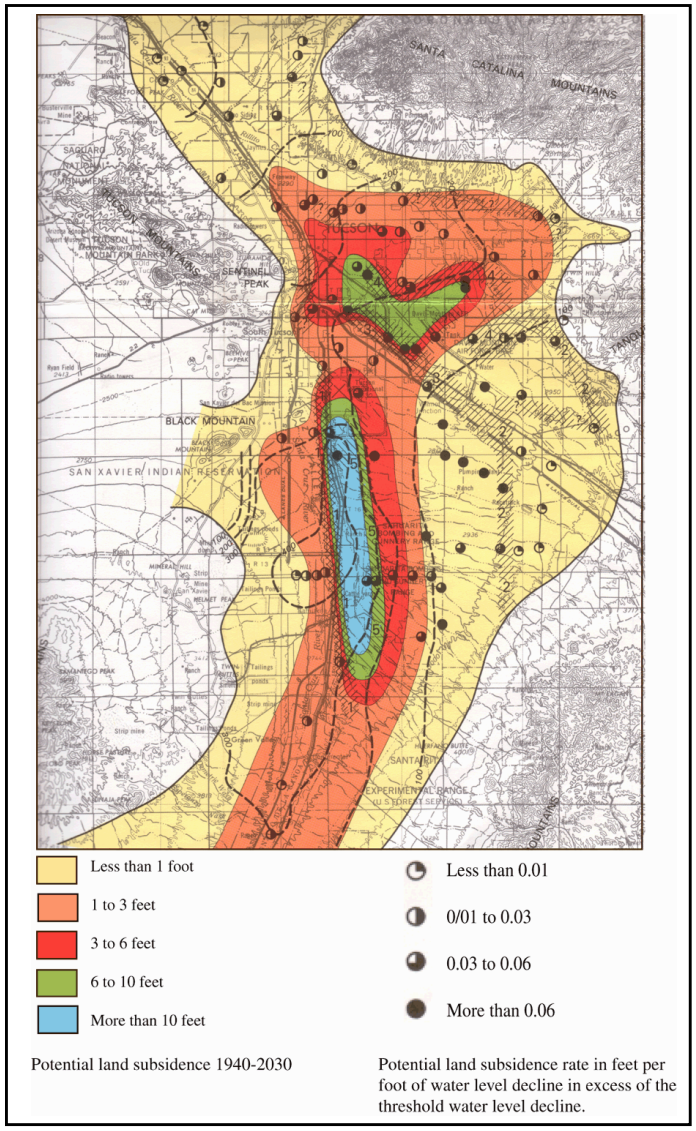

Fig. 3-24 Areas of potential subsidence 1990-2030 in the Tucson Area. Anderson et al. 1988. U.S. Geological Survey.

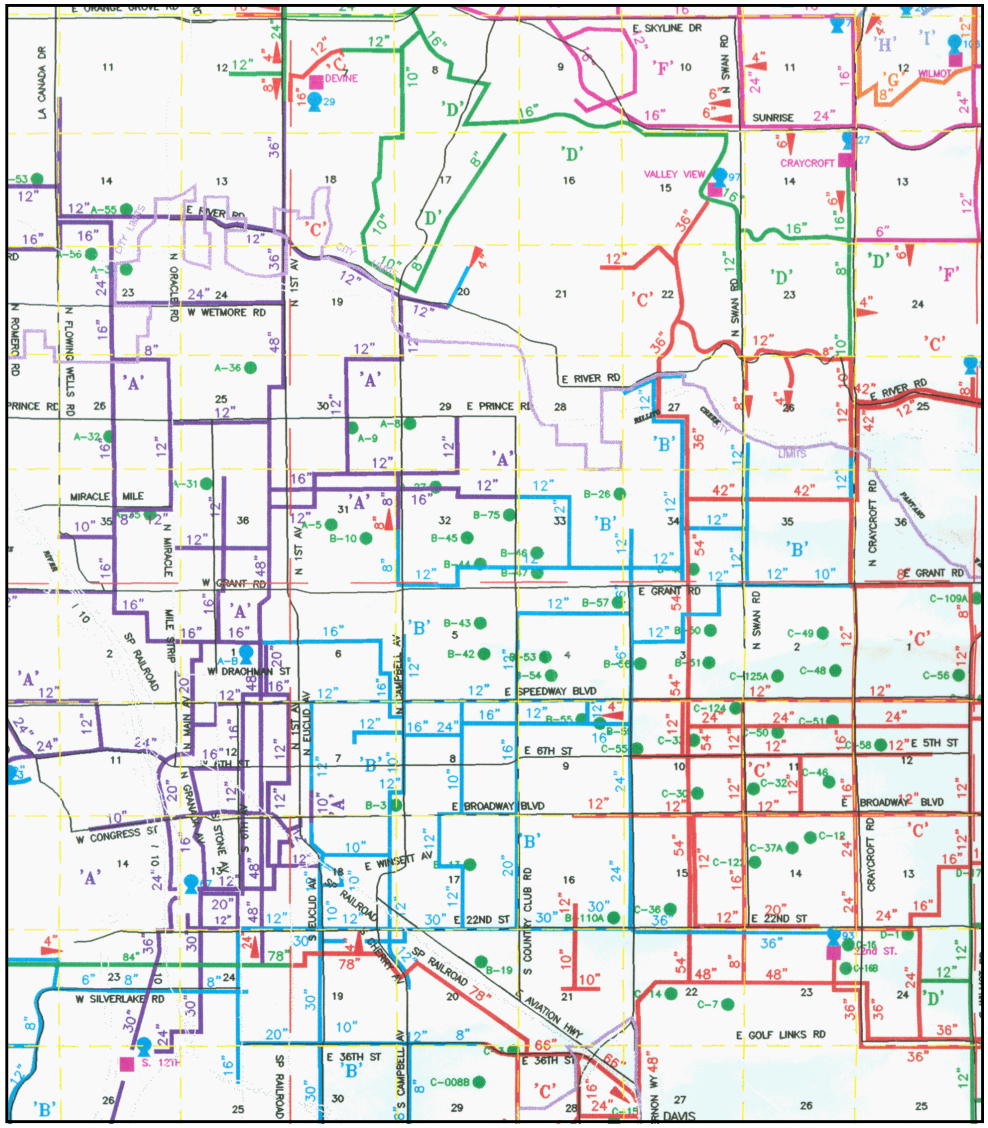

Fig. 3-25 Detail of the Tucson Water distribution system in 2000. Tucson Water.

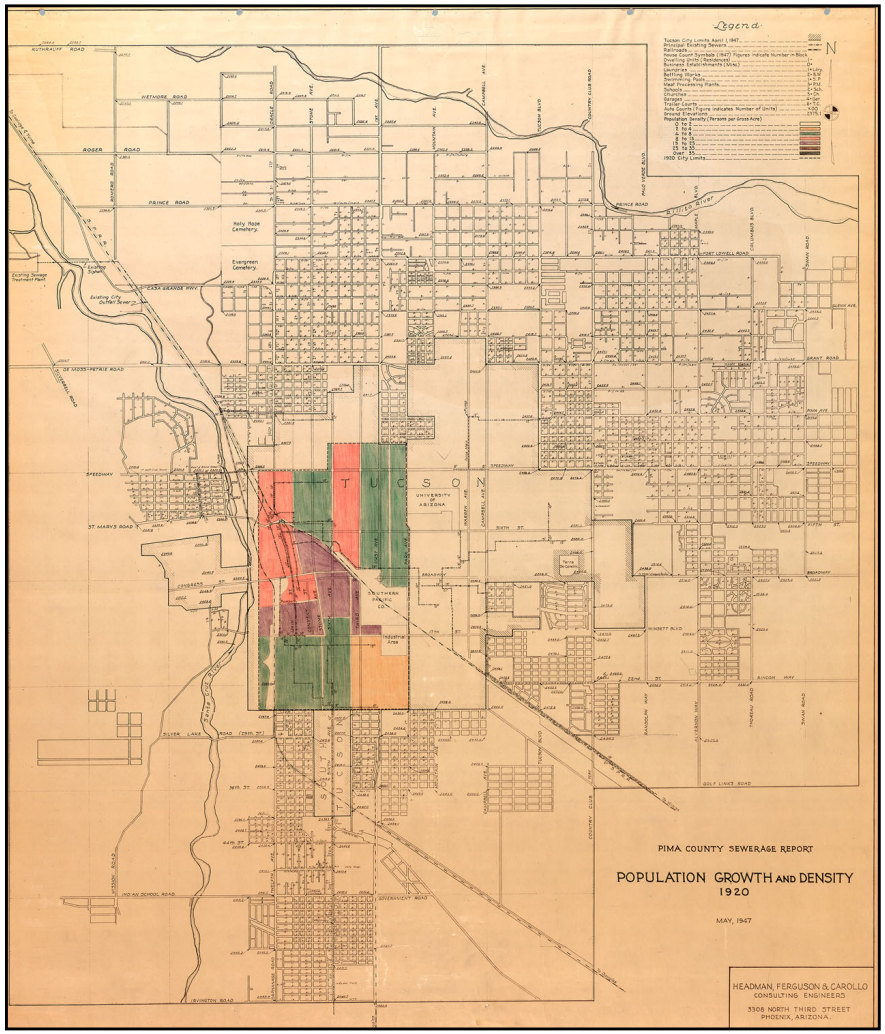

Fig. 3-26 Population growth and density in 1920 prepared for planning the sewer system for the city.

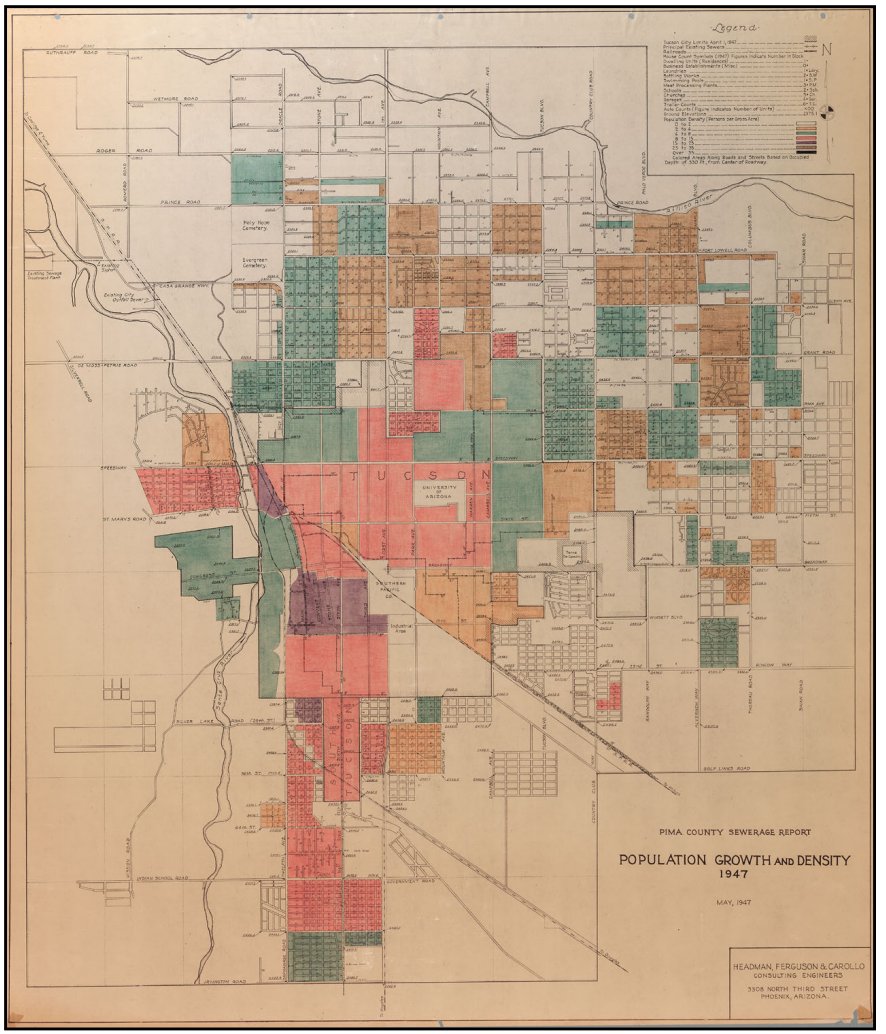

Fig. 3-27 Population growth and density in 1947 prepared for planning the sewer system for the city. Maps from Pima County Wastewater Management Department.

Floods and Floodplains

Rivers and floodplains are mapped to determine areas of past flooding and future flood and erosion hazards. Aerial photography, developed in the 1830s. plays an important role in helping to determine past flood locations. Rivers tend to move around, changing their channels making it difficult to predict future configurations. In mapping Rillito Creek in 1969, aerial photography played a major role.

Fig. 3-29 Aerial photo of the same section of Rillito Creek in 1969. Both from the Pima County Department of Transportation and Flood Control District.

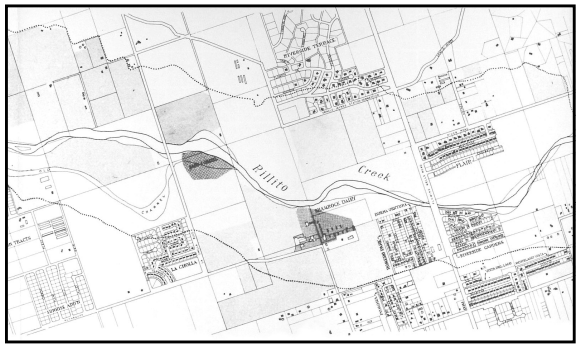

Fig. 3-28 Map of the floodplain of a section of Rillito Creek in 1969.

Parks and Recreation

Maps are useful for planning recreation areas and open space and for giving the user a guide to location of facilities such as campgrounds and hiking trails.

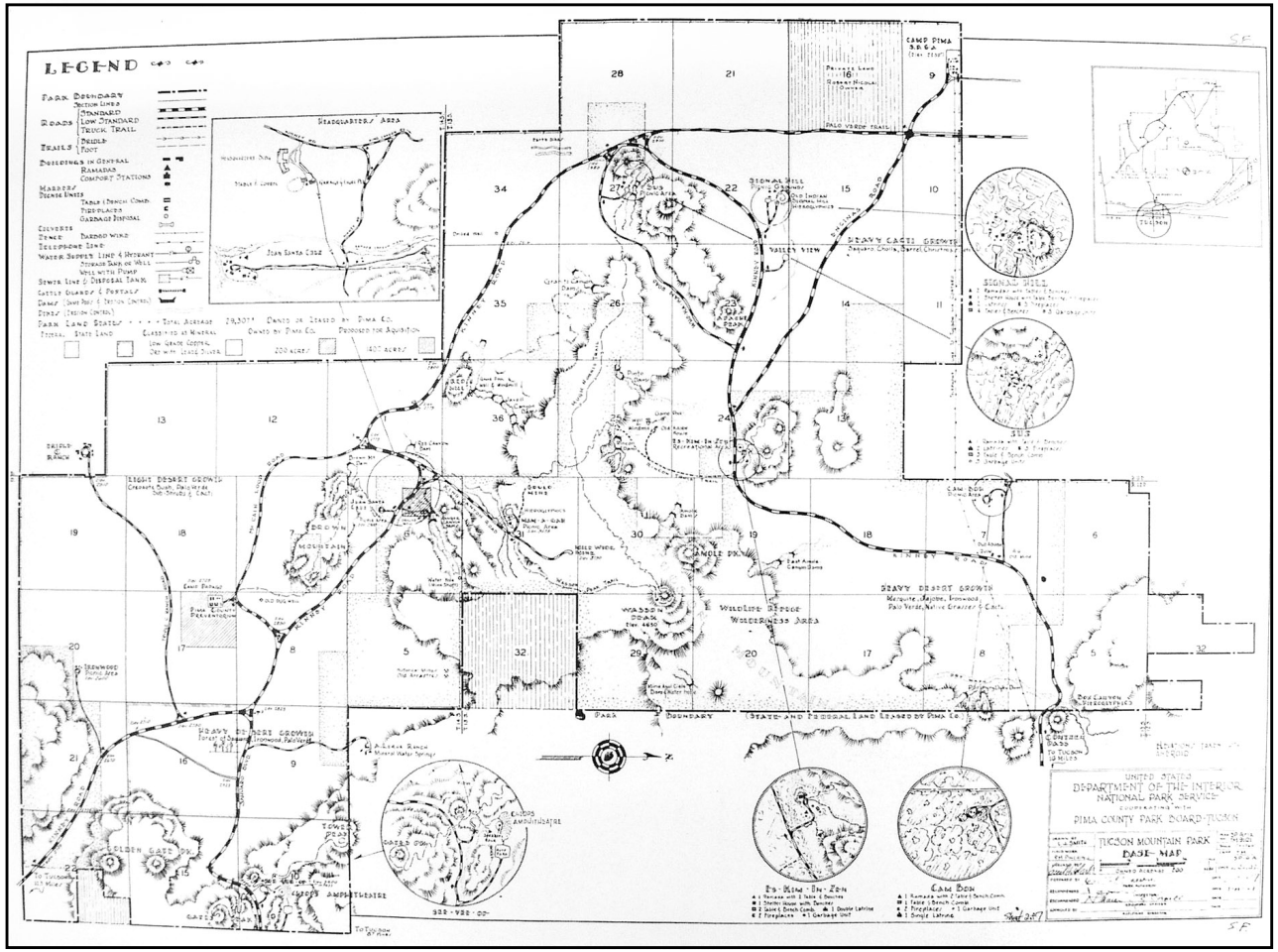

Fig. 3-30 Map of the new Tucson Mountain Park in the 1930s. Pima County Parks Department.

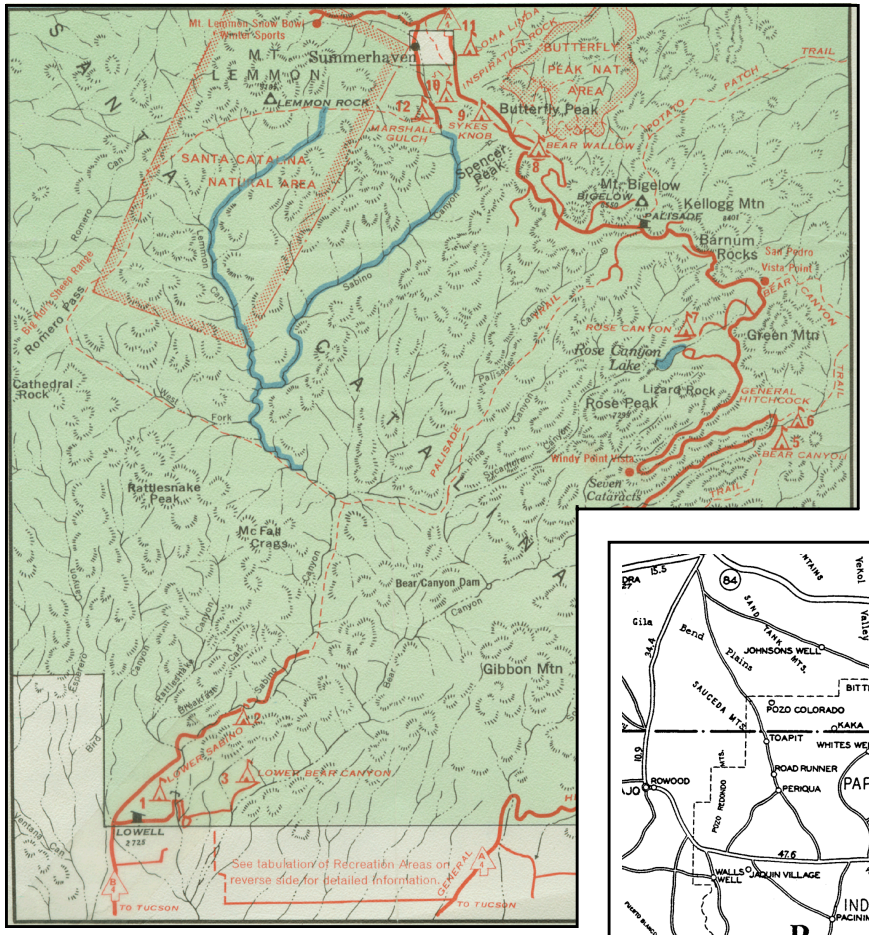

Fig. 3-31 The Mount Lemmon recreation area in 1959. US. Forest Service recreational map.

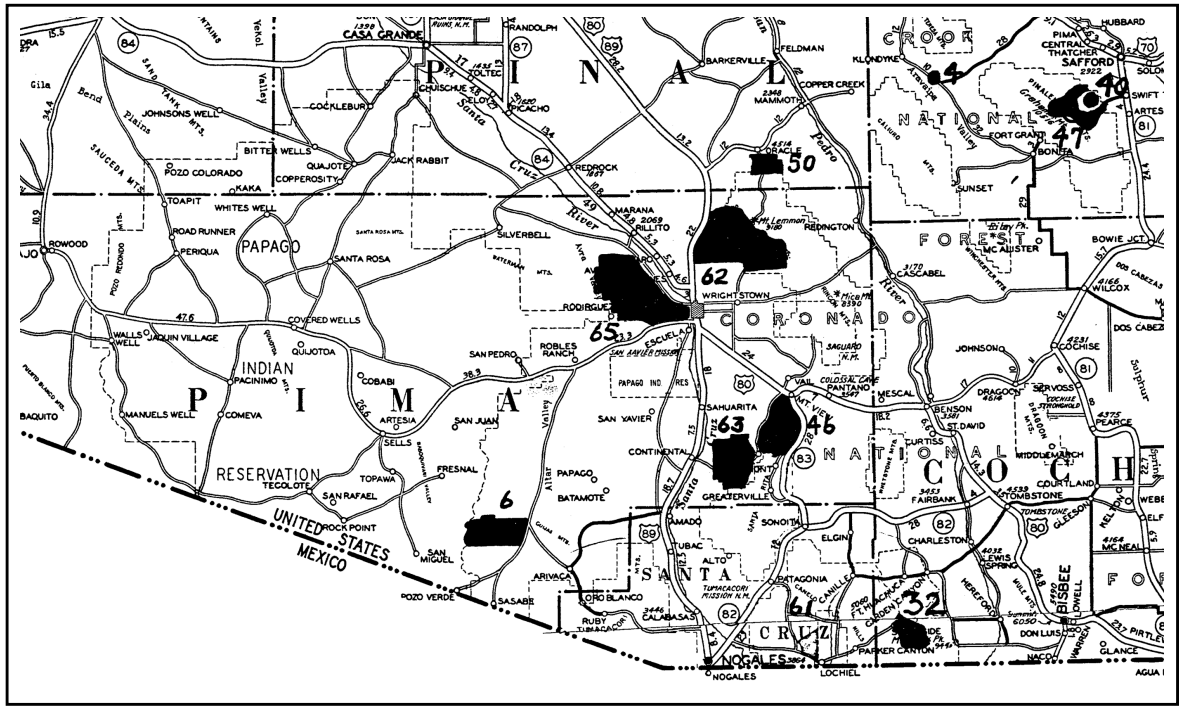

Fig. 3-32 Game refuges in 1959. Arizona Game and Fish Department.

