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CITY OF PHOENIX

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175. Updated resume of Douglas E. Kupel

176. Resume of Thomas Buschatzke

177. Decision and Decree in Case #4564, Hurley v. Abbott (1910)

178. "Two Bridge Questions" Arizona Republican , May 5, 1909 (I, 2: 1-4).

179. Excerpt from Richard D. Lingenfelter, Steamboats on the Colorado. University of Arizona Press.

180. Excerpt from Maria Morisawa, 1968: Streams, Their Dynamics and Morphology. McGraw-Hill Book Co.

181. Excerpt from William D. Sellers, ed., Arizona Climate. University of Arizona.

182. B.W. Thomsen and J.J. Porcello. 1991. "Predevelopment Hydrology of the Salt River Indian Reservation, East Salt River Valley, Arizona." U.S. Geological Survey Water-Resources Investigations Report 91-4132.

183. Excerpt from 1954 "Compilation of Records of Surface Waters of the United States through September 1950, Part 9, Colorado River Basin." U.S. Geological Survey Water Supply Paper No. 1313.

184. Title page from T.A. Hayden. A Study of the Water Supply of the Salt River Project, Arizona Showing the Need of Storage on the Verde River and the Effect of the Over-Developed Verde District, Phoenix, Arizona. August 26, 1933.

185. Earl Zarbin, "Dr. A.J. Chandler, Practitioner in Land Fraud," 36: Journal of Arizona History: 173-188.

186. Excerpt from Karen L. Smith, The Magnificent Experiment. University of Arizona Press, 1986.

187. January 10, 1879, and June 14, 1879, Executive Orders establishing the Salt River Pima-Maricopa Indian Reservation.

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188. Agreement Between the United States and the Salt River Valley Water Users Association, 1935.

189. Excerpted map from David F. Myrick, Railroads of Arizona, Volume 2.

190. Excerpted map from David F. Myrick, Railroads of Arizona, Volume 2.

191. Historic American Engineering Record report on Ash Avenue Bridge, 1991.

192. Excerpt from Willis T. Lee, 1905. "Underground Waters of the Salt River Valley," USGS Water Supply Paper No. 136 (Washington: Government Printing Office).

193. "Vehicular Bridges in Arizona" National Register of Historic Places nomination, 1987.

194. Excerpt from the Rivers and Harbors Act of 1899 (30 Stat. 1121).

195. Plate 59 from the 1890 Statistical Abstract of the United States (published 1898) showing navigable rivers in the United States.

196. Excerpt from 1971 report, Ownership and Administration of Public Lands in Arizona.

197. Excerpt from W.H. Code, 1900. "Report of Investigations for 1900." U.S. Department of Agriculture, Office of Experiment Stations-Bulletin No. 104. (Washington: Government Printing Office, 1902).

198. Excerpt from 1899, "Surface Water Supply of the U.S. - Colorado River Basin," U.S. Geological Survey Water Supply Paper No. 38.

199. Excerpt from 1901, "Surface Water Supply of the U.S. - Colorado River Basin," U.S. Geological Survey Water Supply Paper No. 66.

200. Excerpt from 1902, "Surface Water Supply of the U.S. - Colorado River Basin," U.S. Geological Survey Water Supply Paper No. 85.

201. Excerpt from 1904, "Surface Water Supply of the U.S.- Colorado River Basin," U.S. Geological Survey Water Supply Paper No. 133.

202. 1904, Salt River Project, Salt River Valley Arizona, Topographic and Irrigation Maps, 1902-1903.

203. Hydrograph of Combined Flow of Salt and Verde Rivers, 1889-1912. Salt River Valley Water Users Association.

204. Hydrograph of Combined Flow of Salt and Verde Rivers, 1889-1912 and Average Flow 1899-1912.

205. Excerpt from A.P. Davis, 1897. "Irrigation Near Phoenix, Arizona." U.S. Geological Survey Water Supply and Irrigation Paper Number 2. U.S. government Printing Office, Washington.

TB:cf/NatRes:1359

EXHIBIT 175

Douglas E. Kupel
City of Phoenix
Law Department
200 W. Washington, Suite 1300
Phoenix, AZ 85003-1611
(602) 495-5853

EDUCATION

Ph.D. - History, Arizona State University, Tempe (May, 1995).
Dissertation title: Urban Water in the Arid West: Municipal Water and Sewer Utilities in Phoenix, Arizona.

M.A. - History, University of Arizona, Tucson (May, 1986)
Thesis title: Diversity Through Adversity: Tucson Basin Water Control Since 1854

B.A. - History, University of Oregon, Eugene (March, 1979)

TEACHING EXPERIENCE

Courses taught:

GateWay Community College (Phoenix)
- Western Civilization since 1789
- US History to 1870

Phoenix College:
- US History to 1870

Courses qualified to teach:

- U.S. History Survey (pre- & post- 1870)
- Western Civilization
- American West
- Arizona History
- Urban History
- Environmental History
- Latin America.