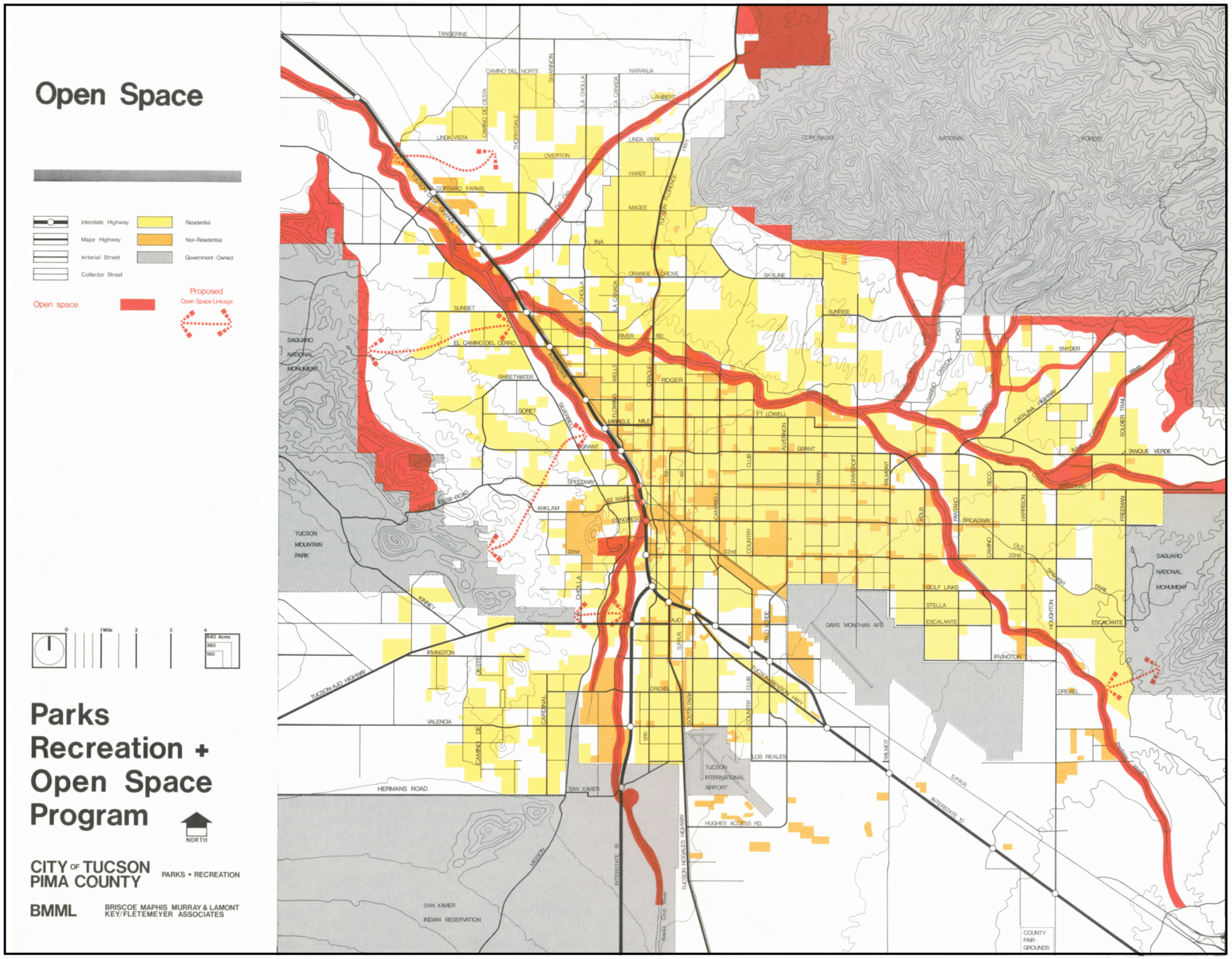

Fig. 3-33 Parks, recreation, and open space plan. City of Tucson and Pima County 1978.

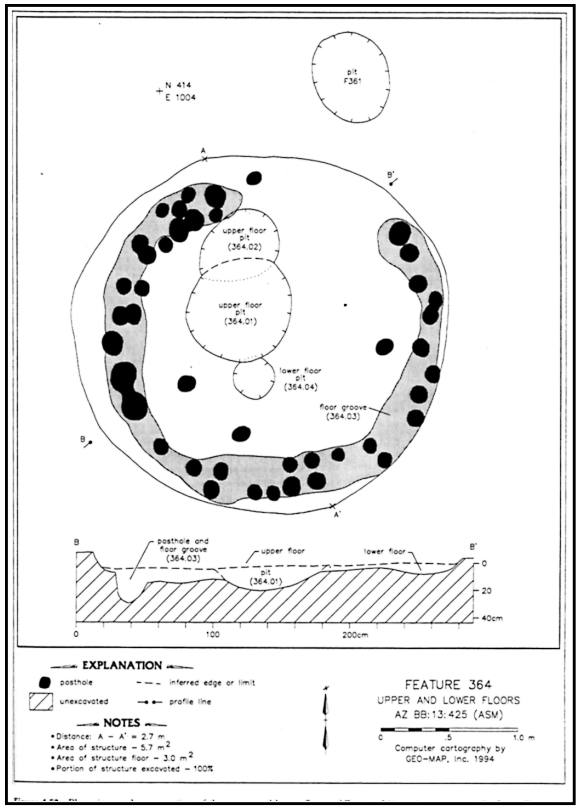

Fig. 3-34 A pit structure in the Santa Cruz Valley. Center for Desert Archaeology.

Archaeology and History

One of the most important tasks of archaeologists is to provide accurate maps of sites they are investigating. Accurate location of facilities and artifacts aids enormously in interpreting the data and in some cases for restoration and preservation. Archaeological and historical maps also map out patterns of sites throughout an area. Chapter IV shows how this type of map is useful for SDCP.

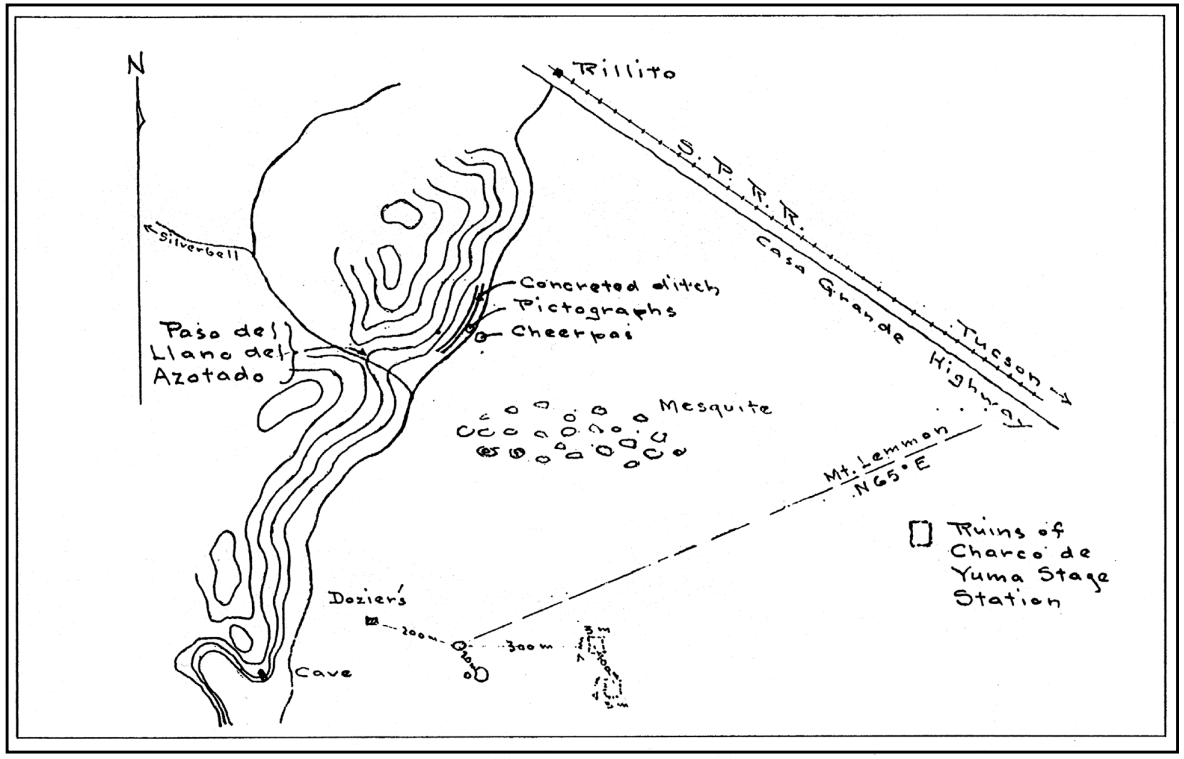

Fig. 3-35 Los Morteros. Center for Desert Archaeology.

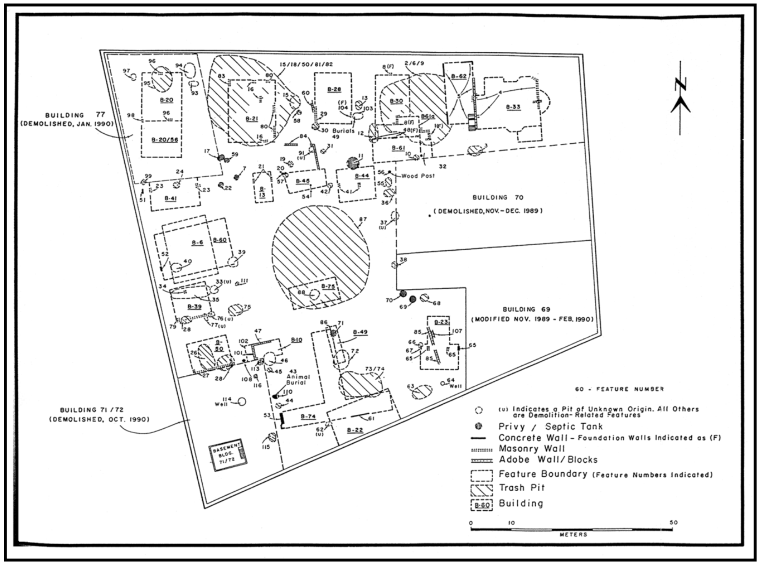

Fig. 3-36 Tucson Presidio archaeology. Center for Desert Archaeology.

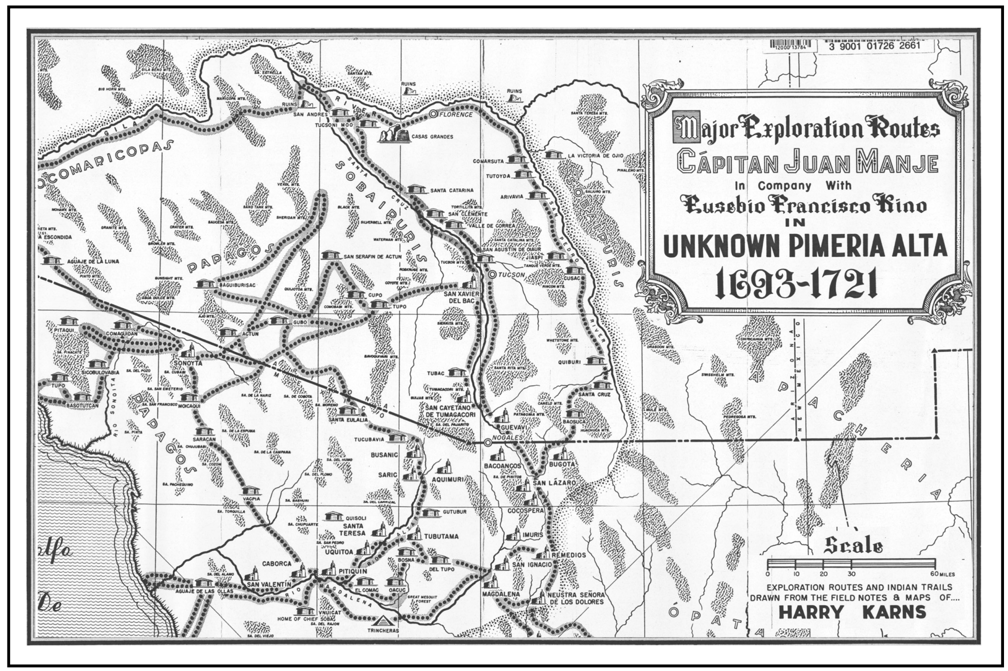

Fig. 3-37 Major exploration routes 1693-1721. Map by Harry Karns. Courtesy University of Arizona map collection.

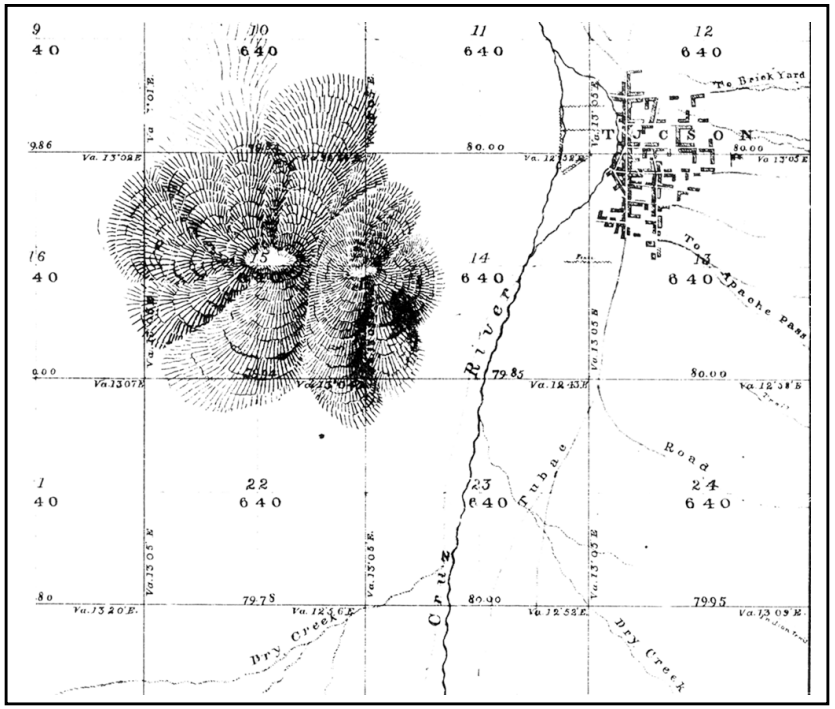

Fig. 3-38 The first official survey of Tucson by the U.S. General Land Office in 1871. Historians use these maps to document lands uses and locations of features such as roads and streams.

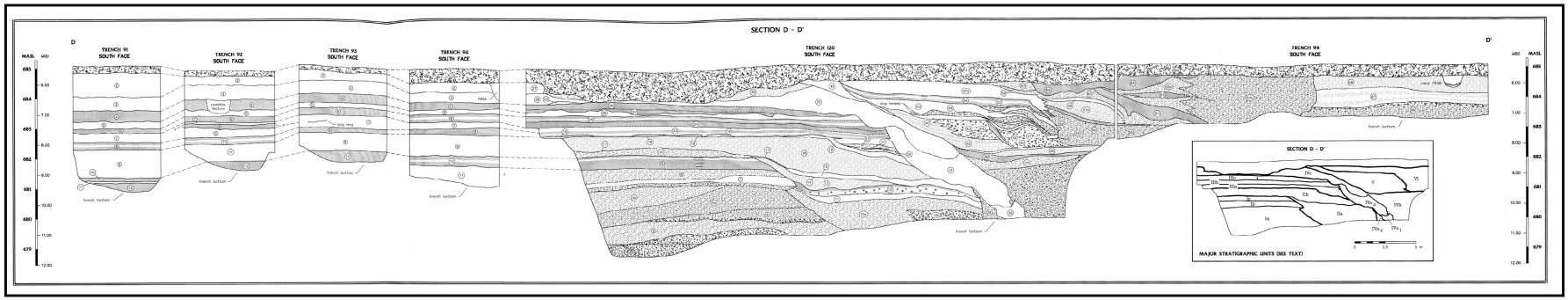

Fig. 3-39 Map of an archaeological site showing stratigraphy on the site. Knowledge of the layers helps in interpretations of the age of artifacts and structures.

Geology

Geological maps serve many purposes. Establishment of the U.S. Geological Survey in the late 19th century and later the Arizona Geological Survey enabled systematic mapping to occur. Geological maps show rock formations, soils, occurrence of minerals, oil, and water, natural hazards, and many other kinds of features. Topographic maps of Arizona show not only changes of elevation but also man-made features such as wells or farming areas.

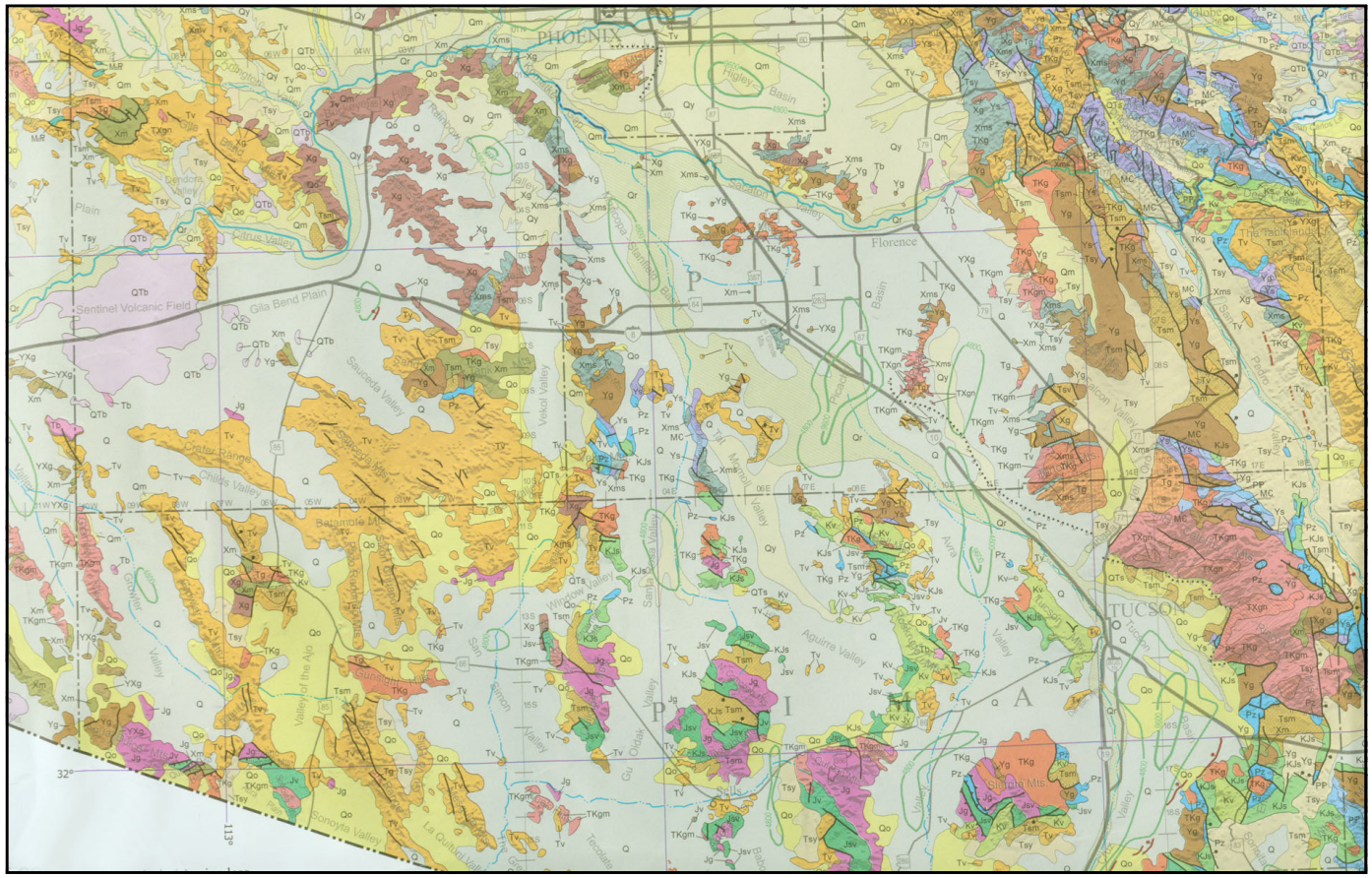

Fig. 3-40 1998. Geological Highway Map of Arizona, Pima County portion. Colors depict geological features. U.S.G.S. WRI Report 85-4225-C, Tucson, 1989.

Weather, Climate, and Natural Disasters

Weather and climate maps depict daily changes in weather as well as long-term trends that can be used for many purposes.

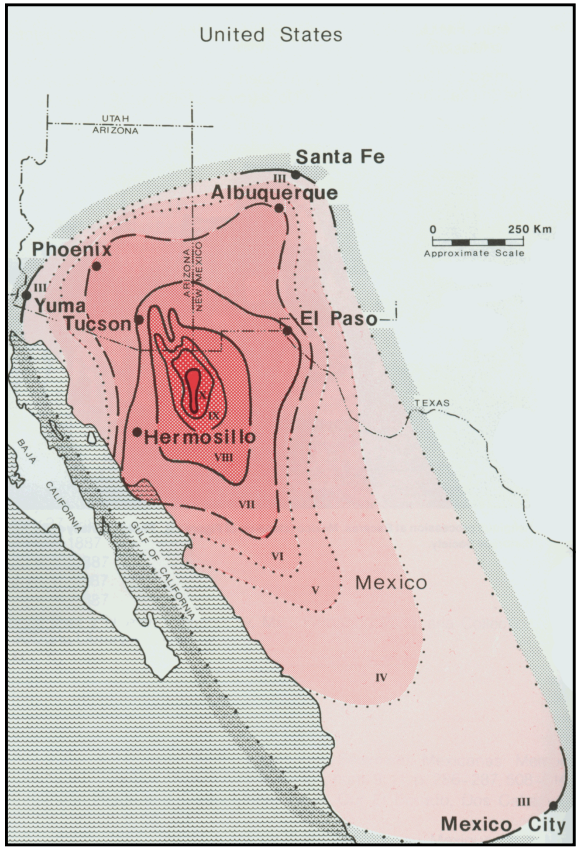

Fig. 3-4 Areas impacted by the 1887 earthquake. DuBois, S. and A.W. Smith. *The 1887 Earthquake in San Bernardino Valley, Sonora*. Arizona Geological Survey. 1980.