Certified Community College Instructor, Arizona

PUBLIC HISTORY EXPERIENCE

City of Phoenix Law Department, Phoenix, Arizona (4-11-88 to present).
Historian for City Attorney's Office, Civil Division. Organized and directed historical research for litigation in the area of environmental law and natural resources. Main project is compiling historic information for the Gila River Stream Adjudication, a large water rights lawsuit involving thousands of claimants. The adjudication is part of a team litigation effort under the direction of two attorneys and in conjunction with other technical experts, legal assistants, and administrative personnel. Other ongoing projects include research into the deregulation of the electrical utility industry, an examination of the potential navigability of Arizona's rivers and streams, and research into waste water treatment methods. This technical and analytical position entails the frequent preparation of oral and written reports on policy issues presented to top city management and elected officials.

Arizona State Historic Preservation Office, Phoenix, Arizona (1-27-86 to 4-8-88).
Historian for state agency, a division of Arizona State Parks. Coordinated National Register of Historic Places program. Reviewed, edited, and wrote National Register nominations. Reviewed Federal and state projects for compliance with applicable historic preservation legislation. Monitored historic preservation fund grant projects. Continue to serve Arizona State Parks in a volunteer capacity as a reviewer for its Arizona Heritage Fund Project grant applications.

Consulting Archaeologist and Historian (1979-1986)
During this seven year period worked on a large number of contract projects as a consulting historian and archaeologist. This project work included a wide variety of jobs and employers. Government employers included the National Park Service's Historic American Buildings Survey and Historic American Engineering Record, the University of Arizona, the Arizona Historical Society, the California State Department of Transportation, the California State Department of Parks and Recreation, and the State of Nevada Department of Transportation. Private employers included Cultural and Environmental Systems (Tucson), Linda Laird and Associates (Tucson), Acuna-Coffeen Landscape Architects (Tucson), TerraMar International Services (Tucson), Roth and Associates (San Diego), Wirth Environmental Services (San Diego), Larry Seeman Associates (Newport Beach, CA), Regional Environmental Consultants (San Diego), Carolina Archaeological Services (Columbia, South Carolina), Heritage Environmental Services (San Diego), Archaeological Planning Collaborative (San Diego), Paul G. Chase and Associates (Escondido, CA), and Multi-Systems Associates (San Diego).

PROFESSIONAL AFFILIATIONS

Arizona Archaeological and Historical Society
Arizona Archaeological Society
Arizona Preservation Foundation (Board member, former President)
Arizona Historical Foundation
Arizona Historical Society
Coordinating Committee for History in Arizona
National Council on Public History
National Trust for Historic Preservation
Organization of American Historians
Society of Historical Archaeologists
Society of Professional Archaeologists (certified archaeologist)

AWARDS

1995 Special recognition award for the best National Register of Historic Places nomination prepared for a historical property. Presented by the Arizona Historic Sites Review Committee.

1994 James E. Officer prize for best paper on Arizona's Hispanic history at the Arizona Historical Convention. Presented by the Arizona Historical Society.

1987 Best paper delivered at the Arizona Historical Convention. Presented by the Arizona Historical Society.

1981 Full scholarship to the University of South Carolina. Presented by the Federal Highway Administration.

WRITING PROJECTS

Academic Papers and Reports:

1996 "Taking a Bath: Civic Improvement in Clifton," Journal of Arizona History 37: (Autumn, 1996): 269-282.

1996 Taking a Bath: Civic Improvement in Clifton. Paper presented before the Arizona Historical Society Convention, April 27, 1996.

1995 Book Review of Indian Water in the New West edited by Thomas R. McGuire, William B. Lord, and Mary G. Wallace, published in Journal of Arizona History 36: (Winter, 1995): 415-420.

1995 Urban Water in the Arid West: Municipal Water and Sewer Utilities in Phoenix, Arizona. Ph.D. dissertation, Arizona State University.

1995 "Patagonia: Jewel of the Sonoita Valley," Journal of Arizona History 36:1(Spring, 1995): 55-82.

1994 Water and Wastewater History, City of Phoenix. Paper presented before the American Public Works Association Arizona Chapter Summer Workshop, July 25, 1994.

1994 Tempe's First Families: Soza, Sotelo and Elias. Paper presented before the Arizona Historical Society Convention, April 23, 1994.

1994 Book Review of Turning on Water with a Shovel: The Career of Elwood Mead, by James R. Kluger, published in Journal of Arizona History 35:2 (Summer, 1994): 219-220.

1994 Book review of Old Crosscut Canal, by Fred Anderson, published in The Public Historian 16:1 (Winter, 1994): 88-90.

1993 Book review of American Indian Water Rights and the Limits of Law, by Lloyd Burton, published in Western Legal History 6:2 (Summer/Fall, 1993): 235-236.

1992 Book review of Water Politics: Continuity and Change, by Helen Ingram, published in the Journal of Arizona History 33:1 (Spring, 1992): 110-112.