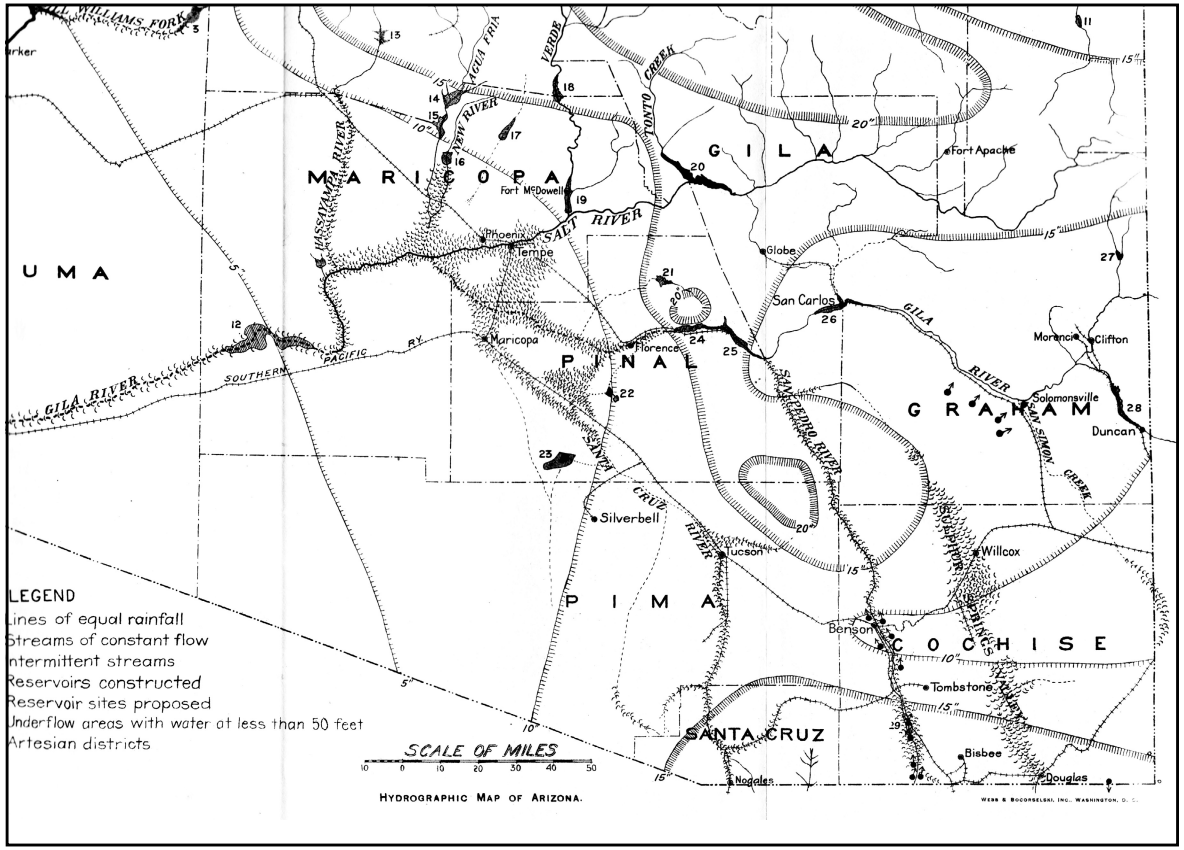

Fig. 3-42 Perennial and intermittent streams and lines of equal rainfall. 1912 Bulletin of the Arizona Agricultural Experiment Station, University of Arizona.

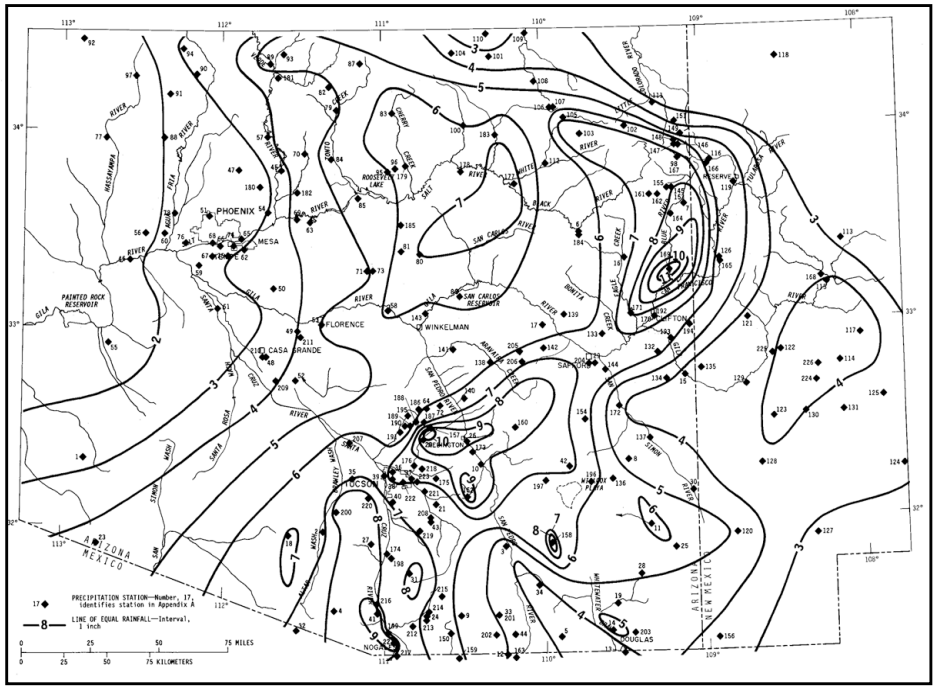

Fig. 3-43 Lines of equal rainfall in the 1983 flood.

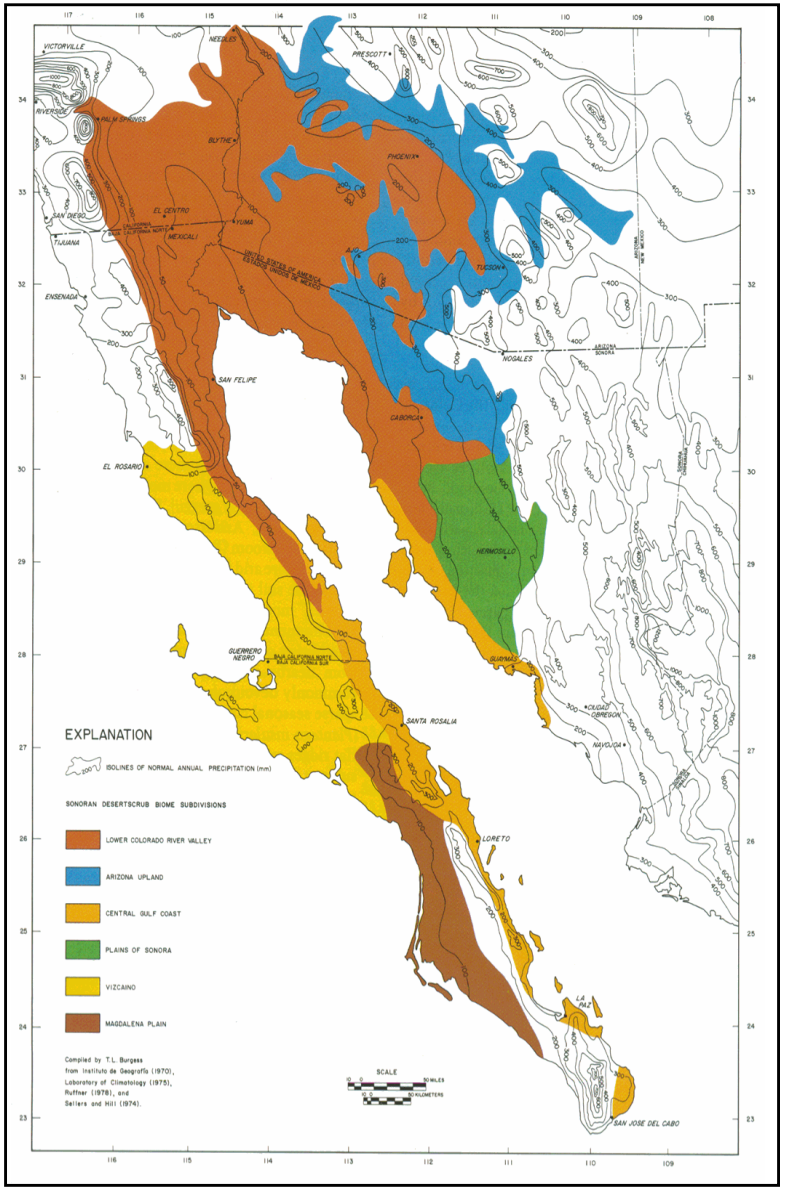

Fig. 3-44 The Sonoran Desert and average rainfall in different regions. Map by T.L. Burgess.

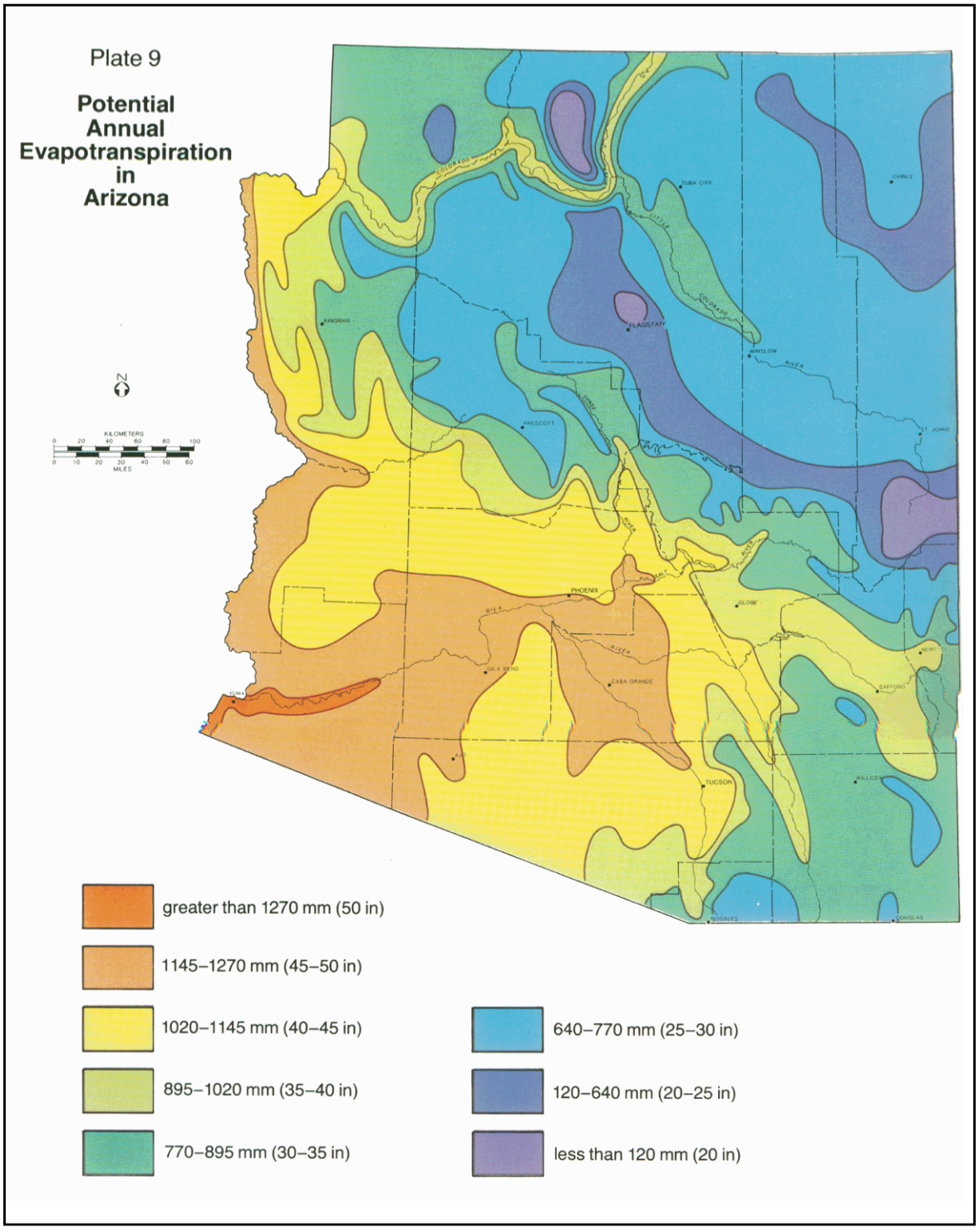

Fig. 3-45 Potential annual evapotranspiration in Arizona. Arizona Soils by David Hendricks. 1985. College of Agriculture, University of Arizona.

Vegetation and Wildlife

Maps are used to map large-scale features such as the Sonoran Desert or maps of very specific occurrences of a particular species. These maps are used for many purposes such as hunting or designing areas for preservation. The importance of vegetation and wildlife mapping to SDCP is discussed in Chapter IV.

Fig. 3-46 The range of the ringtail cat in the south and least weasel in the north according to Ernest Thomas Seton and the U.S. Biological Survey in 1923.

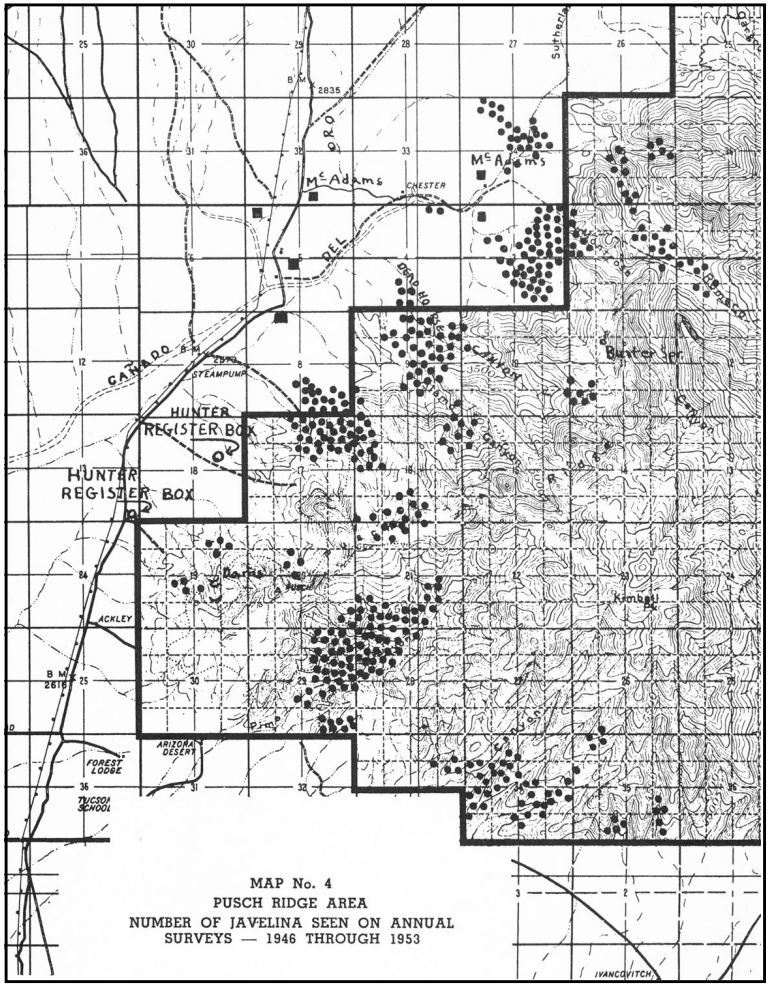

Fig. 3-47 Javelina in the Pusch Ridge area in 1950 according to the Arizona Game and Fish Department

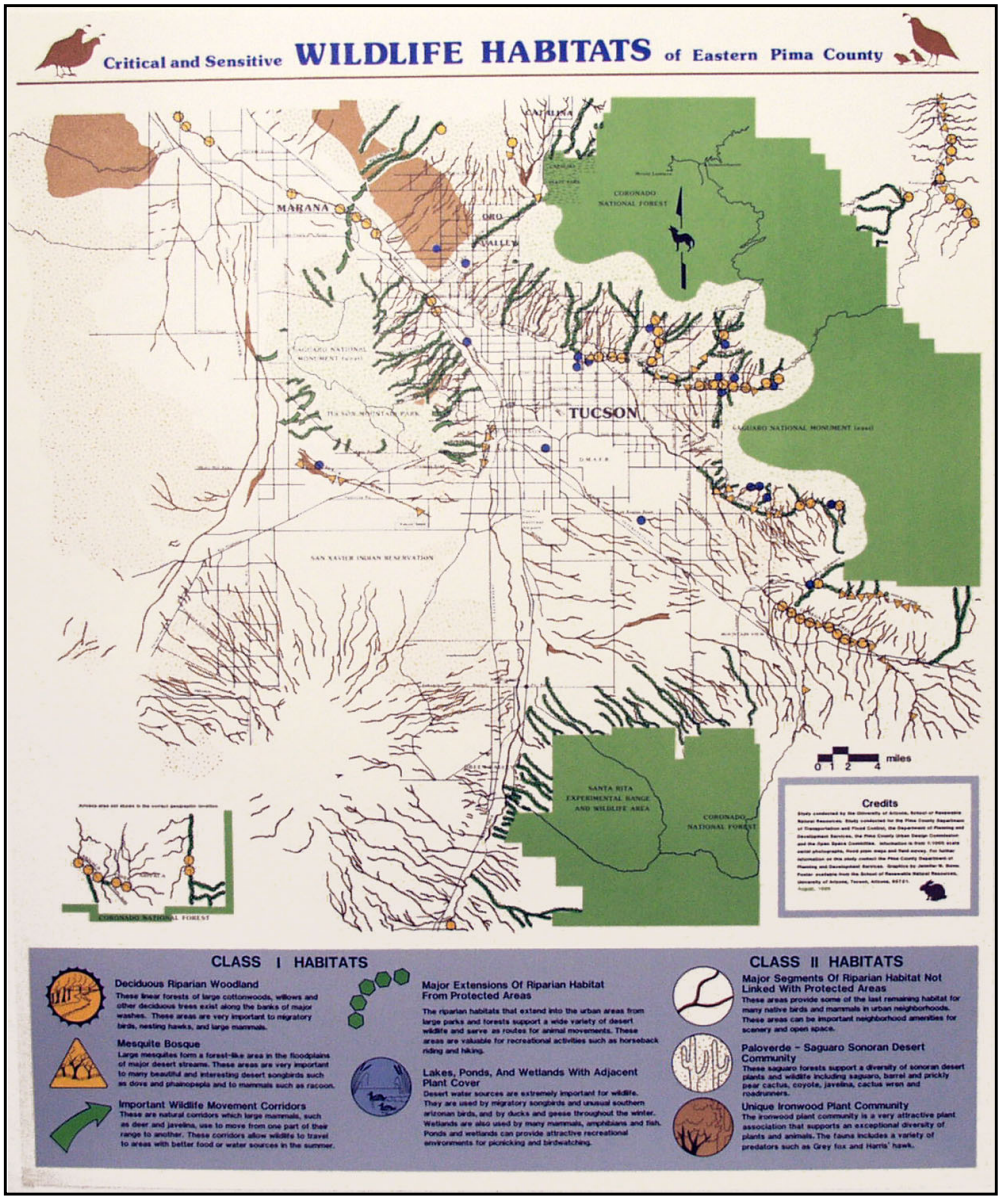

Fig. 3-48 Bill Shaw's 1988 Critical and Sensitive Wildlife Habitats of Eastern Pima County. School of Renewable Natural Resources, University of Arizona.

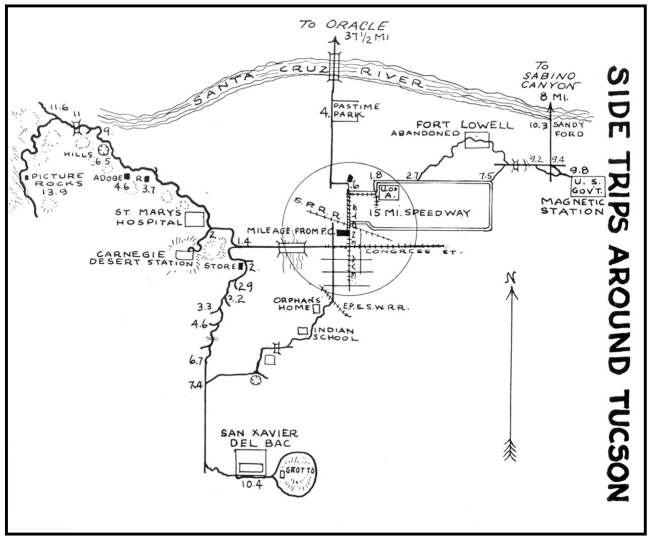

Fig. 3-49 Side trips around Tucson in 1912 according to the Good Roads Association. Note the wrong placement of the Santa Cruz River.

Tourism

Maps are used to promote tourism, showing people where the interesting sites are. Arizona Highways has been significant in Arizona in using maps to promote recreational travel.