1992 Convenience or Necessity? The Phoenix Sewer System, 1870-1912. Paper presented before the Arizona Historical Society Convention, April 30, 1992.

1991 Book review of Beyond the Wasatch: The History of Irrigation in the Uinta Basin and Upper Provo River Area of Utah, edited by Gregory D. Kendrick, published in The Public Historian 13:1 (Winter, 1991): 92-94.

1991 Historical Research and Litigation in the Municipal Environment. Paper Presented at the 13th Annual Conference of the National Council of Public History, May 4, 1991.

1990 Search for Documentation: The Tucson Groundwater Experience. Paper Presented to the Water in the 20th Century West Symposium, March 31, 1990.

1989 The Drive for Municipal Ownership: Phoenix Water Works, 1898-1907. Paper Presented before the Arizona Historical Society Convention, March 21, 1989.

1987 Arizona Water History Archives Project. Prepared for University of Arizona Library, December 3, 1987.

1987 Persistent Perceptions: Ideology of Modern Water Use. Paper Presented before the Arizona Historical Society Convention, April 4, 1987.

1986 Diversity Through Adversity: Tucson Basin Water Control Since 1854. Master's Thesis, University of Arizona, Tucson.

1986 Mythology and Technology in Western Water Development. Paper Presented before the Phi Alpha Theta History Honor Society Regional Meeting, May 5, 1986.

1985 University of Arizona Architectural Development. Paper Presented before the Arizona Historical Convention, May 3, 1985.

1985 University of Arizona National Register District Nomination Form (with Robert C. Giebner, David Blackburn, and Adelaide Elm).

1983 Plank Road Discontiguous District Nomination form (with Pat Welch and Lisa Capper).

1981 A Modern Material Culture study: South Carolina's Migrant Farmworkers. Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

1981 Historic Preservation and Mass Transit Planning. American Society for Conservation Archaeology Report 8: (3):8-19 (with Dale E. Hicks).

1980 Conservation Management Strategies: State Departments of Transportation. Department of Anthropology, University of South Carolina, Columbia.

1979 Spaniards in Early Oregon. Paper presented to the Gran Quivera Conference.

Prepared for Private Consulting Firms:

1995 National Register Nomination of the Laveen School Auditorium, Laveen, Arizona. Laveen Elementary School District No. 59. Laveen.

1988 National Register Nomination for City-County Building, Phoenix, Maricopa County. Gerald A. Doyle and Associates, Phoenix.

1985 Historical and Archaeological Character, Fort Lowell Park Master Plan. Acuna-Coffeen Landscape Architects, Tucson.

1985 San Xavier Historic Artifact Analysis. Cultural and Environmental Systems, Tucson.

1984 Diversity Through Adversity: Water Control at San Xavier. TerraMar International Services, San Diego.

1983 Plank Road Research. Wirth Environmental Services, San Diego.

1983 Picacho Basin Historic Research. Wirth Environmental Services, San Diego.

1983 Miguel Substation Historic Research. Wirth Associates, San Diego.

1980 Final Report of the Rincon, et al., Cultural Resource Survey; Jamul. Regional Environmental Consultants, San Diego (with Paige Talley).

1980 Final Report of the Rincon, et al., Cultural Resource Survey: La Jolla. Regional Environmental Consultants, San Diego (with Paige Talley).

1980 Final Report of the Rincon; et al., Cultural Resource Survey: Pala. Regional Environmental Consultants, San Diego (with Paige Talley).

1979 Cultural Resource Study of a Proposed Electrical Transmission Line from Jade to the Sand Hills, Imperial County, California. Regional Environmental Consultants, San Diego (with Carol Walker).

Prepared for the California Department of Transportation:

1984 A Proposal to Construct a Plank Road Exhibit at the Proposed Imperial Safety Roadside Rest.

1984 Historic Property Survey Report, Proposed Sand Hills Interchange.

1984 Request for Determination of Effect, Plank Road.

1984 First Addendum Archaeological Survey Report, Proposed Sand Hills Interchange.

1983 Historic Property Survey Report, Proposed MTDB East Urban Transit Corridor.

1983 Architectural Survey Report, Proposed MTDB East Urban Transit Corridor.

1983 Request for Determination of Eligibility, La Mesa Depot (with John W. Snyder).

1982 The Calhoun Street Parking Lot: A Historical and Archaeological Investigation of Block 408, Old Town San Diego.

1982 Archaeological Survey of the Old Town Maintenance Station, Blocks 363, 364, 378, 396, 397, Old Town San Diego.

1982 Archaeological Survey Report of the Old Town Excess Parcel Sale, Blocks 379, 380 and 395, Old Town San Diego.

1982 Archaeological Survey Report of the Calhoun Street Parking Lot, Block 408, Old Town San Diego.

1981 Proposed Archaeological Phase II Excavation at SDi 8873H (with Joan M. DeCosta).

1981 Historical and Archaeological Investigation of a Proposed Old Town Excess Parcel Sale, Blocks 379, 380, and 395. Old San Diego.