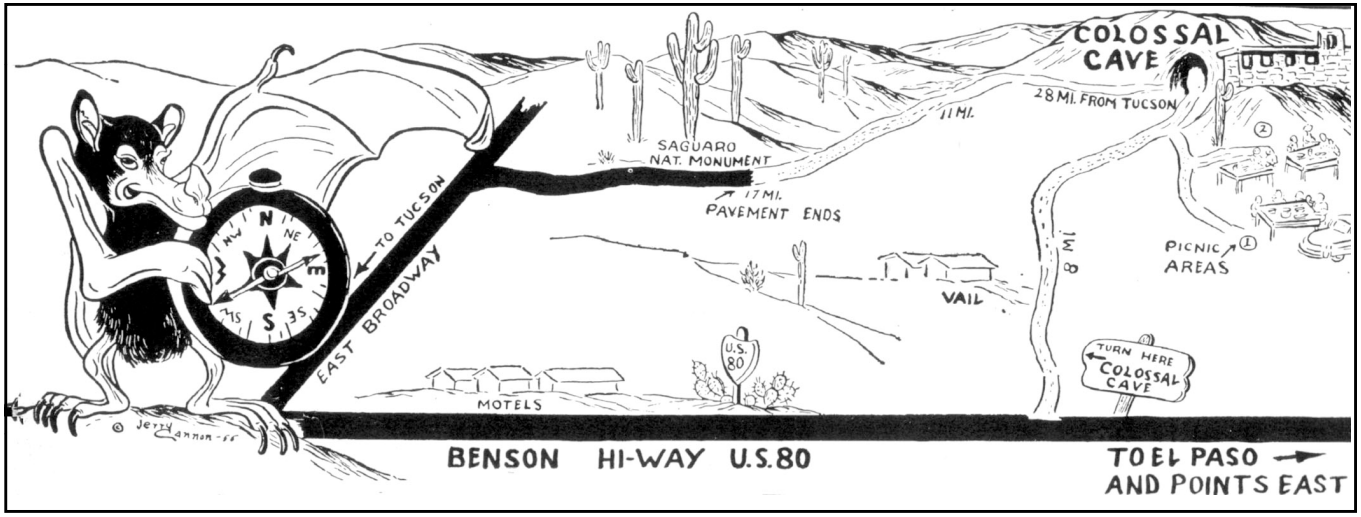

Fig. 3-50 The way to Colossal Cave in 1950 according to Arizona Highways.

Fig. 3-51 Pictorial Guide to Southern Arizona. Valley National Bank 1950s.

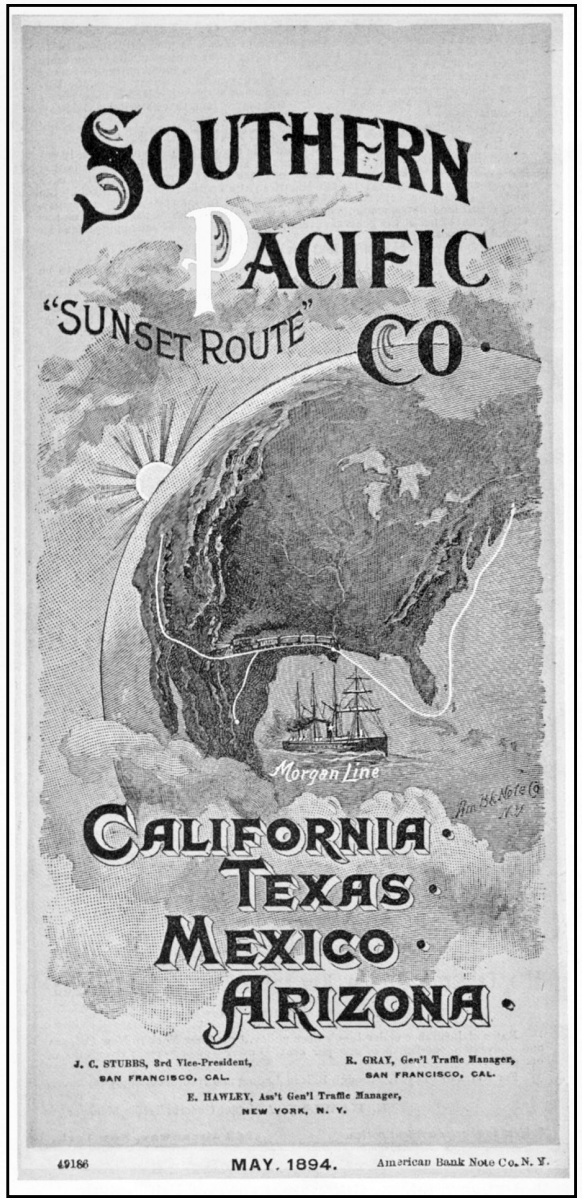

Fig 3-52 Railway adventure in 1894 according to a Southern Pacific Company ad.

Political Commentary

Maps are also be used for political or societal commentary.

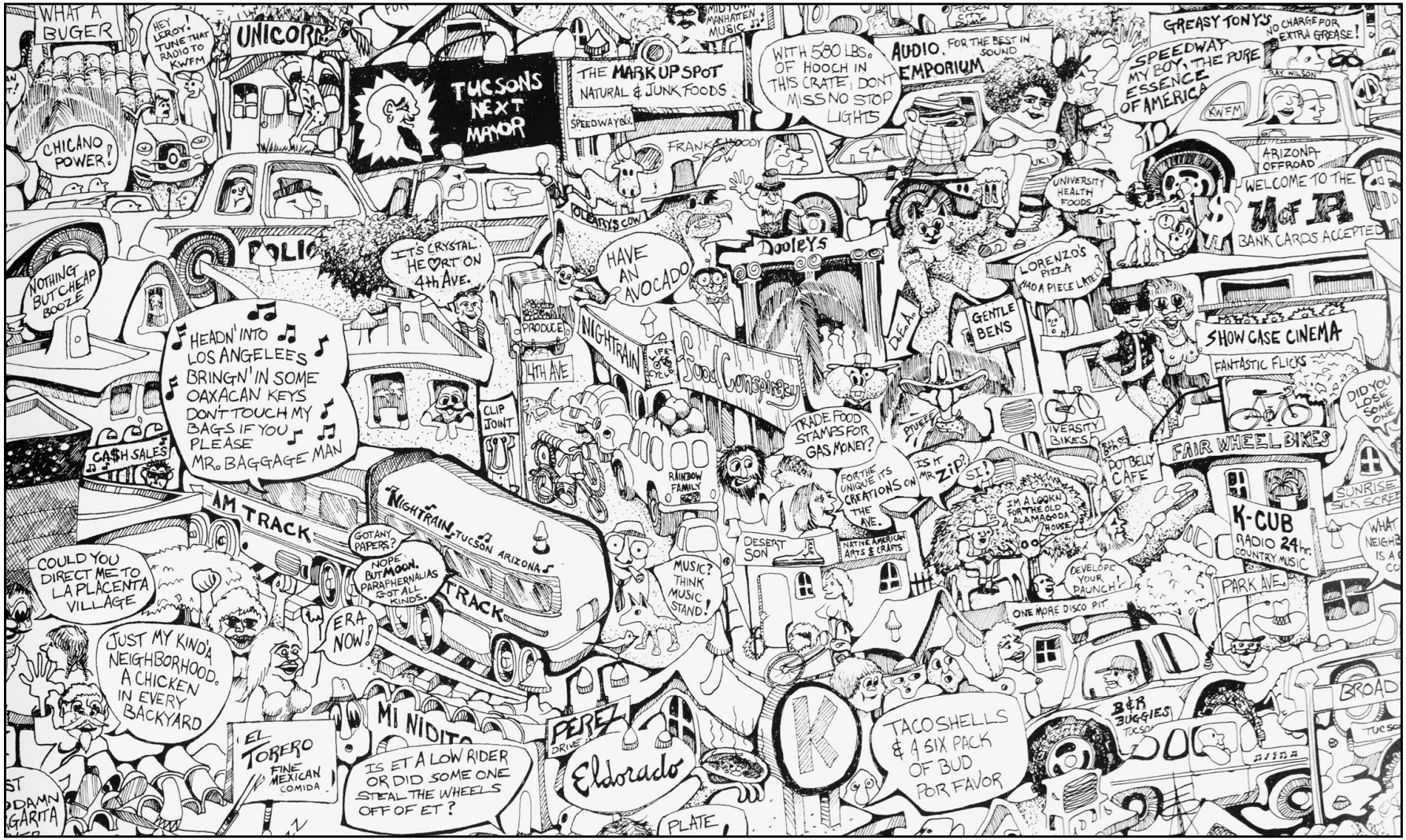

Fig. 3-53 Tucson as tourist attraction, with sardonic political commentary according to Royce in 1979. This is a small portion of a large poster.

Fig. 3-54 The "great threat" posed by Chinese immigration according to Arana, a Mexican artist in the 1880s. Courtesy University of Arizona map collection.

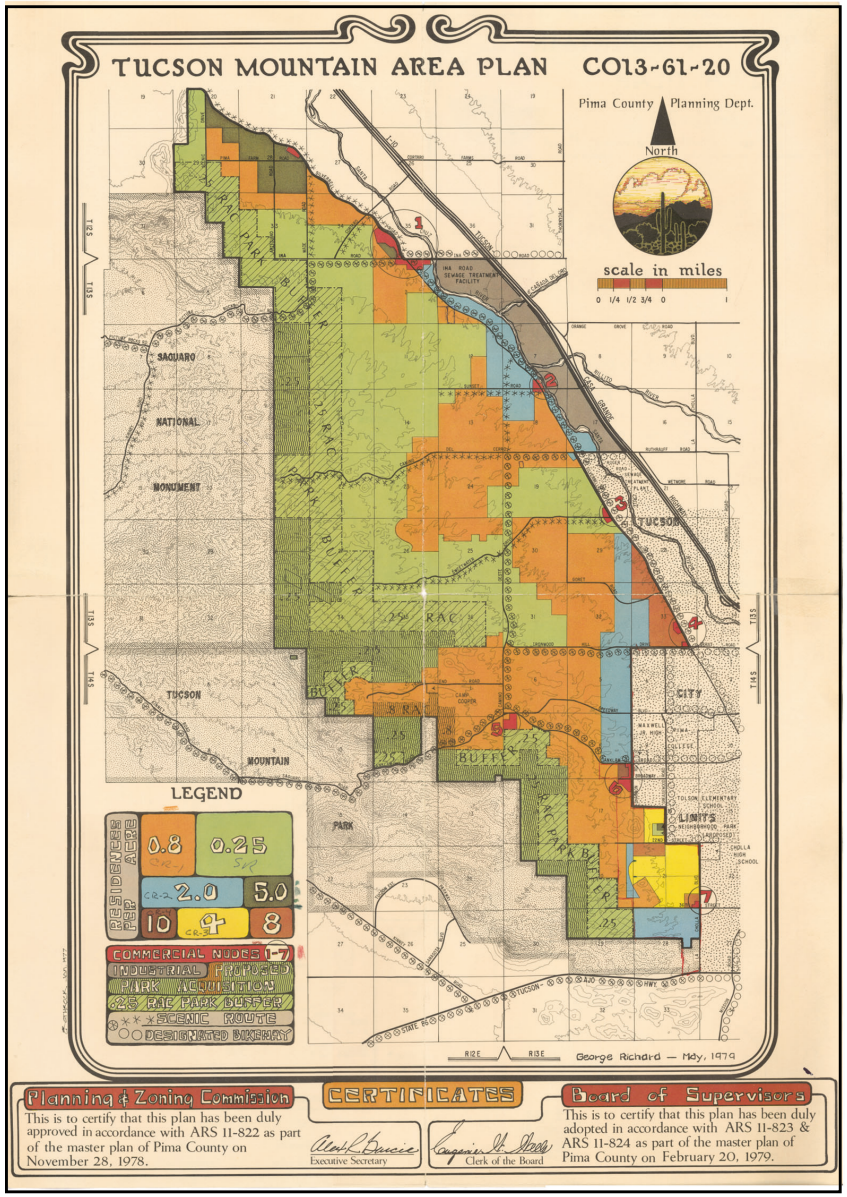

Fig. 3-55 The Tucson Mountain Area Plan in 1978, a part of the Pima County Master Plan. Pima County Planning Department.

Land Use Planning

Maps are vital to land use planning and zoning. There have been several major comprehensive planning efforts in the Tucson area since the 1930s. State law required cities and counties to have land use plans delineating land uses in different parts of the area. The use of land use mapping in SDCP is discussed in Chapter IV.

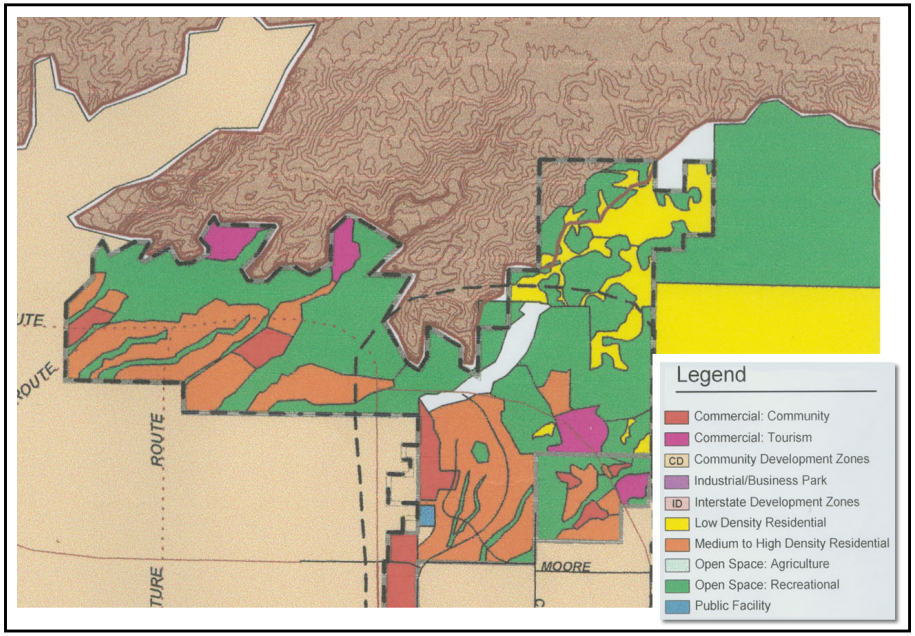

Fig. 3-56 The Tortolita Mountains portion of the Future Land Use Plan for Marana, 1999. Marana Planning Department.

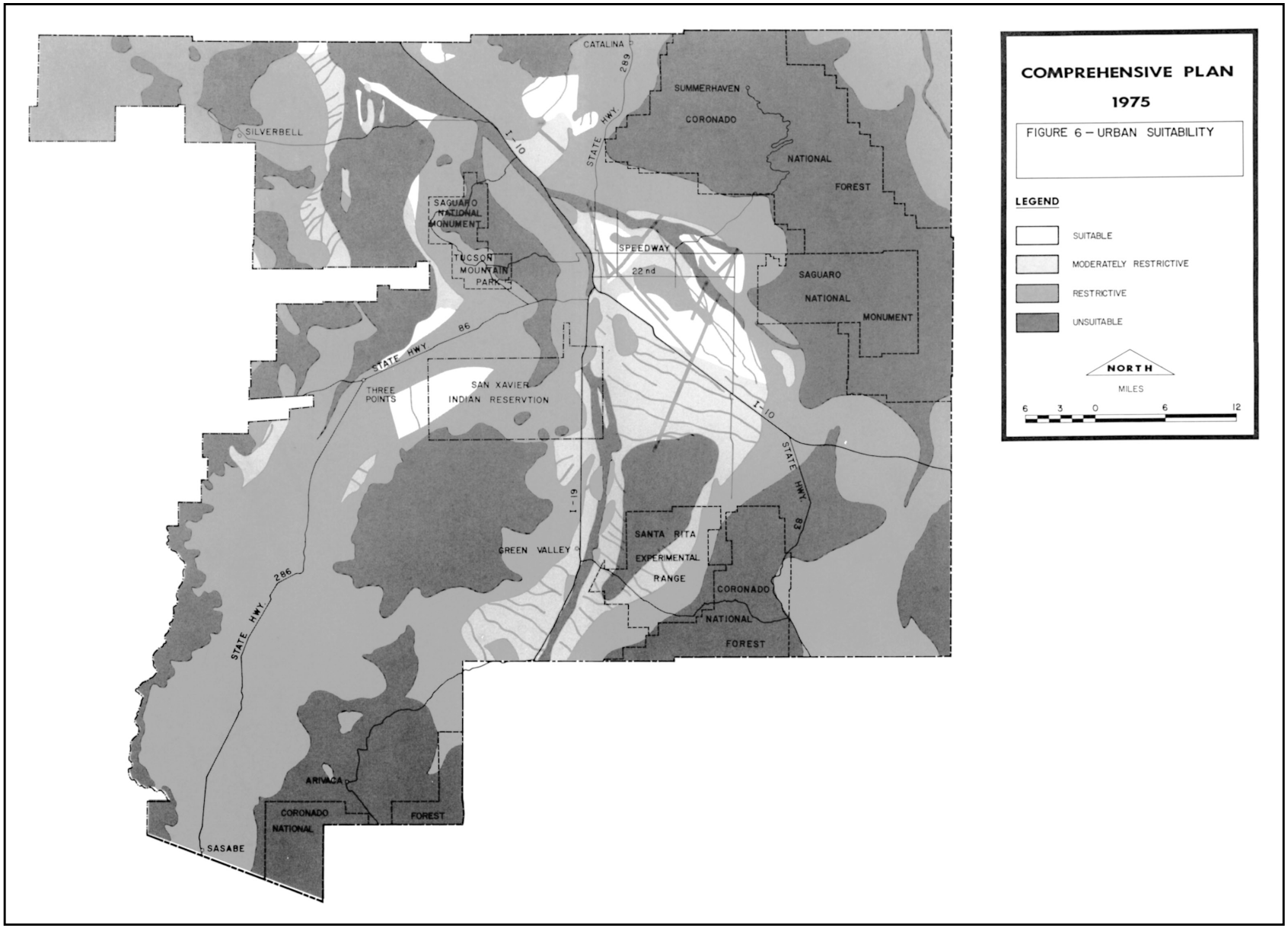

Fig. 3-57 Urban suitability from the 1975 Regional Comprehensive Plan.

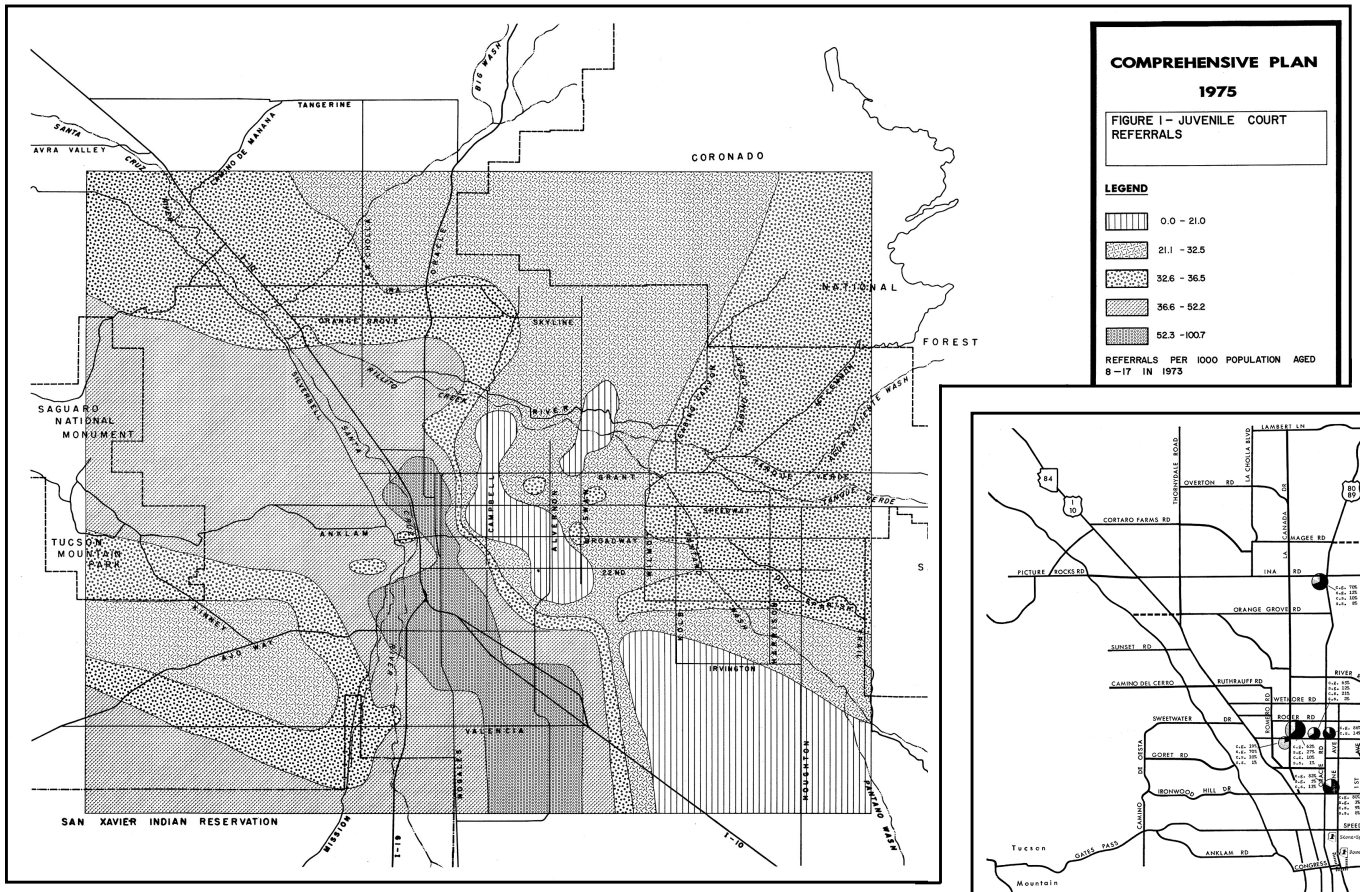

Fig. 3-58 Juvenile court referrals. 1975 Comprehensive Plan

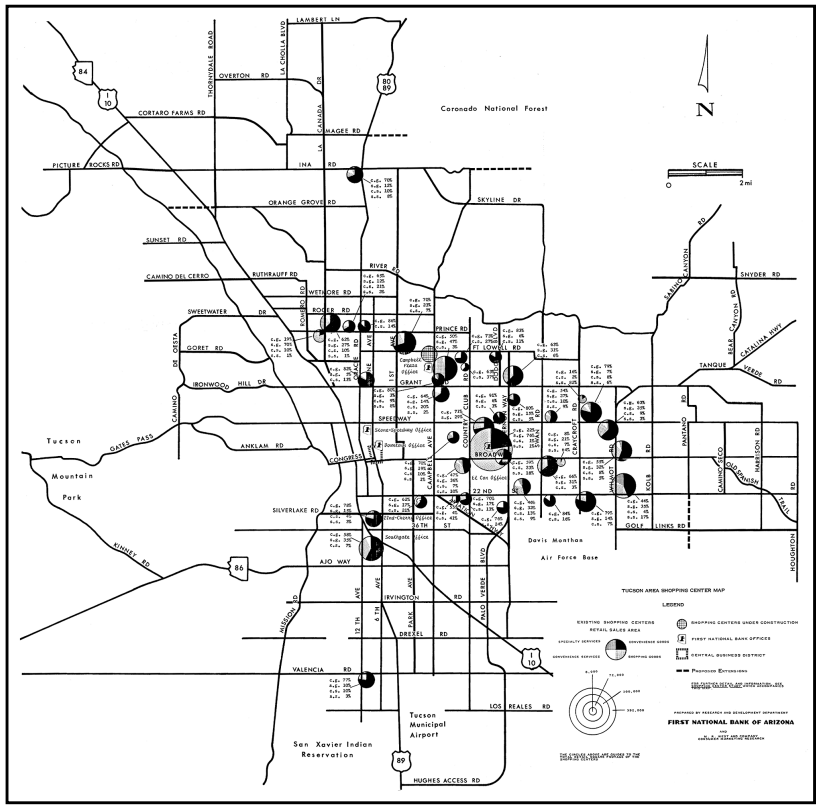

Fig. 3-59 Tucson area shopping centers in the 1950s. Pima County Planning Department.

Social and Economic Analysis

Maps are used to analyze community elements such as employment, housing, income, race, health, age, and other elements. The decadal U.S. censuses provide much of the basic information for these maps.

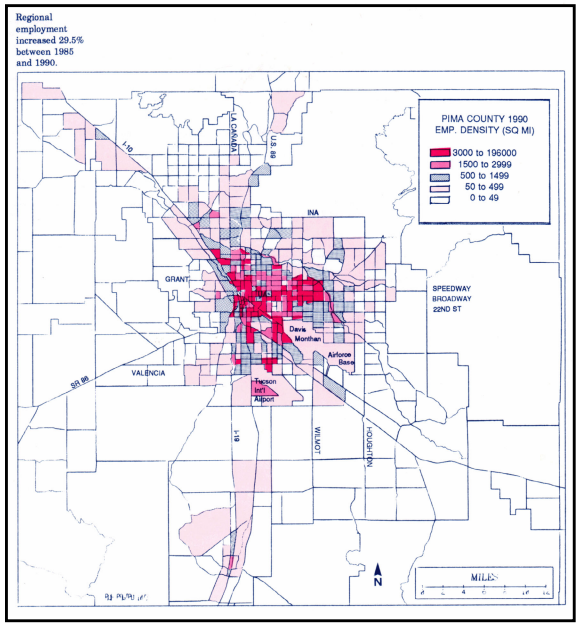

Fig. 3-60 1990 Employment density.

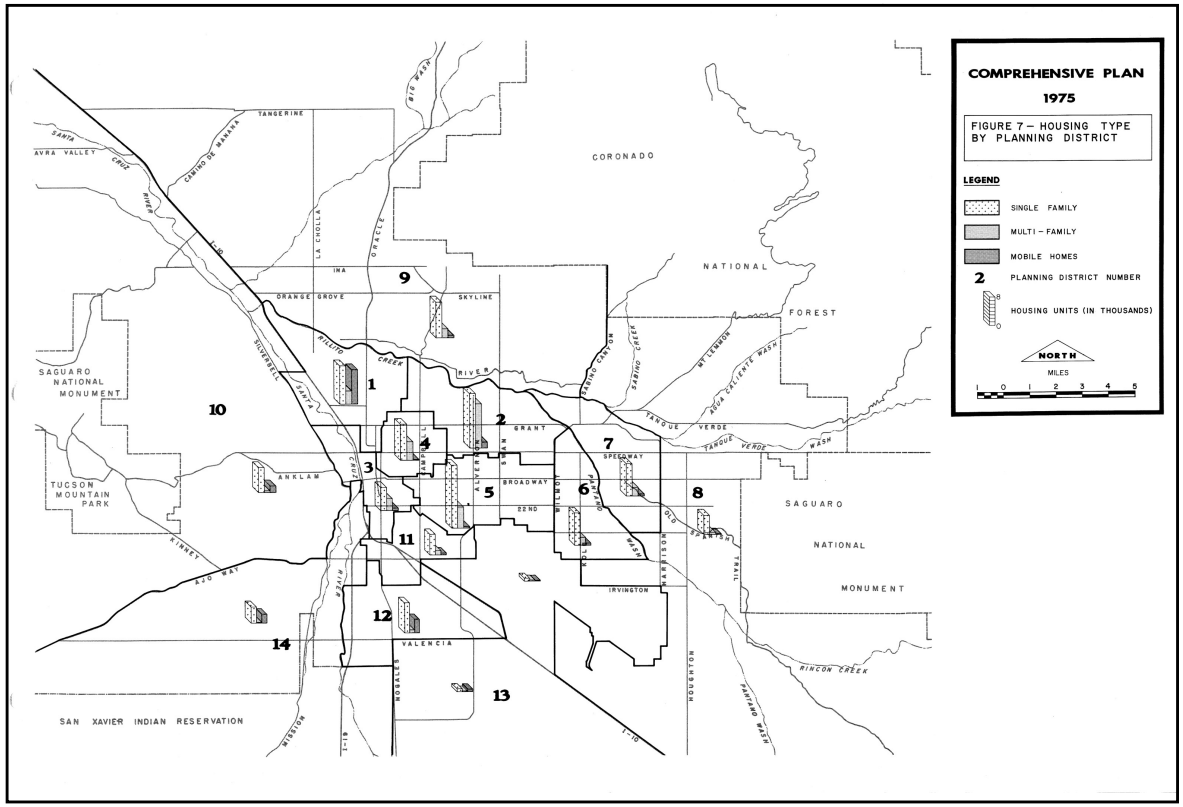

Fig. 3-61 Housing type by planning district. 1975 Comprehensive Plan

Population and Land Use Trends

Maps are also used to express long-term trends such as population growth and to predict future trends. The Arizona Department of Economic Security and the Pima Association of Government provide the basis population statistics and projections that form the official basis for local planning.

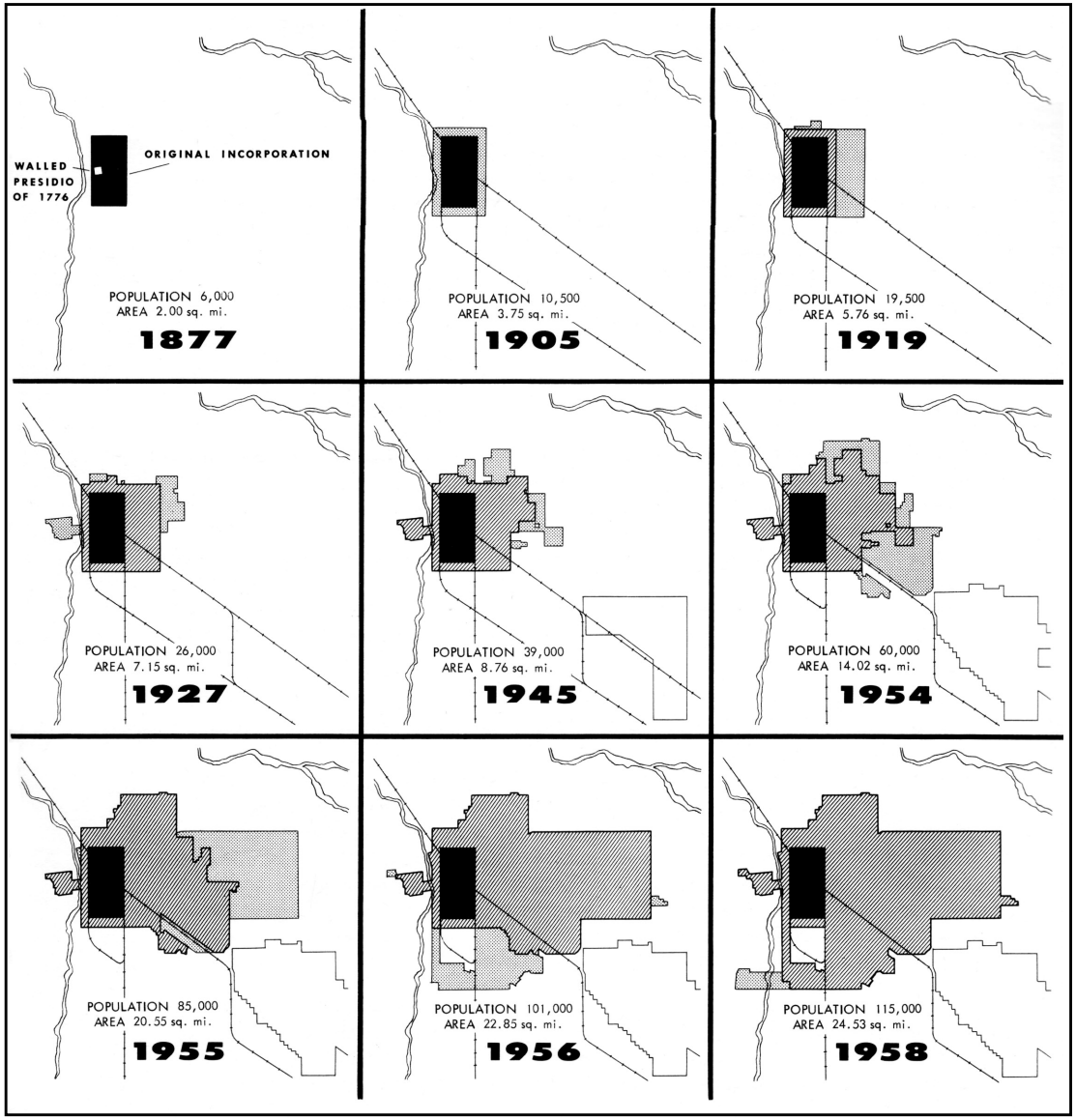

Fig. 3-62 Growth of the City of Tucson 1877 to 1958. City of Tucson Planning Department.

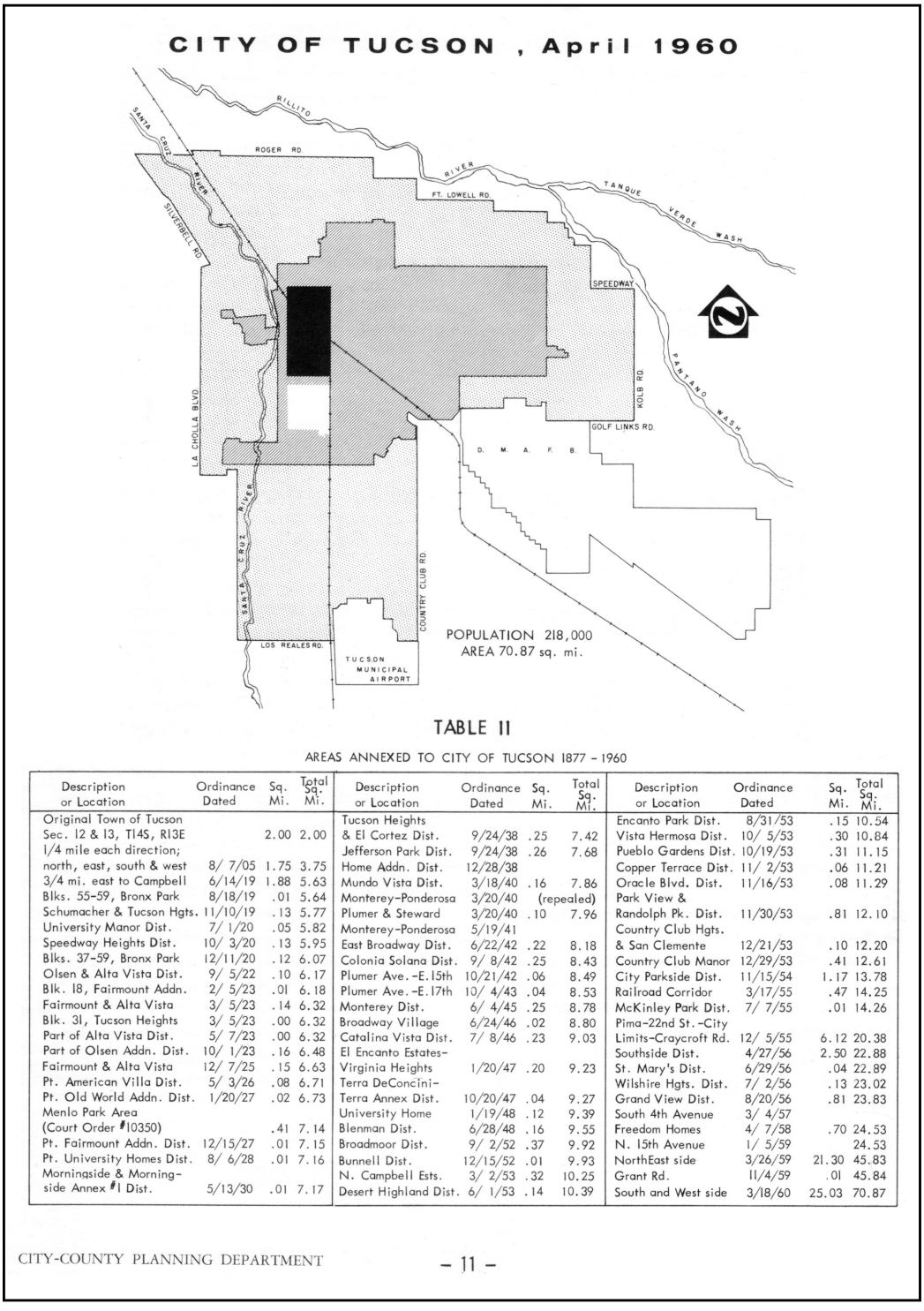

TABLE II

AREAS ANNEXED TO CITY OF TUCSON 1877 - 1960

Description or Location	Ordinance Dated	Sq. Mi.	Total Sq. Mi.
Original Town of Tucson			
Sec. 12 & 13, T14S, R13E		2.00	2.00
1/4 mile each direction;			
north, east, south & west	8/ 7/05	1.75	3.75
3/4 mi. east to Campbell	6/14/19	1.88	5.63
Blks. 55-59, Bronx Park	8/18/19	.01	5.64
Schumacher & Tucson Hgts.	11/10/19	.13	5.77
University Manor Dist.	7/ 1/20	.05	5.82
Speedway Heights Dist.	10/ 3/20	.13	5.95
Blks. 37-59, Bronx Park	12/11/20	.12	6.07
Olsen & Alta Vista Dist.	9/ 5/22	.10	6.17
Blk. 18, Fairmount Addn.	2/ 5/23	.01	6.18
Fairmount & Alta Vista	3/ 5/23	.14	6.32
Blk. 31, Tucson Heights	3/ 5/23	.00	6.32
Part of Alta Vista Dist.	5/ 7/23	.00	6.32
Part of Olsen Addn. Dist.	10/ 1/23	.16	6.48
Fairmount & Alta Vista	12/ 7/25	.15	6.63
Pt. American Villa Dist.	5/ 3/26	.08	6.71
Pt. Old World Addn. Dist.	1/20/27	.02	6.73
Menlo Park Area			
(Court Order #10350)		.41	7.14
Pt. Fairmount Addn. Dist.	12/15/27	.01	7.15
Pt. University Homes Dist.	8/ 6/28	.01	7.16
Morningside & Morning-side Annex #1 Dist.	5/13/30	.01	7.17
Tucson Heights & El Cortez Dist.	9/24/38	.25	7.42
Jefferson Park Dist.	9/24/38	.26	7.68
Home Addn. Dist.	12/28/38		
Mundo Vista Dist.	3/18/40	.16	7.86
Monterey-Ponderosa	3/20/40	(repealed)	
Plumer & Steward	3/20/40	.10	7.96
Monterey-Ponderosa	5/19/41		
East Broadway Dist.	6/22/42	.22	8.18
Colonia Solana Dist.	9/ 8/42	.25	8.43
Plumer Ave.-E.15th	10/21/42	.06	8.49
Plumer Ave.-E.17th	10/ 4/43	.04	8.53
Monterey Dist.	6/ 4/45	.25	8.78
Broadway Village	6/24/46	.02	8.80
Catalina Vista Dist.	7/ 8/46	.23	9.03
El Encanto Estates-			
Virginia Heights	1/20/47	.20	9.23
Terra DeConcini-			
Terra Annex Dist.	10/20/47	.04	9.27
University Home	1/19/48	.12	9.39
Blenman Dist.	6/28/48	.16	9.55
Broadmoor Dist.	9/ 2/52	.37	9.92
Bunnell Dist.	12/15/52	.01	9.93
N. Campbell Ests.	3/ 2/53	.32	10.25
Desert Highland Dist.	6/ 1/53	.14	10.39
Encanto Park Dist.	8/31/53	.15	10.54
Vista Hermosa Dist.	10/ 5/53	.30	10.84
Pueblo Gardens Dist.	10/19/53	.31	11.15
Copper Terrace Dist.	11/ 2/53	.06	11.21
Oracle Blvd. Dist.	11/16/53	.08	11.29
Park View &			
Randolph Pk. Dist.	11/30/53	.81	12.10
Country Club Hgts.			
& San Clemente	12/21/53	.10	12.20
Country Club Manor	12/29/53	.41	12.61
City Parkside Dist.	11/15/54	1.17	13.78
Railroad Corridor	3/17/55	.47	14.25
McKinley Park Dist.	7/ 7/55	.01	14.26
Pima-22nd St.-City			
Limits-Craycroft Rd.	12/ 5/55	6.12	20.38
Southside Dist.	4/27/56	2.50	22.88
St. Mary's Dist.	6/29/56	.04	22.89
Wilshire Hgts. Dist.	7/ 2/56	.13	23.02
Grand View Dist.	8/20/56	.81	23.83
South 4th Avenue	3/ 4/57		
Freedom Homes	4/ 7/58	.70	24.53
N. 15th Avenue	1/ 5/59		24.53
NorthEast side	3/26/59	21.30	45.83
Grant Rd.	11/4/59	.01	45.84
South and West side	3/18/60	25.03	70.87

CITY-COUNTY PLANNING DEPARTMENT

- 11 -

Fig. 3-63 Annexations to the City of Tucson from 1905 to 1960. City-County Planning Department 1960.

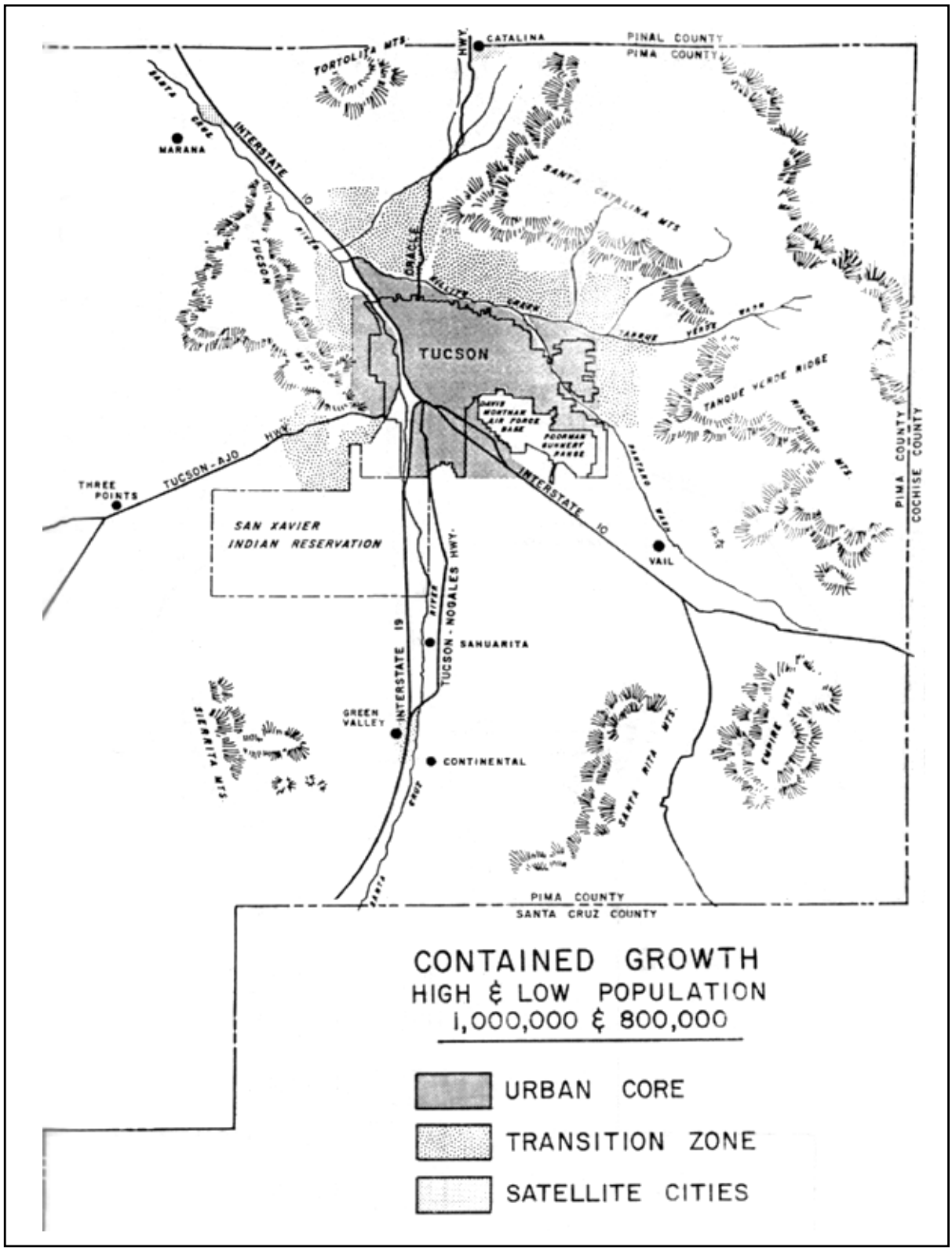

Fig. 3-64 Prediction of the lowest cost pattern for growth as analyzed by Booz-Allen in a 1975 report for the Comprehensive Plan. This report assumed the official numbers for projected population, then analyzed ways of distributing that population in the area. Booz, Allen, and Hamailton. 1974. Cost/ Revenue Analysis: Fourt Alernate Plans for Growth.

IV. USE OF MAPS FOR THE SONORAN DESERT CONSERVATION PLAN

Sophisticated mapping techniques are vital to the SDCP. Many of the more than 200 reports involve mapping of features such as wildlife habitat, archaeological features, or land use. The maps are compiled so they are compatible with each other and easily manipulated to produce composite maps providing new information.

At the heart of this is the Geographic Information System (GIS). An entire SDCP report, GIS Primer, explains how it works. In brief, data bases using geographic information can be turned into maps that show the information visually in ways that tables or verbal descriptions cannot. Information from one data base can then be visually displayed and layered with information from other compatible data bases to produce individual layers of information which can then be compared to other data bases. A valuable feature of the process is that the data can easily be updated as things change and new maps created.