1981 Historical Evaluation of the Sunset Street Property, Lot 1, Block 394, Old San Diego.

EXHIBIT 176

THOMAS BUSCHATZKE
City of Phoenix Law Department
200 West Washington, Suite 1300
Phoenix, Arizona 85003-1611
(602) 495-5874

Education

28 credit hours in Master of Science program in geology at Arizona State University, 1978-1982

B.S. Geology, State University of New York, May, 1977.

Experience

City of Phoenix Law Department, Phoenix, Arizona. Hydrologist in the Civil Division of the Law Department. Provide hydrologic, technical and administrative expertise to the Law Department and city management regarding all aspects of the City's water rights, water supply and water use. Major responsibilities include the Gila River general stream adjudication and the establishment of water rights and use for a new water appropriation to be developed by Modified Roosevelt Dam. 3/17/88 - present.

State of Arizona, Department of Water Resources, Phoenix, Arizona. Began as Water Resources Specialist and progressed to Water Resources Program Supervisor. Highest level of responsibility included the development and publication of Hydrographic Survey Reports on watersheds within the Gila and Little Colorado Rivers and on Indian reservations. These reports contained hydrologic, technical and water rights data as part of the technical assistance rendered by the Department of Water Resources to the courts for the general stream adjudications. Collected, compiled and analyzed data for inclusion in those Hydrographic Survey Reports at varying levels of responsibility in positions leading up to Water Resources Program Supervisor. 2/84 - 3/88

Bureau of Reclamation, Arizona Projects Office, Phoenix, Arizona. Water Rights Examiner responsible for examining eligibility for Central Arizona Project allocations. 1/84 - 2/84.

Arizona Department of Water Resources, Phoenix, Arizona. State Service Intern responsible for verification and determination of the extent of grandfathered groundwater rights within the Phoenix Active Management Area. 2/82 - 12/84

Woodward-Clyde consultants, San Diego, California. Responsibilities included investigation and classification of soil samples for engineering properties in a laboratory, logging drill cores in the field and performing in-situ soil density tests. 5/79-8/79

Soil Mechanics Drilling Corp. Seaford, New York. Geologist responsible for measuring groundwater levels and mapping the groundwater table, performing percolation tests, logging drill cores, mapping stratigraphy using soil and rock samples, performing in-situ soil density tests and investigation of potential sites for preparation of job bids. 1/78 - 8/78

Professional Affiliations

American Water Resources Association

EXHIBIT 177

IN THE DISTRICT COURT OF THE THIRD JUDICIAL DISTRICT OF THE TERRITORY OF ARIZONA, IN AND FOR THE COUNTY OF MARICOPA.

PATRICK T. HURLEY, *Plaintiff*, THE UNITED STATES OF AMERICA, *Intervenor*, Against CHARLES F. ABBOTT and Four Thousand Eight Hundred Others, *Defendants*.	No. 4564 DECREE.

This cause having come on regularly to be heard upon the complaint of the Plaintiff, the Petition in Intervention and Cross Complaint of the United States of America, and upon the Pleas and Answers of various defendants herein, and upon the default of certain defendants in appearing and answering; the Plaintiff appearing herein by Messrs. Joseph H. Kibbey, and Roy S. Goodrich, his attorneys, The United States of America by Mr. J. L. B. Alexander, United States Attorney for the Territory of Arizona, and various defendants by Messrs. Anderson & Anderson, C. F. Ainsworth, Thomas Armstrong, Jr., A. C. Baker, Walter Bennett, Alexander Buck, Lysander Cassidy, Chalmers & Wilkinson, Christy & Lewis, E. S. Clark, Frank Cox, J. W. Crenshaw, J. K. Doolittle, E. B. Goodwin, P. H. Hayes, J. M. Jamison, W. J. Kingsbury, J. H. Langston, A. D. Leyhe, Reese M. Ling, Frank H. Lyman, B. E. Marks, O'Neill & McKean, J. C. Phillips, Thomas J. Prescott, C. H. Rutherford, G. W. Silverthorn, and Charles Woolf, their attorneys, and the Court having heard the evidence and the proofs, and having duly considered the same and being fully advised in the premises and having filed its decision in writing herein, with accompanying tables,

IT IS ORDERED, ADJUDGED AND DECREED, That the various parties hereto, and their successors in interest be, and they hereby are, entitled to divert or to have diverted from the water flowing in the Salt River to and upon the land owned or possessed by them as their interest may appear, for beneficial use upon such land, such amount of water as may be necessary and proper for the economical and successful irrigation and cultivation of such land, in area and extent, and in duration, and according to the relative rights in priority of appropriation, and in the amount, manner and form as shown, set forth and determined in the following decision herein of this date, and the tables annexed thereto, which decision and accompanying tables are hereby made a part of, and are to be considered as incorporated in, this Decree and to which reference is hereby made for exact and particular description and provision,

AND IT IS FURTHER ORDERED, ADJUDGED AND DECREED, That Frank P. Trott, be and he hereby is appointed Commissioner of this Court to execute and to carry out the provisions of the decision and decree herein, with the powers and duties as in said decision more fully set forth, subject at all times to the control and supervision of the Court, and the said Commissioner shall be paid as compensation for his services by the owners of the land, through the canal agencies serving them, the amount and in the manner as in said decision specified.