One use of this type of map is to incorporate it into presentations for technical experts and the general public. Individual layers can be shown on the screen, then combined as desired to show cumulative effects, a much more graphic way of presenting data for interpretation. In some applications, for example, it is possible to use the data so that different parameters can be applied. In one such presentation it was possible to change the assumptions to show what the impacts would be under different scenarios. If more homes are built in an area, the impacts on wildlife or scenic values can be demonstrated.

Much of the information had previously been compiled for specific uses outside SDCP. For example, zoning information is available in this format for use by the Development Services Department. When zoning details change, the changes are recorded in the database so that up-to-date maps can be made. New SDCP information can be incorporated into data bases used by various departments.

Some of the Many Map Layers Available to the SDCP

Land Use
- Current zoning
- Planned land uses
- Agricultural and ranching land
- Industrial and mining uses

Infrastructure
- Wastewater facilities
- Roads
- Water providers and systems
- Landfills

Services
- Schools
- Parks
- Hospitals

Physical Characteristics
- Elevation and slope
- Watercourses and floodplains
- Average temperature and precipitation

Biological
- Occurrence of species
- Potential habitat

Cultural
- Historic and archaeological sites

Archaeological and Cultural Maps

In Mapping and Modeling: *The Making of the Cultural and Historical Resources Element Report,* Pima County Cultural Resources staff describe the process they used to develop maps.

In brief, they assembled a team of leading local historians and archaeologists to help devise a comprehensive system for mapping cultural resources. The next step was to assemble all available information sources, beginning with the Arizona State Museum's AZSITE. This information system is now in the county's computer system where the information is kept confidential to minimize site looting. In addition, information not in the AZSITE system was collected from places such as the National Park Service. The Pima County portion of the database, exclusive of Tribal lands has records for 7,643 sites and 2,913 inventory surveys which is far higher than the professionals originally projected. Where information was not fully available, staff estimated data gaps by several methods.

At an Archaeological Expert Workshop, participants noted that although more than 4,000 sites have been recorded, this represents surveys of only 12.1 percent of the land in the county. The professionals then analyzed the areas of missing data to get an idea of the most current thought on what additional information could gained for the purpose of preservation.

The result was a series of maps of cultural resources with layers that can be arranged by type of site, period and other criteria.

The team assembled will continue to work on cooperative efforts to map cultural and archaeological resources and develop protective programs.

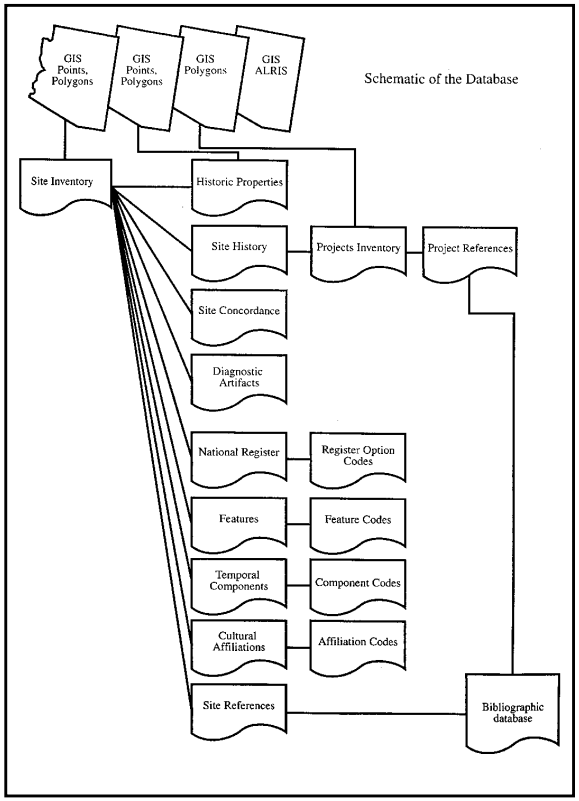

Fig. 4-1 Schematic of the Database for the Cultural and Historic Resources Element of SDCP.

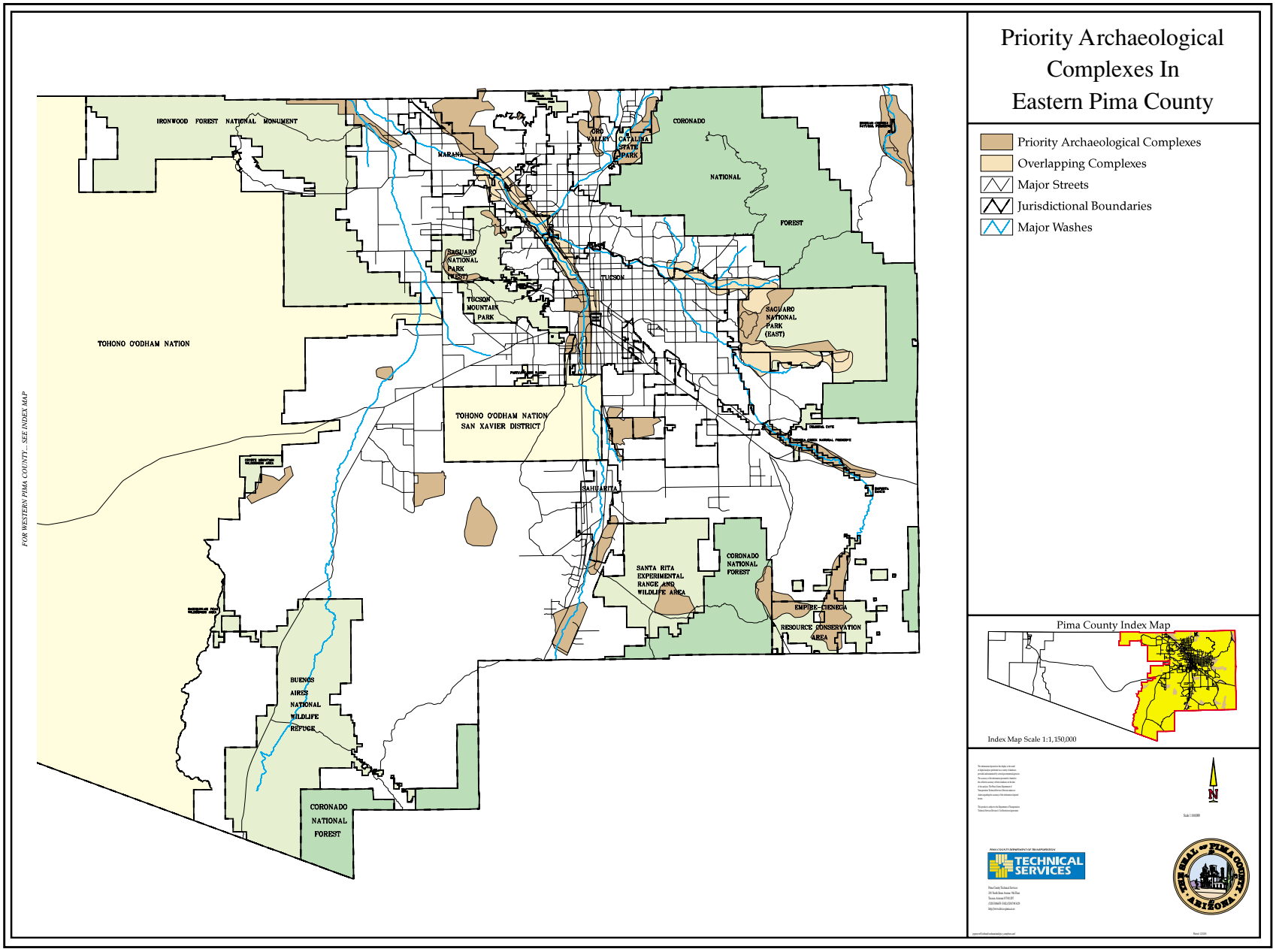

Fig. 4-2 One of the layers that contribute to the list of priority areas in cultural element of SDCP.

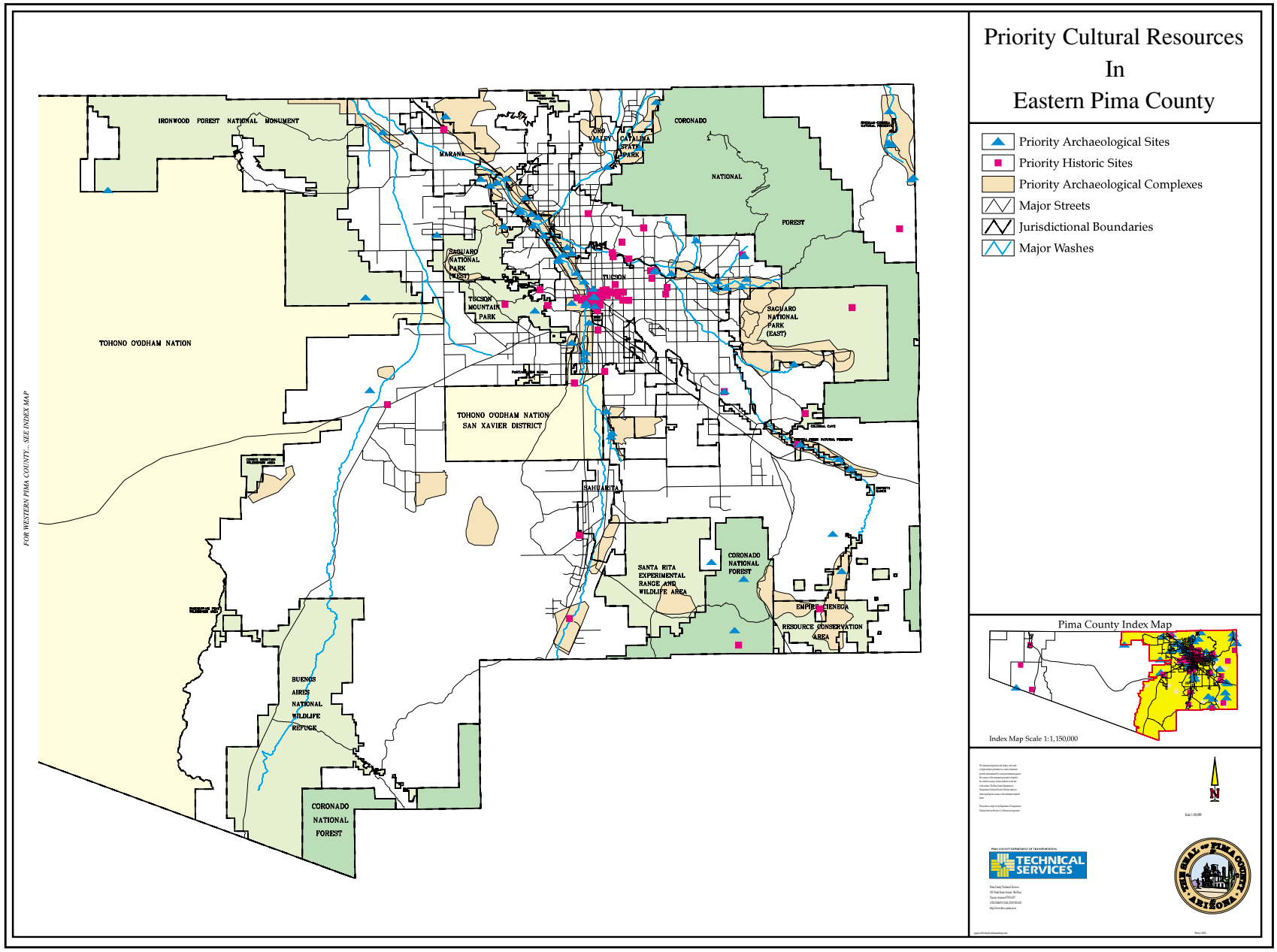

Fig. 4-3 The combined map showing areas most in need of protection of their cultural resources.

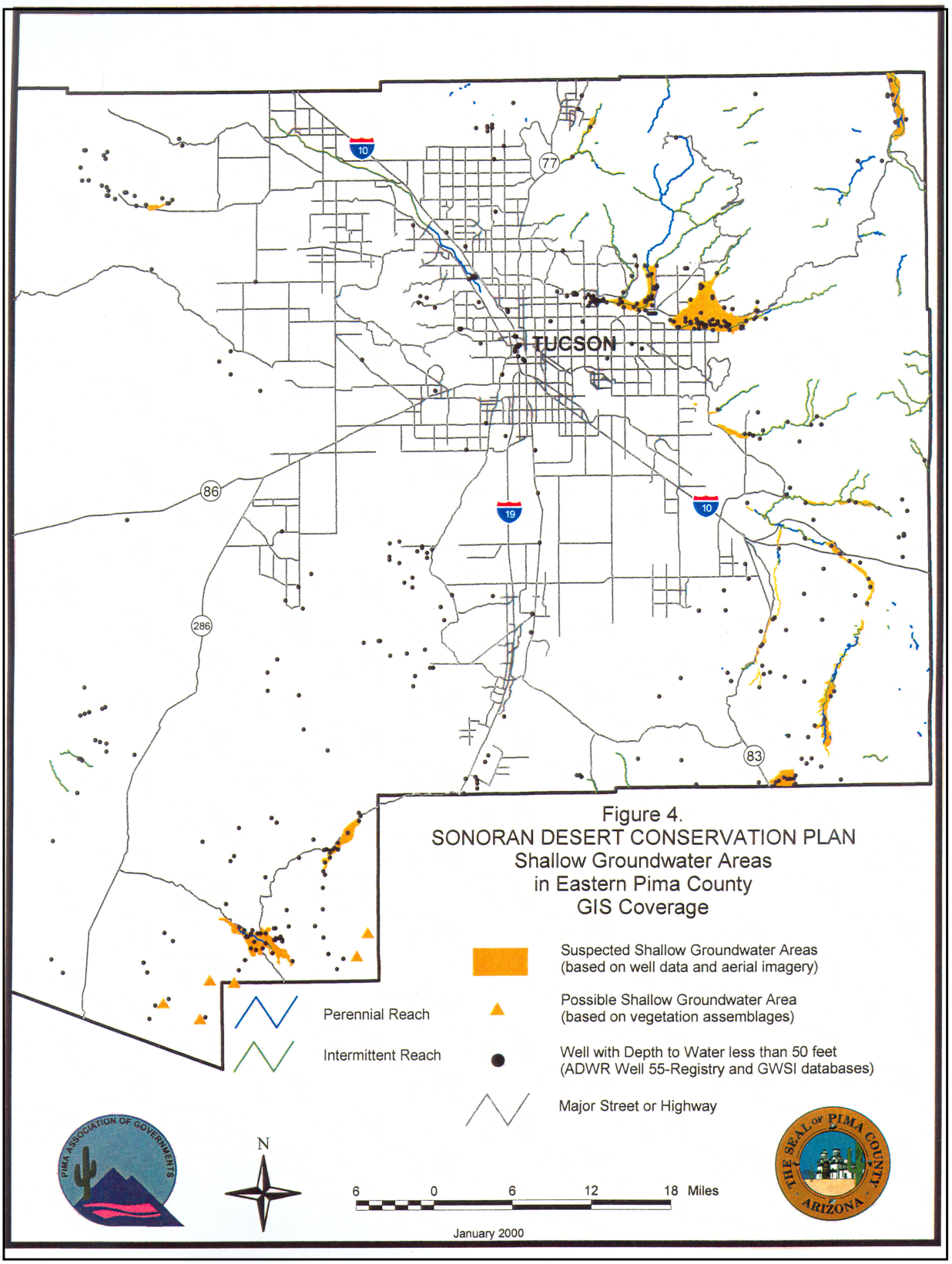

Fig. 4-4 This is one of several maps by the Pima Association of Governments that delineated perennial streams, springs, and shallow groundwater areas. These were used for the biological mapping as well as for predicting which areas were most in danger of loss of water from increased groundwater pumping.

Species and Reserve Design Maps

Leading local biological scientists joined the SDCP process as volunteer members of the "Science Team." This team met frequently with the County and the consultants to determine which species need special protection, what the habitat needs are of these special species, where appropriate habitat exists, and what the threats are to those species. All this information was mapped on individual map layers which were then combined to develop composite maps that form the basis of recommendations for areas that would form the core of the biological preserve. That information was in turn combined with current land use information to develop the final recommendations.

The process was extremely complex and involved hundreds of variables, map layers, and iterations. Only a small part of this complexity can be represented here. For much more information, see the SDCP report *Reserve Design Process Update*.

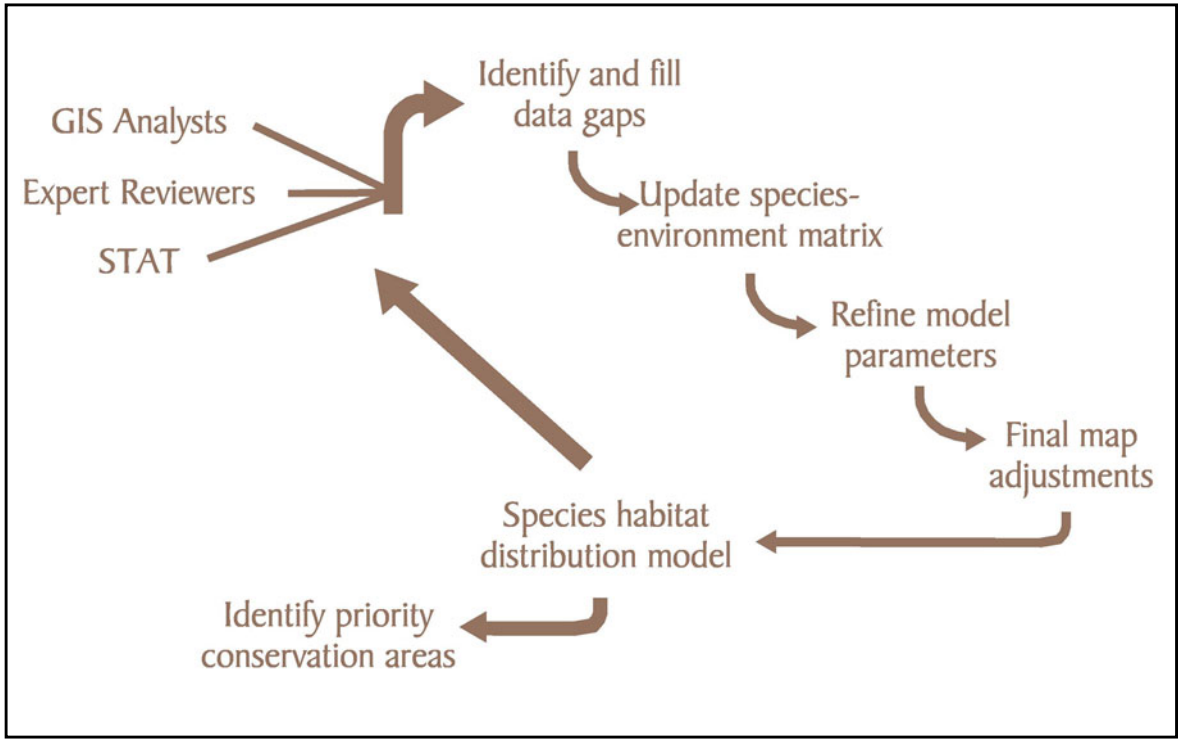

Fig. 4-5 Schematic diagram of the general process for habitat modeling. These and the next four illustrations by RECON Consulting.

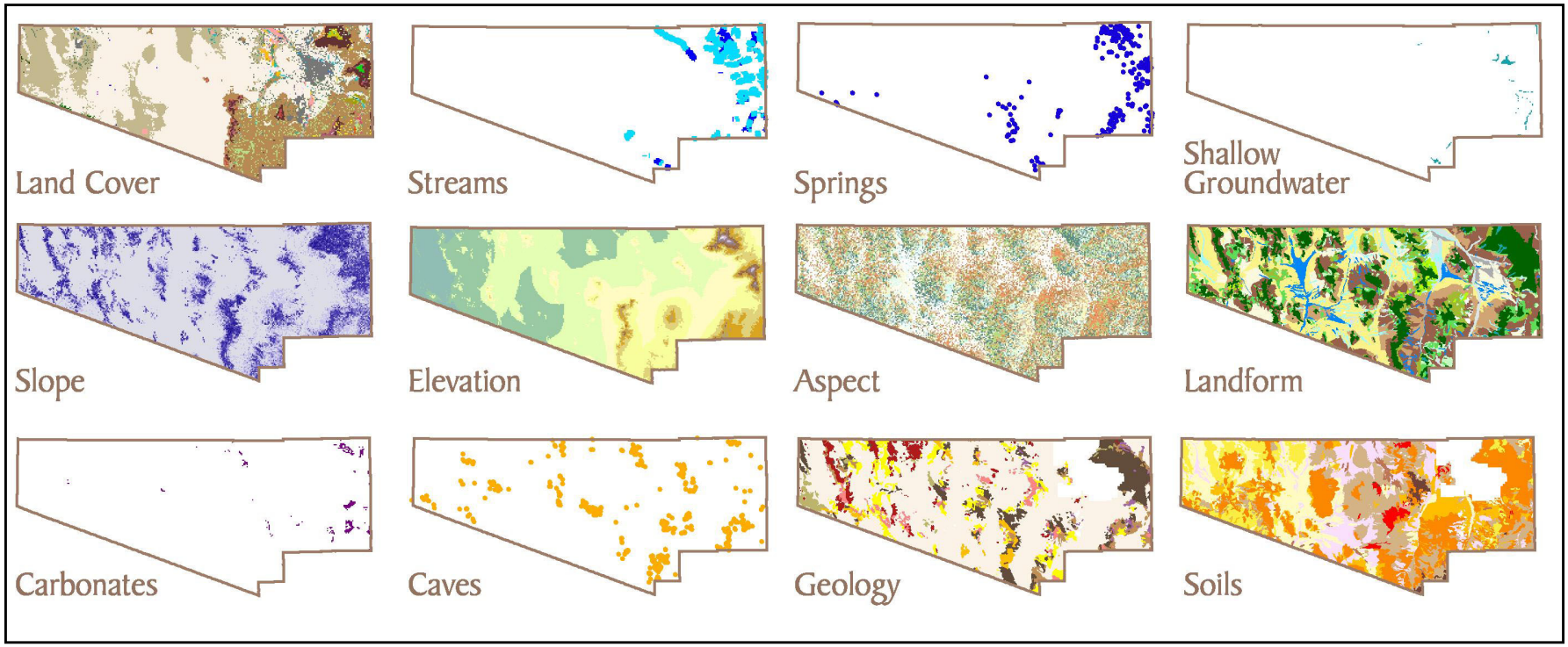

Fig. 4-6 Some of the many environmental variables used in habitat modes. Some variables will be more important to some species than to others. In some cases the species will require that all the requirements be met, while other species are more flexible.