The Plaintiff and the United States of America, intervenor, shall each recover as against the defendants their costs to be taxed.

The Court retains jurisdiction of the cause and of the issues embraced herein and, upon good cause shown, may from time to time modify, enlarge, or abrogate any portion or feature of this decree, or of the decision and tables filed herewith as a part hereof, by order or supplemental judgment or decree to be entered at the foot hereof.

This Decree, and the Provisions of the Decision herein, shall become effective on and after April 1st, A. D. 1910.

Dated, Phoenix, March 1, 1910.

EDWARD KENT,
Judge.

IN THE DISTRICT COURT OF THE THIRD JUDICIAL DISTRICT
OF THE TERRITORY OF ARIZONA, IN AND
FOR THE COUNTY OF MARICOPA.

PATRICK T. HURLEY, *Plaintiff*, THE UNITED STATES OF AMERICA, *Intervenor*, Against CHARLES F. ABBOTT and Four Thousand Eight Hundred Others, *Defendants*.	**DECISION**

The Salt River Valley, so-called, is an alluvial plain, nearly level, lying in the central portion of the Territory of Arizona, the soil of which, when supplied with sufficient water, is extremely fertile. Its approximate length from east to west as far as the Agua Fria river is thirty-five miles; its average width fifteen miles. The climate is arid with but a slight rainfall, and artificial application of water to the land is necessary in order for the successful growth of agricultural products. Entering the valley from the northeast is the Salt river, a non-navigable stream. Into the Salt river and just before its entrance into the valley, flows the Verde river; the Salt river, after such conflux, empties into the Gila river in the southwestern part of the valley. In the valley are located the city of Phoenix and the towns of Tempe, Mesa, Lehi, Scottsdale, Peoria, Glendale and Alhambra; and these places and the farming country lying east of the Agua Fria river tributary to them are irrigated by water diverted from the Salt river by means of canals. The river is subject to very great variations in the amount of water flowing in it; from time to time there is a large volume of water in the river, more than adequate for the irrigation of all the land hitherto attempted to be cultivated; for the greater part of the year the supply is inadequate for such cultivation.

The land shows evidence of cultivation in prehistoric times by irrigation from the same source as at present. Cultivation in recent times began about the year 1869. From the cultivation of a few hundred acres in 1869, the area of such cultivation in the valley has increased until at the present time there are approximately 151,000 acres attempted to be cultivated from water diverted from the Salt river at various points of diversion on the river at or above the "Joint Head" hereinafter described. Although all the water flowing in the Salt river is, in the lower stages of the water in the river, diverted by canals which have their heads at such points in the river, nevertheless additional land lying to the westward, not covered by the ditches aforesaid, is irrigated by means of ditches which have their heads in the river below the Joint Head. This is made possible by the peculiar conditions which obtain in the river whereby, though dry above, water rises in the channel of the river below, forming a new source of supply independent of that diverted above. Such additional land and the relative rights of such land or the owners thereof to water for irrigation purposes are not included within the issues of this suit.

The canals serving the land embraced in this suit lying to the north of the river are the Salt River Valley Canal, the Maricopa, the Grand, and the Arizona; those serving land embraced in this suit lying to the south of the river are the Tempe, the Broadway, the San Francisco, the Utah, the Mesa, the Highland, and the Consolidated. A general map showing the river, the land in question, and the means of diversion thereto of the water supply, is attached hereto, marked Map No. 1.

Of the canals on the north side, the canal now known as the Salt River Valley Canal is the oldest of those now in service; it was commenced in the year 1867 and was originally known as the Swilling ditch. Its head was at a point about five miles east of the present site of the city of Phoenix. The slope of the land on the north side of the river being generally to the southwest, this canal in general serves the land lying to the south and west of its course—approximately 19,000 acres.

Some time after the construction of the original Swilling ditch, it was extended and a branch was taken from it at a point about two miles below its divergence from the river, and constructed to the north and west, and became known as the Maricopa canal, serving in general land lying between it and the Salt River Valley canal, approximately 18,000 acres; the head of this canal in the river is the same as that of the Salt River Valley canal, and is known as the "Joint Head."

In 1878 construction was begun of the Grand canal, which had its head on the river at a point about three miles above the Joint Head, serving land lying between it and the Salt River Valley canal, approximately 17,000 acres. After the great flood of the year 1891, the head of the Grand canal was discontinued and the Grand canal thereafter received its water from the Arizona canal by means of a cross-cut therefrom.

In 1883 the construction of the Arizona canal was begun. The head of this canal was above that of all the other canals in the valley at a point some twenty-eight miles east of the city of Phoenix. The Arizona canal is the most northerly of all the canals and serves land lying between it and the Maricopa canal, and also some land on the north side of the river east of the Grand, Maricopa, and Salt River Valley canals, in all approximately 38,000 acres.

Water is also diverted from the river by means of the Arizona canal and conveyed through the cross-cut to the Maricopa and Salt River Valley canals, thus adding to the supply of the two latter canals over and above that taken by them from the river at the Joint Head.

On the south side of the river the first canal constructed was the Tempe irrigating canal, begun in the year 1870, its head being at a point on the south side of the river about nine miles above the Joint Head. This canal serves the land lying under it and its various branches, approximately 24,400 acres.

A small ditch called the Broadway was taken out about 1870, with its head originally about four miles west of the Joint Head. The head, however, was abandoned about twelve years ago, and since then the land for which the canal was originally built, approximately 450 acres, has been served partly by an extension of the original Broadway ditch, receiving a part of the water through the Tempe canal (which water for more than the year last past, however, has been carried by the San Francisco canal), and partly through the Marmonier or French ditch, which latter ditch has its head below the Joint Head.

About that time a canal known as the San Francisco canal was also constructed, with a head about a mile and one-half above the Joint Head, serving land under it similarly situated, approximately 4,000 acres. An independent head for this canal has long since been discontinued and it receives its water through the Tempe canal.

In 1877 the Utah canal was constructed, with a head about five miles above the head of the Tempe canal, and it, together with the extension thereof afterwards built, serves land under it, approximately 11,200 acres.

In 1878 the construction of the Mesa canal was begun, which had a head in the river about two and one-half miles above the head of the Utah canal, and it serves land under it, approximately 16,400 acres.

In 1888 the construction of the Highland canal was begun, with a head about three miles above the head of the Mesa canal, and it serves land lying under it similarly situated, approximately 425 acres.

In 1891 the construction of the Consolidated canal was begun, with a head about three miles above the head of the Utah. It serves land under it approximately 2,300 acres.

In the year 1874 C. T. Hayden, a shareholder in the Tempe Canal Company, erected a flour mill at Tempe on the banks of the Tempe canal, and by an arrangement with the other shareholders of the Tempe Canal Campany, had supplied to him through that canal water sufficient to operate his mill, being a maximum amount of water equal to a flow of 1,100 miners' inches. Since that date this mill has been continuously so served.

In the year 1887 a suit was begun in this Court entitled M. Wormser and others against the Salt River Valley Canal Company and others. It was a suit instituted for the purpose of enjoining certain parties to it, owners of the canal systems, from the diversion of the water from the Salt river in derogation of the rights of the plaintiffs. The purpose of such suit and the reasons for it, historically applicable to this present suit, are set forth in the following extract from the opinion of Judge Kibbey rendered therein in the year 1892:

"The earlier efforts of the settlers under these older ditches toward cultivation was confined to the production of hay and grain, and a few garden vegetables, the cultivation of which was confined to that period of the year when the water in the river was very abundant. As the settlement became older and its population increased, a more extended cultivation began to be undertaken. Instead of confining themselves to hay and grain, as above mentioned, the ranchers gradually began the planting and cultivation of alfalfa, fruits and vines, which required water during the entire year. Under the conditions as they originally existed, and as is usual in such cases, there were many usurpations and concessions of rights to the diversion of water, unnoticed at the time, or, if noticed, tacitly and without objection acquiesced in because of the then abundance of water. As the population increased and with it the more extended form of cultivation, a deficiency in water began to be noticed. While the river during the months in which hay and grain and the ordinary agricultural crops are being grown had in it a vast volume of water, this volume diminished with the advance of the season, from thousands of cubic feet per second to about, at a minimum of, three hundred cubic feet per second, and as both the increase of population and the different products to which the land was cultivated increased, the demand for water in the summer months, when the supply is the least, aggravated by an unnecessary and very considerable waste of water, exceeded the supply. This deficiency of supply made at once the question of priority of right to appropriate water, important, and that question is the subject matter of this suit."

In that case Judge Kibbey, after setting forth at length the facts in the case, in an exhaustive and able opinion covering the questions of law that arose therein, held that, as the parties to the suit, as was disclosed by their pleadings, had proceeded on the theory that an association of individuals or a corporation may become entitled to divert from a natural water course a definite quantity of water, and that this right depended, not on the fact that the constituent members of an association or corporation had for the water a beneficial use, and applied it to that use, but that the right and title to divert depended on the amount that they had been actually accustomed to divert, there was an omission to make that particular proof of the rights of individual appropriators upon which the right of diversion necessarily depended; and that under the pleadings and evidence in the case no attempt could be made to define the rights of individual appropriators, since an attempt to define in such suit the rights of individual irrigators would not operate as an adjudication thereof. The findings of fact in the case were therefore confined to a determination of the amount of land from time to time brought under cultivation and supplied by the various canals and ditches, and a table was prepared showing the number of quarter sections of land brought into cultivation under the various canals from time to time from the year 1868 to and including the year 1889, the determination in the case being expressly confined to the rights of the several owners of the canals and not to a determination of the rights of individual customers of such canal companies. The Court decreed that the amount of water which the various canal companies were entitled in each year to divert from the Salt river by means of their several canals and dams, was the amounts necessary under proper methods of irrigation to cultivate and irrigate the number of quarter sections set forth in such table, but did not find the amount of water actually necessary for such cultivation.