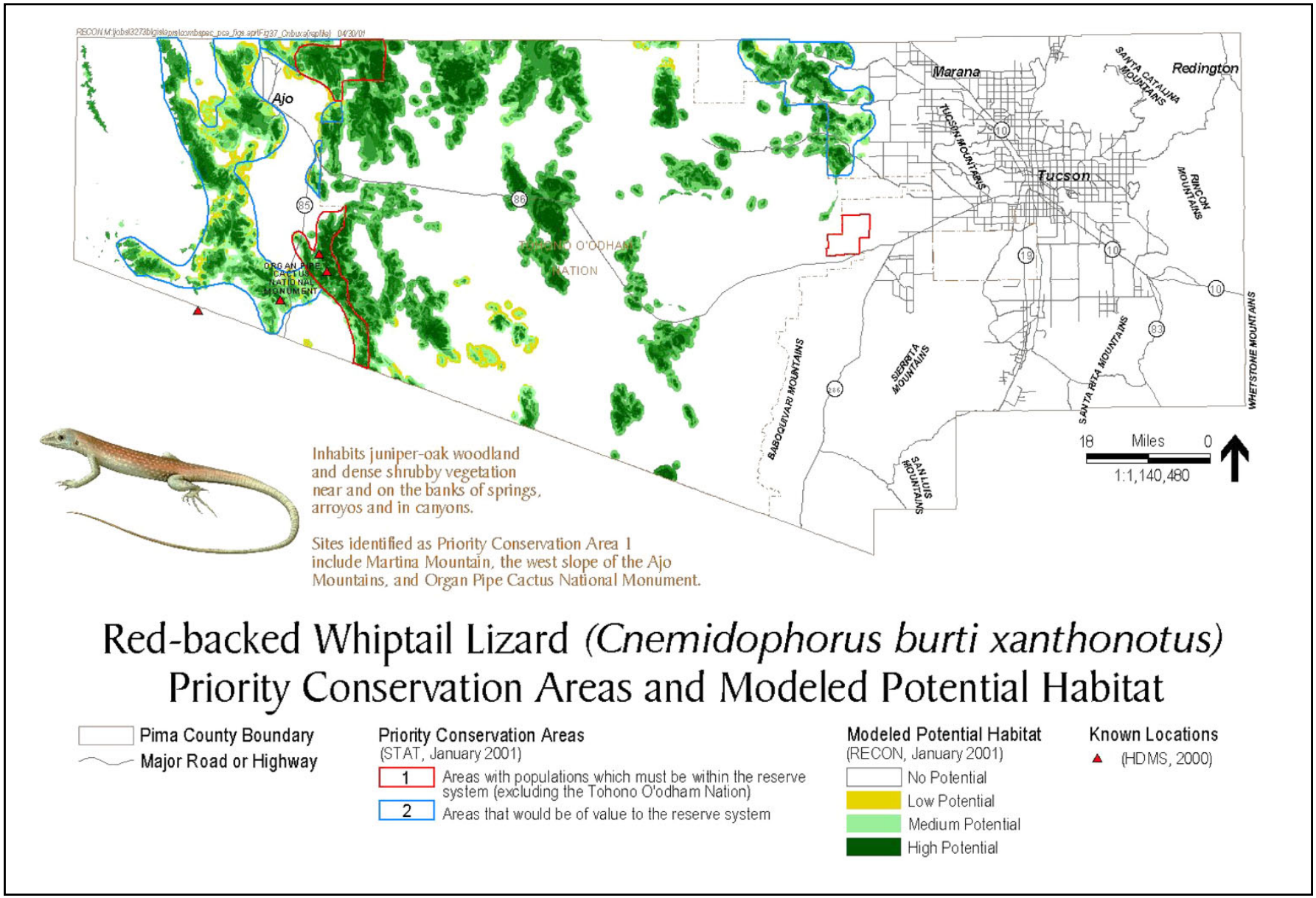

Fig. 4-7 An example of a habitat map for one species, the Red-backed whiptail lizard.

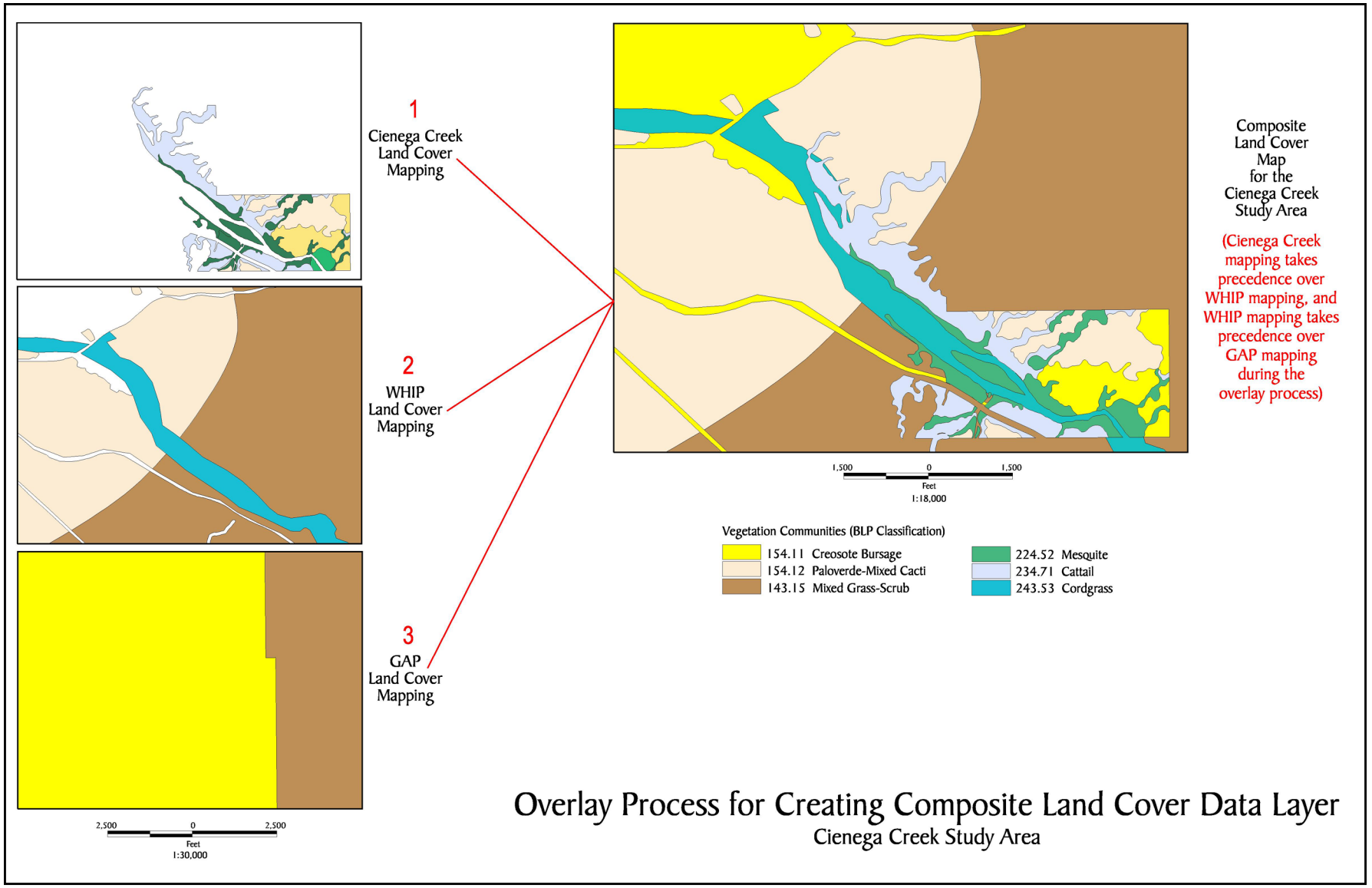

Fig. 4-8 The map on the right was created by combining information from three very different maps of the same location. Map 1 had rather detailed covered of Cienega Creek. Map 2 generally showed primary land cover and Map 3 had very little detail about the area. The combined map conveys a great deal of information.

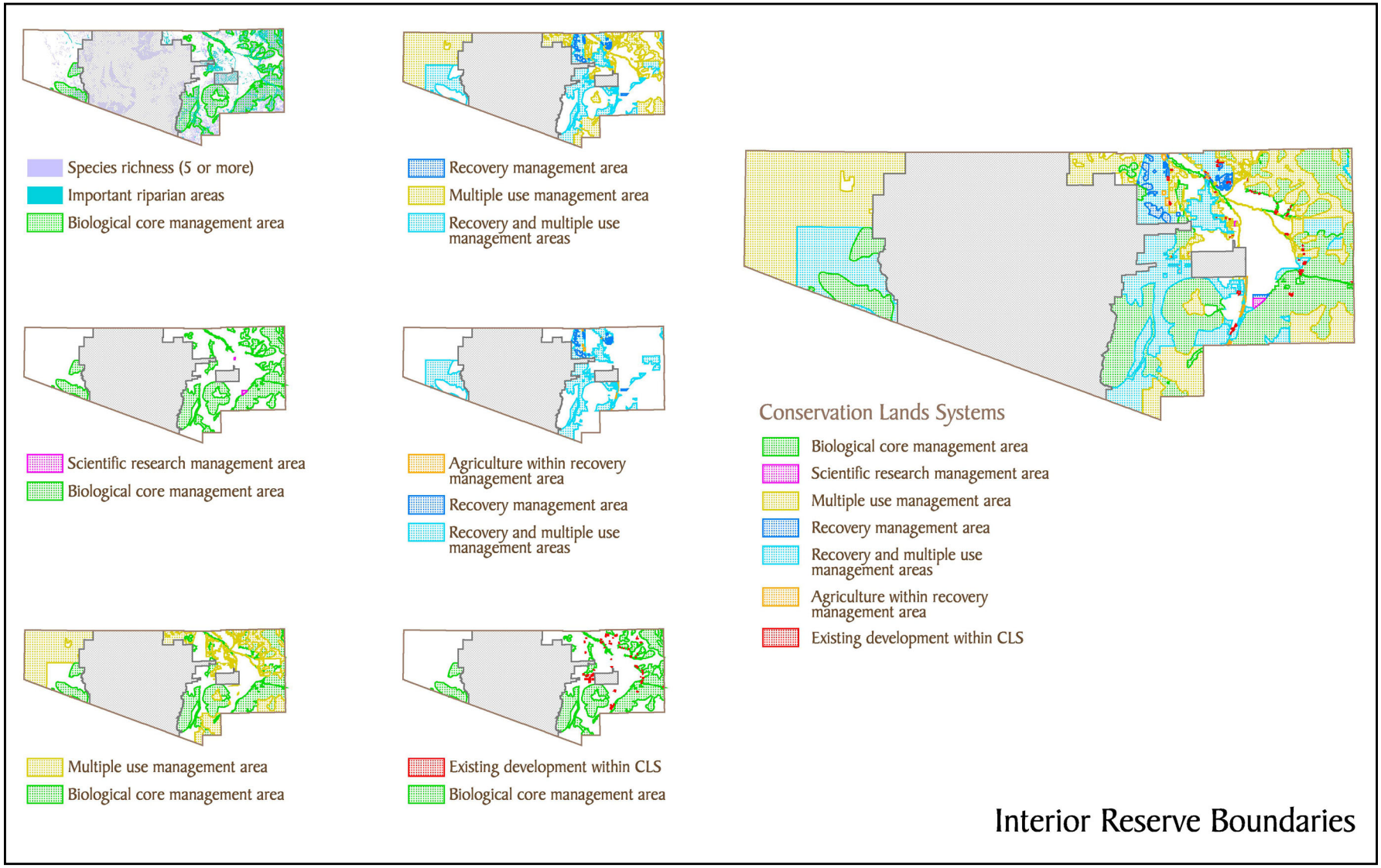

Fig. 4-9 A combined map showing proposed interior reserve boundaries. This map includes species richness, important riparian areas, recovery areas, agriculture and other components, as shown.

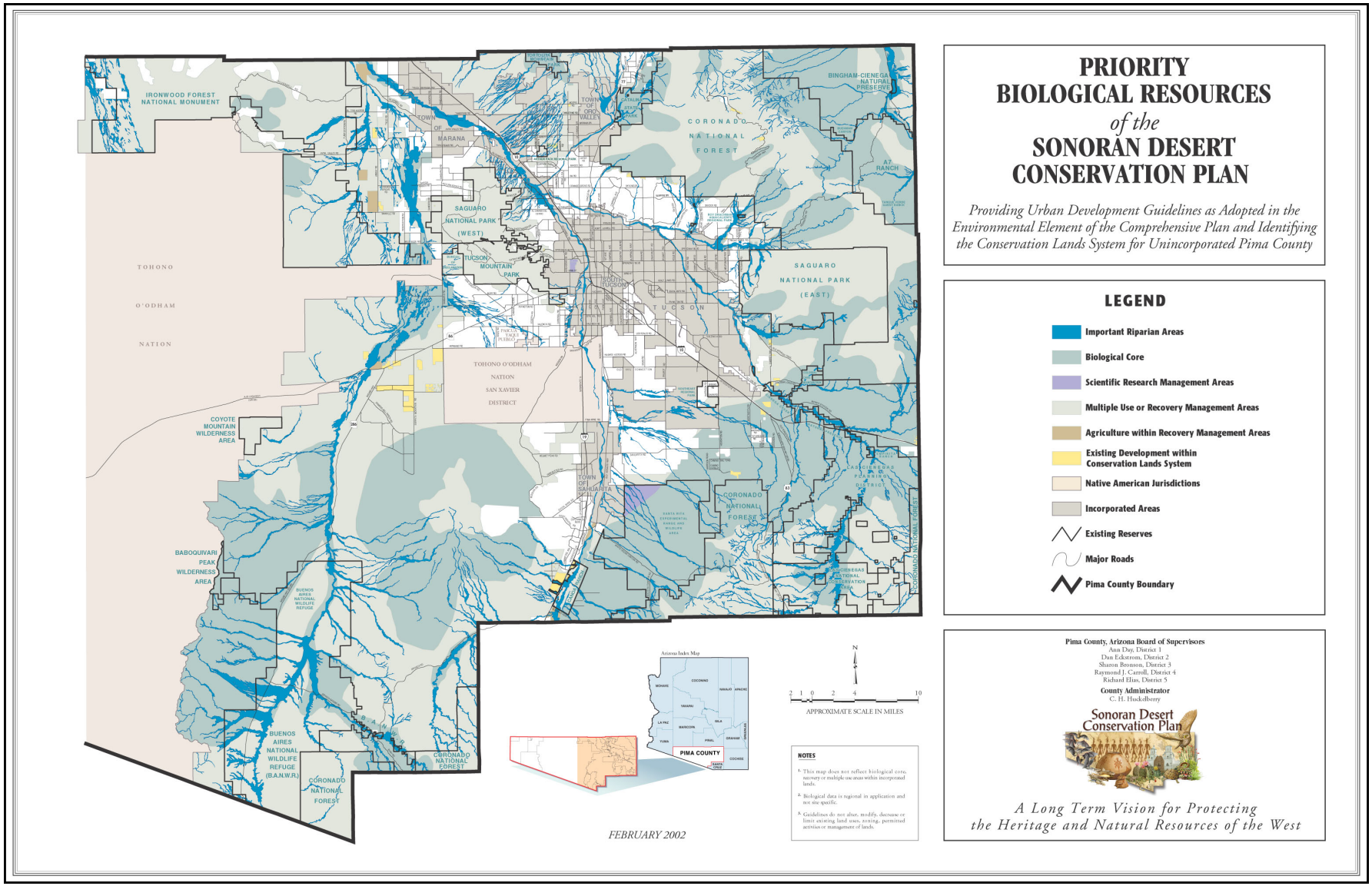

Fig. 4-10 A composite map showing priority biological resources for SDCP.

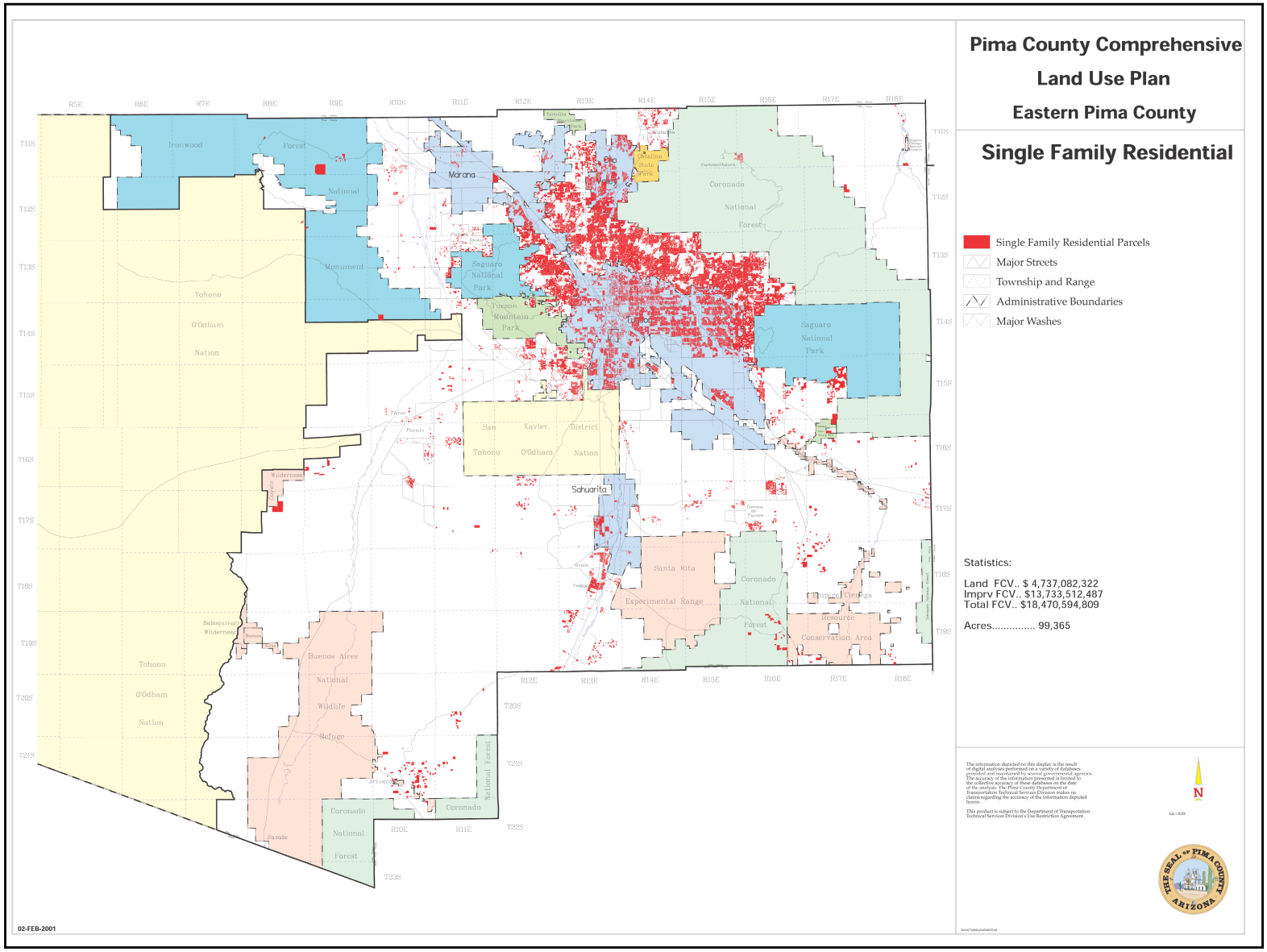

Fig. 4-11 This map shows the distribution of single family homes in eastern Pima County, the most prevalent building type. Other maps of this type include multiple family; hotel, motel, and resort; condominium and townhouses; mobile homes, commercial, partially completed structures, industrial, agriculture, natural resources, special use, and others.

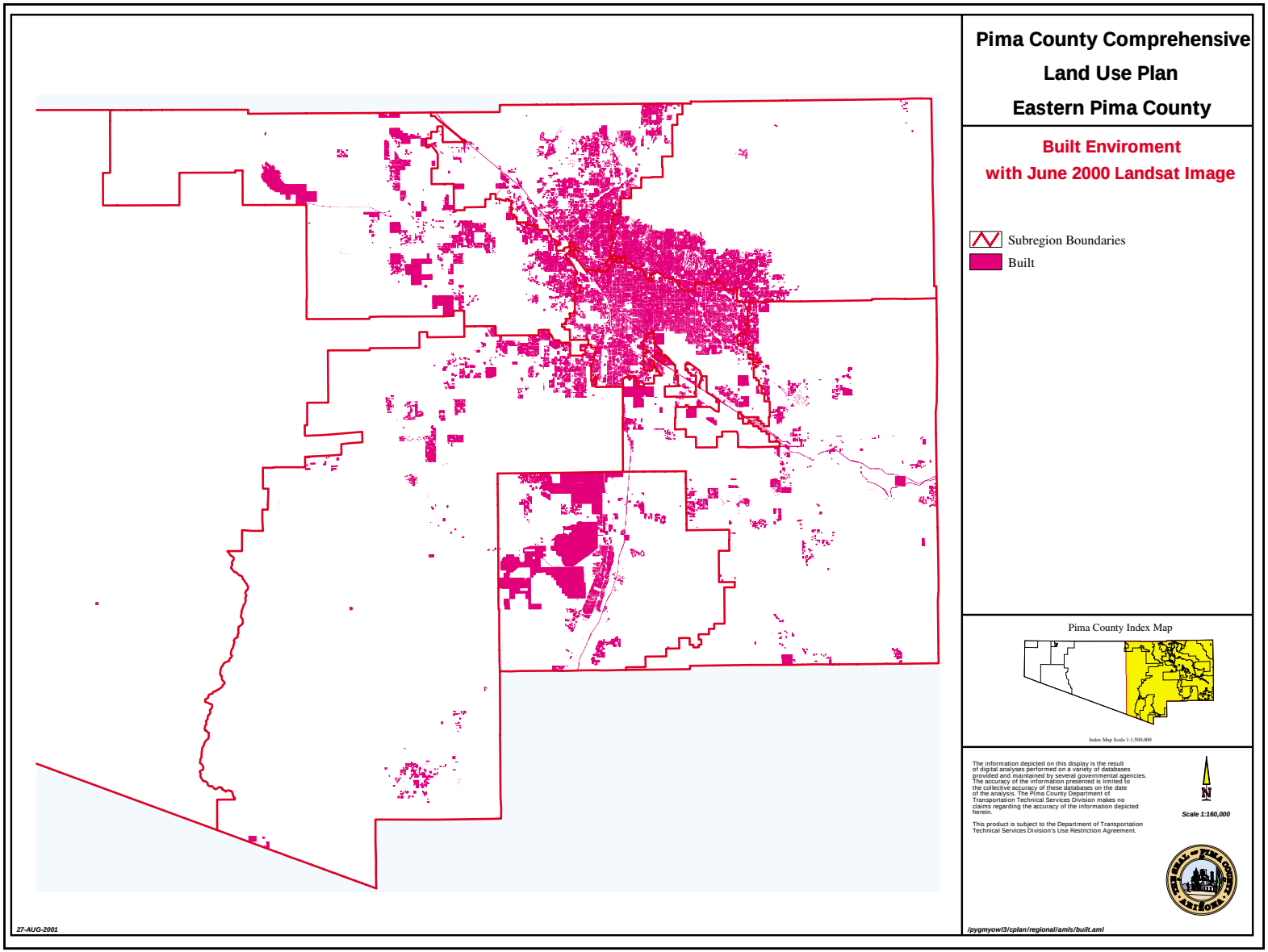

Fig. 4-12 This layer shows the "built environment." These are the areas where there are already homes or approved subdivisions under construction. These areas would be unavailable or inappropriate for biological reserves.

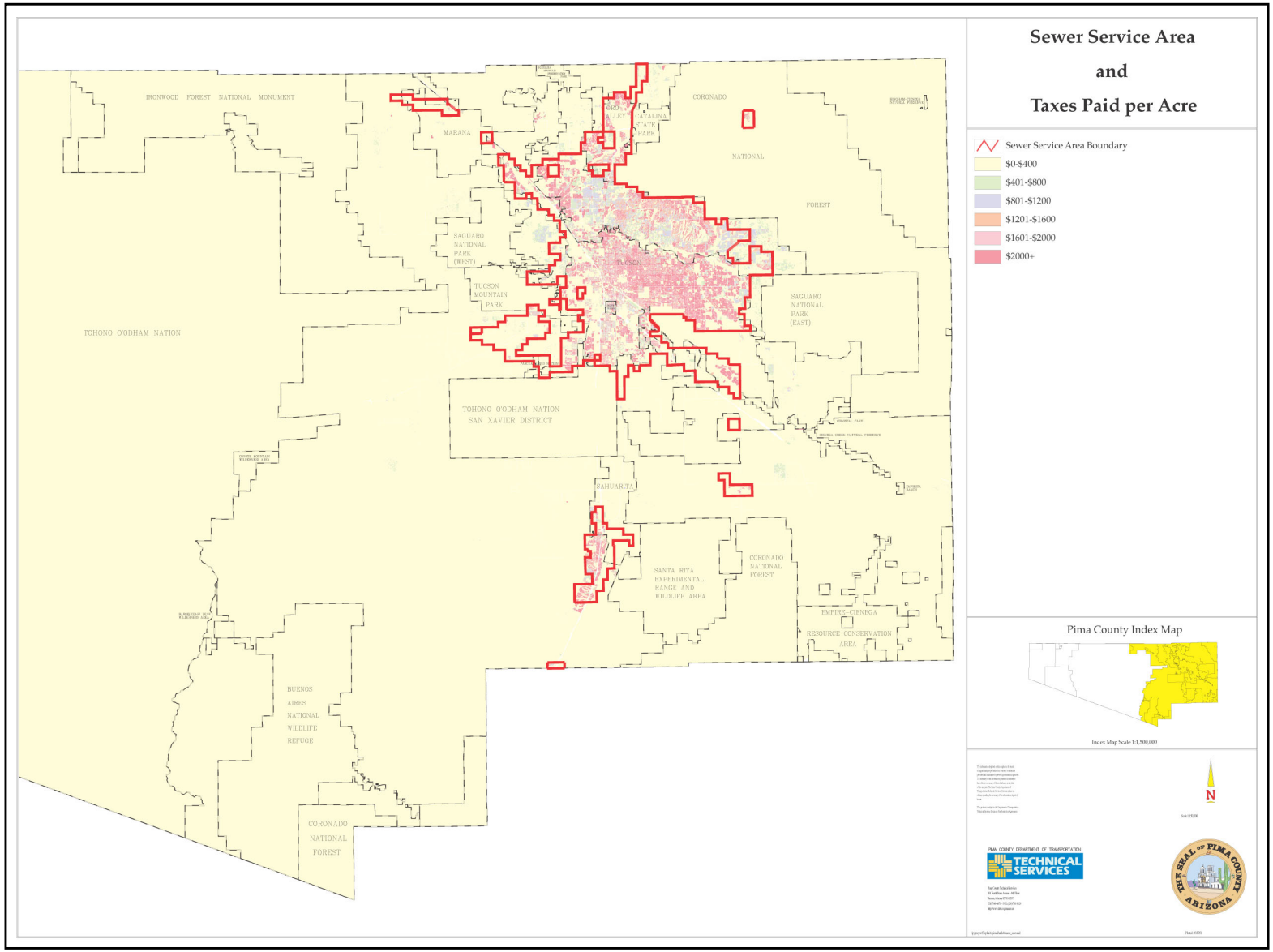

Fig. 4-13 In order to do an economic analysis of the impacts of various options, maps such as this are made showing the tax collected per acre by Pima County. Other maps show cost of services per acre, land costs per acre and other factors.

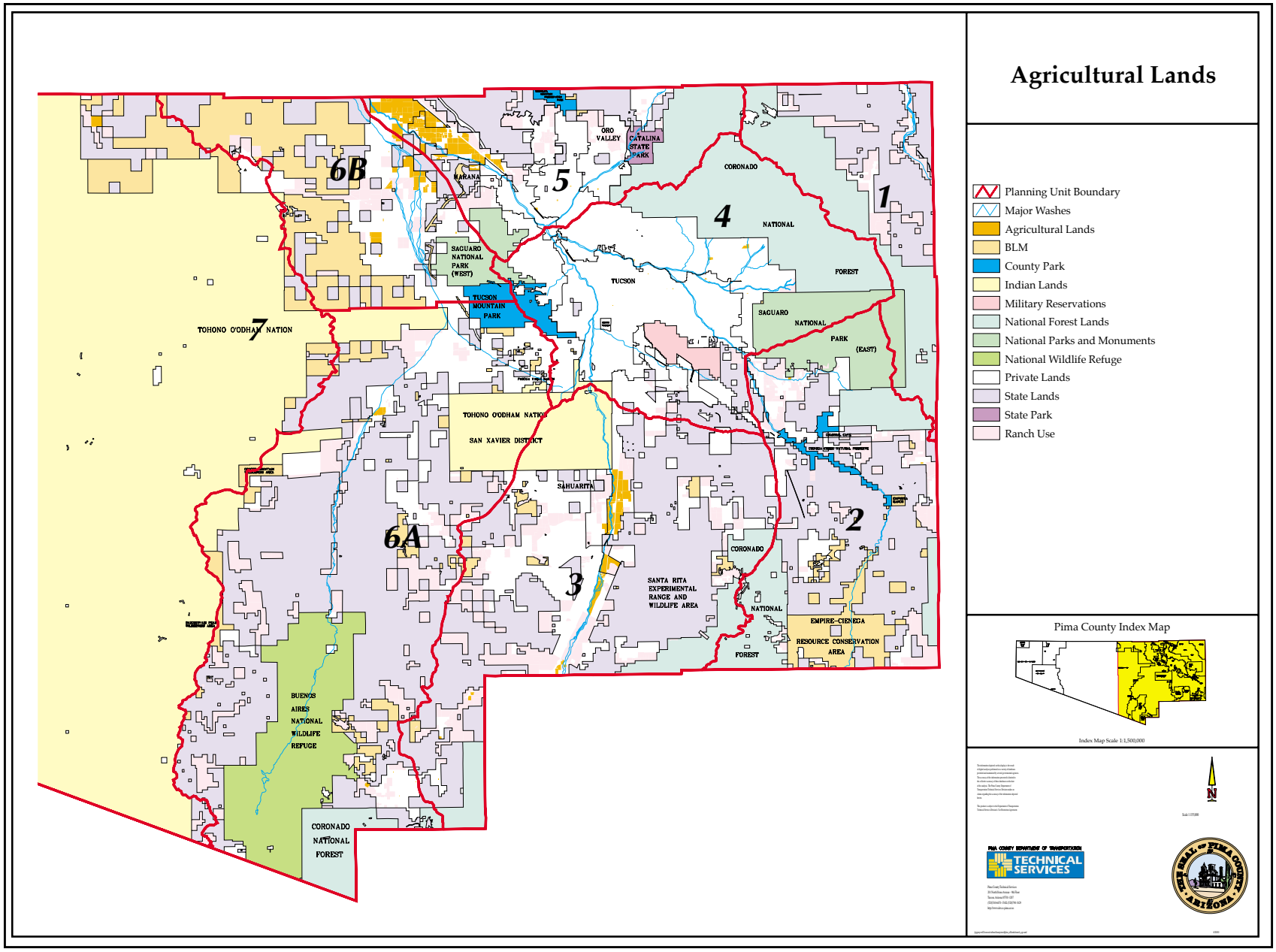

Fig. 4-14 Agricultural and ranching land. These are areas with high potential value as future preserves and relatively low land costs in most cases.

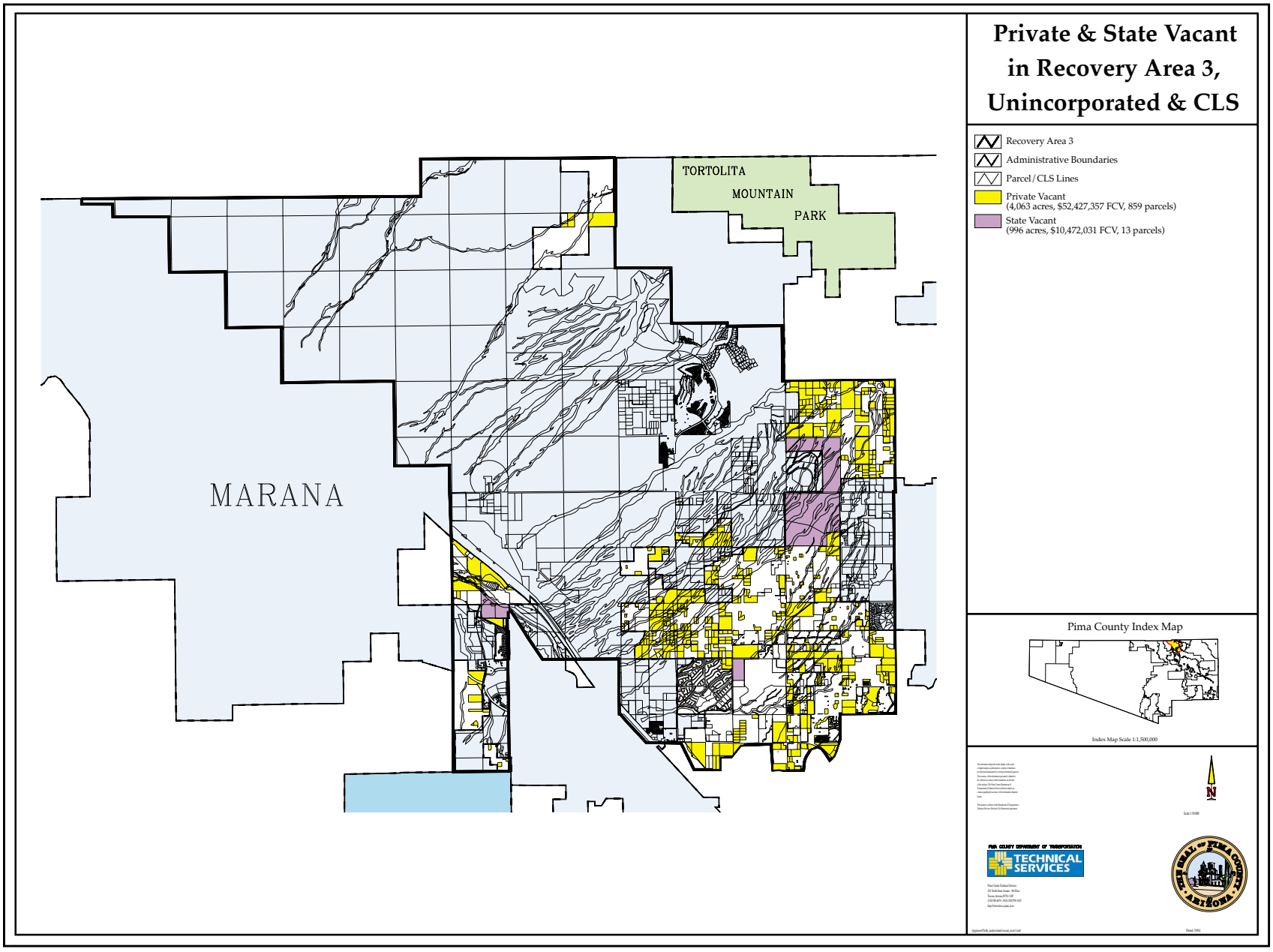
Private & State Vacant
in Recovery Area 3,
Unincorporated & CLS
Recovery Area 3
Administrative Boundaries
Parcel / CLS Lines
Private Vacant
(4,063 acres, $52,427,357 FCV, 859 parcels)
State Vacant
(996 acres, $10,472,031 FCV, 13 parcels)
TORTOLITA
MOUNTAIN
PARK
MARANA
Pima County Index Map
Index Map Scale 1:1,500,000
PIMA COUNTY DEPARTMENT OF TRANSPORTATION
TECHNICAL SERVICES
SEAL OF PIMA COUNTY
ARIZONA

Fig. 4-15 Vacant land on the northwest side of town, the Tortolita area. The yellow areas are private vacant land and the purple areas are State Trust Lands that may be available for sale to the highest bidder in the future. The rest is committed or in incorporated areas. This map shows that vacant land available for purchase as preserves is very limited and mostly in scattered noncontiguous parcels unsuitable for use as wildlife corridors or preserves.

The final maps for the Conservation Plan will be based on:

1. The reserve design maps developed by the Science Team, County staff, and consultants.
2. Riparian priorities map developed by County staff.
3. The cultural and historical priorities maps developed by the Cultural Resources Team and County staff.
4. Maps of existing and committed land use developed by County staff.
5. Maps of important economic factors including cost of land, tax revenue per acre and other economic variables.
6. Recommendations of the SDCP Steering Committee.
7. Consultation with other governmental jurisdictions.
8. Public input.
9. Decisions of elected officials.
10. Acceptance by the U.S. Fish and Wildlife Service.

V. WHERE TO GET MORE INFORMATION ABOUT MAPS AND MAPMAKING

Books

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Local Map Collections

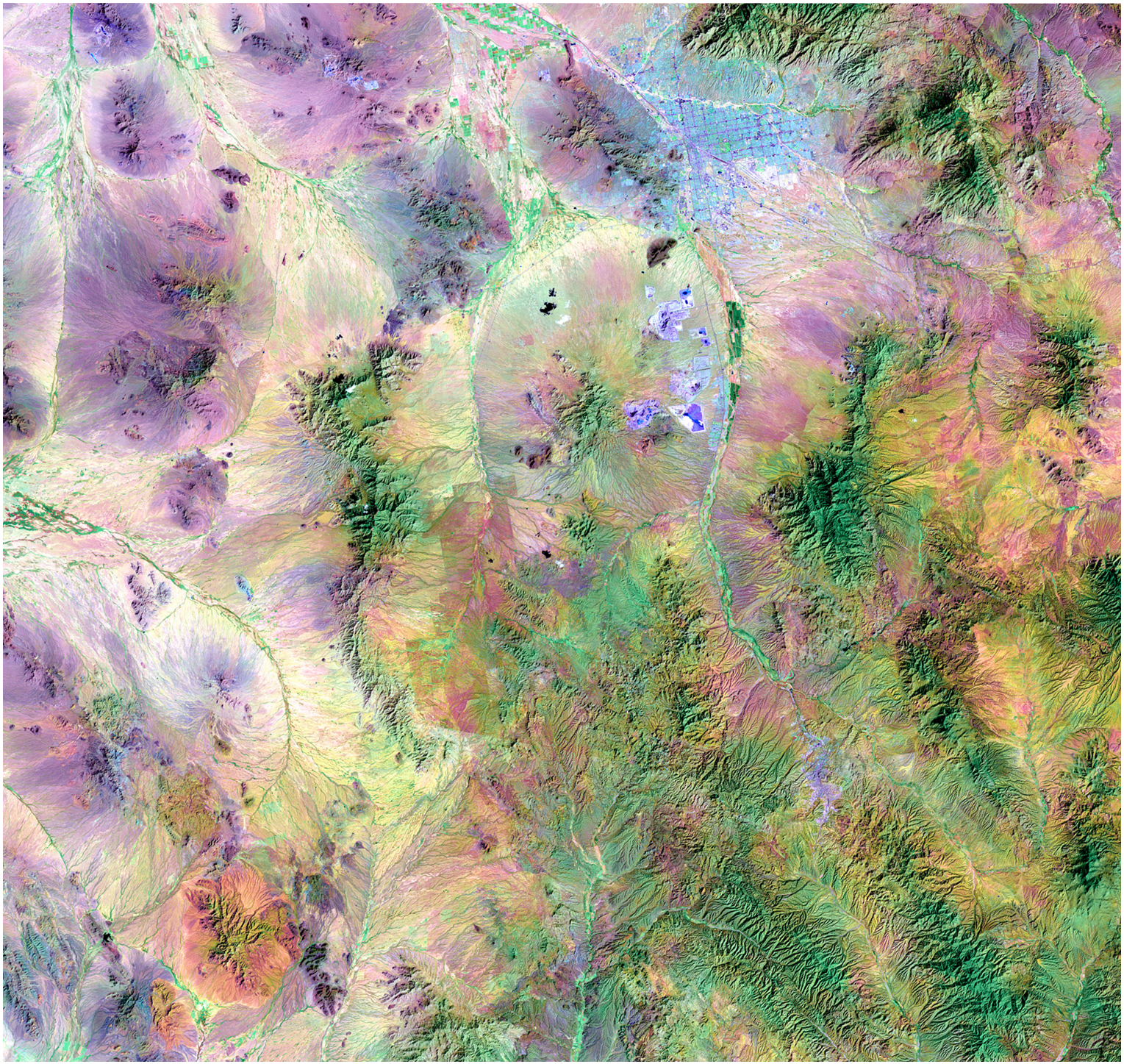
The Arizona State Library and Archives in the State Capitol in Phoenix has a large collection of historic maps.

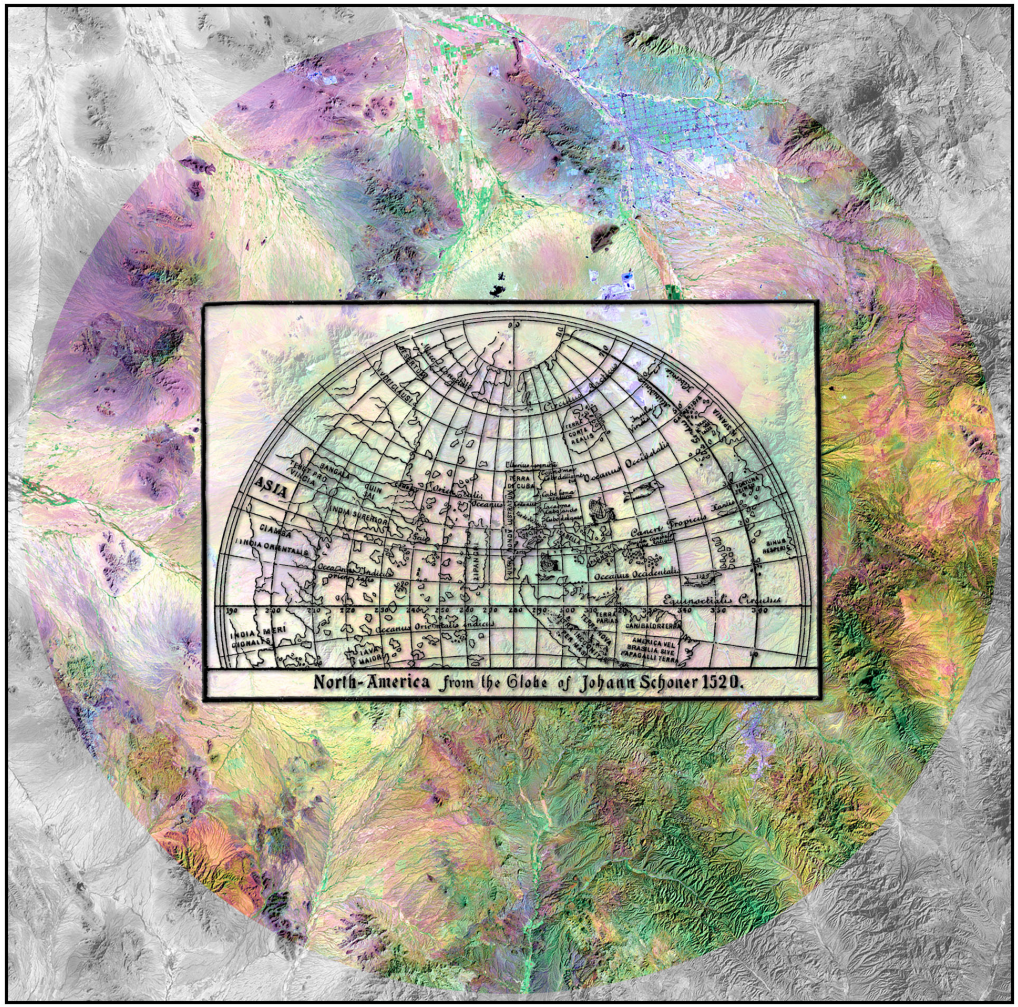
The Arizona Historical Society has many local maps in its collection.

The University of Arizona Library has many maps in its map collection. Rare and older maps in the Special Collections Library.

The Arizona Geological Society has maps for sale as well as an extensive library of Arizona and U.S. geological maps.

The U.S. Bureau of Land Management has extensive maps of the cadastral surveys.




ASIA
Occanus Occidentalis
Æquinoctialis Circulus
North-America from the Globe of Johann Schoner 1520.