Whatever may have been the legal effect of the decree entered in the Wormser suit, there was no effective attempt to enforce it or to distribute water according to its terms. Even prior to its rendition an agreement was entered into by the various canal companies whereby the parcels of land as found by such decree to be entitled to water lying under the Tempe and San Francisco canals should receive water for their irrigation to be diverted from the river by the Tempe canal according to the dates of the reclamation thereof, and in the amount of sixty-four miners' inches to the quarter section measured at the head of the canal. The balance of the normal flow of water in the river at its various stages was divided among the various canal companies in accordance with the terms of the agreement entered into by them independent of the various dates of reclamation of the land lying under the canals as such dates were found in the Wormser decree. Since such agreement the water in the river at its various stages up to 60,000 miners' inches has been distributed theoretically under the provisions of this decree, but practically and actually under the agreement entered into by the canal companies as just stated.

To this agreement and to this distribution of the water protest has been made from time to time since the rendition of the Wormser decree, by individual land owners not content with the action of the canal company serving them with water in that regard, and various suits have been instituted from time to time in this Court to test the validity of such distribution of the water under such arrangement, none of which suits have ever come to final judgment, and one of which, at least, is still pending awaiting the determination of this proceeding.

In the year 1903 the United States Government, acting by the authority of Congress under what is known as the reclamation act, commenced the construction of an impounding dam, known as the Roosevelt dam, upon the Salt river just below the conflux of Tonto creek with the Salt river, at a point about seventy-five miles east of the city of Phoenix, for the purpose of storing the waters of the Salt river in a reservoir at that point. This dam, now rapidly approaching its completion, will be approximately 280 feet in height above bedrock, will create a reservoir lake of some twenty-five miles in length and an average of more than one mile in width, and will impound approximately 1,300,000 acre feet of water. The height of the dam is already sufficient to impound at present a large body of water, and its completion is expected within the next few months. The object of the dam and the purpose of the Government in its erection is to store in the reservoir the surplus water in the Salt river over and above the amount of the normal flow of the river appropriated and used. The Government also finished the construction in the year 1908 of a permanent diversion dam across the Salt river known as the Granite Reef dam at a point about twenty-five miles east of Phoenix, three miles below the conflux of the Verde river, from which dam water is now being diverted into the Arizona canal for the use of the land lying on the north side of the river, and which now diverts a large portion and which is capable of diverting all of the water necessary for the land on the south side of the river.

An association of land owners known as the Salt River Valley Water Users Association was formed, comprising nearly all the owners of the land lying on the north side of the river embraced in this suit, capable of irrigation, and the owners of a majority of all the land lying on the south side of the river. The owners of a large majority of the land lying under the Tempe and San Francisco canals, however, have not joined the association. By contracts between the Government and the members of the water users association, the latter will be entitled to receive for their land their proportionate share of the surplus water that may be stored by the Government in its impounding reservoir. Those not in the association will have no contractual rights with the Government with respect to the water thus impounded.

In the year 1905 this suit was instituted by the plaintiff, P. T. Hurley, he claiming to be an early appropriator of water, and asking to have his title quieted to the use of an amount of water sufficient to cultivate the land owned by him. He made as defendants in the suit a large number of other individual land owners in the valley. After the commencement of the suit, the United States, having acquired the possession and ownership of the canals on the north side of the river, and being interested in its capacity as guardian of a number of Indian settlers on the reservations situated in the valley, by leave of Court first obtained, intervened as a party in the suit and filed its answer and cross complaint, and sought and obtained process to make party defendants to its cross complaint all land owners in the district in the valley irrigated by the canals above mentioned, and prayed for a judgment establishing the rights of each individual defendant and each parcel of land to the water in the river, and the establishment of the various dates of appropriation of water by each individual land owner. These various individual land owners, some four thousand eight hundred in all, were served with process in the suit, and evidence has been taken before the Court respecting the duty of water and the dates of reclamation of the various parcels of land in the irrigable district in the valley in question from the year 1869 to and including the year 1909, the testimony being taken intermittently during a period of two and one-half years. The case is now before the Court for adjudication.

The purpose of this suit is to obtain a judicial determination and definition of the rights of the various parcels of land and the owners thereof under the various canals above mentioned in and to the use of the water flowing in the Salt and Verde rivers. For a complete and effective adjudication of such rights it is necessary not only to determine the date of appropriation of the water to each parcel of land, but also the amount of the water appropriated and the relative right of each parcel to the other.

The doctrine of riparian rights does not obtain in Arizona. The right of the owner of land to divert from a natural non-navigable stream the flow of the water therein and to apply the same to beneficial use upon such land, is and always has been recognized in this Territory. Such diversion and use is termed an appropriation of water. Whatever may be the steps necessary to take to initiate such a right or to evidence the intent to initiate it, the appropriation itself only becomes complete and vested when the water is actually diverted from the stream and placed to a beneficial use upon the land. The right given by such an appropriation is strictly not a right to the water itself, but a right to the use of the water. Its application to a beneficial use upon the land is as necessary in order to complete the right as is the diversion thereof from the stream. An appropriation of water, therefore, for the purpose of the irrigation of a parcel of land may not be established and completed by means merely of a declaration of intention or by the posting of notices of appropriation, nor may it be made by a canal owner or by a canal company as such alone, independent of its ownership of the land; but as application to a beneficial use upon the land is necessary to complete the appropriation, it follows that such appropriator must be an owner of land or have a possessory right thereto. Furthermore, since the land to which the water is to be applied is a necessary integral part of the appropriation and a factor by which the amount of the water appropriated for use is measured, it follows that when the water is no longer applied to the land for which it was diverted, the right of appropriation of such water for such land ceases. The right of appropriation further depends upon a supply of water that is unappropriated. It follows, therefore, that the first in time of appropriation is the first in right to appropriate, since water previously appropriated by another is no longer available for a subsequent appropriator. The extent of the appropriation is limited by the beneficial use to which the water can be applied. The actual amount of water that may be appropriated for irrigation, therefore, is the amount that the land owner can and does actually use in the necessary and economical irrigation of his land for cultivation. This much and no more may he have; and this much he may only have when there is sufficient water available to supply first those prior in date of appropriation. The fundamental principle in the doctrine of appropriation of the normal flow of water in a stream for irrigation is its application by the land owner to the land for a beneficial use. The right to appropriate is a right that belongs to the land owner, but the water appropriated is appropriated for the land, and when so appropriated its use belongs to the land and not to the appropriator. The method of diversion from the river and the means of carriage of the water to the land is immaterial in the establishment or maintenance of the right; it may be done by the individual appropriator or by an association of individual appropriators, or by a canal company, or by any person or corporation; and the means of carriage or the point of diversion from the river may be changed from time to time to suit altered conditions without impairing the right of appropriation already made, provided prior rights of others are not interfered with. There being in this Territory no private property in water, but water being a public property subject to the uses before defined, in so diverting and carrying the water such person, association or corporation acts merely as the agent of the appropriator and acquires no right of appropriation to the water itself, and no rights as against the appropriation made to the land, except a right to proper compensation for such diversion and carriage.

Applying these general principles to the case in hand, it follows that the dates of the reclamation of the land and its first cultivation by the means of water diverted to the land by the land owner, must determine the date of the appropriation in each instance; that each appropriator in turn and prior to the one next succeeding him is entitled to have diverted and applied on his land a quantity of water sufficient for the economical cultivation thereof and no more, until the supply available shall have been exhausted, provided the use of such water on his land shall have been reasonably continuous.

The various dates of the application of water to the land, the amount of water necessary for the economical cultivation thereof, the duration of such cultivation, and the supply of water available, are therefore interstitial facts affecting all questions arising in the case.

A great amount of testimony has been taken as to the dates of application of water to the various subdivisions of land lying under the canals, and the results obtained have been checked in such ways as were possible. The results showing the years in which each piece of land was brought into cultivation have been tabulated, and it is believed are as accurate as is practicably possible in a history which covers so great a period of time and so great an acreage. In each instance where a land owner has brought into cultivation in a given year a portion only of a section or subdivision of a section of land owned by him, but with the intention of speedily reclaiming the balance, and he or his successors in interest subsequently and within a reasonable time have brought the balance of such land into cultivation by irrigation, and such cultivation has been kept up, I have under the doctrine of relation fixed as the date of the appropriation for the whole tract the date of the first cultivation of the part.

Testimony has also in each instance been given as to the duration of cultivation. While in the main correct and accurate, it is my belief that in a number of instances the facts as to the duration and extent of the cultivation of the land have been exaggerated. So far as possible the testimony given has been compared with other reliable data and in a few of such instances the testimony given has been disregarded as undoubted error.

The amount of water flowing in the river varies greatly in each month in the year, in each year, and in a given month in each year. No accurate or probable estimate of the amount of water that will be available either by the month or by the year can be predicted. A table compiled from the records that have been kept by the water commissioner for the past fourteen years, showing the monthly average and the annual precipitation of rain and the daily average amount of water by months and by years that has been received by the canals from the river, is hereby made a part of this decision and filed herewith, and designated as Table No. 1.

By the "normal flow of the river," as that expression is used in this decision, is meant the flow of water in the river at its varying stages available for appropriation. The maximum normal flow is the total amount to be diverted from the river for the cultivation of all the parcels of land to which water has been appropriated. By "flood water" is meant water flowing in the river over and above the maximum normal flow. By "surplus water" is meant the flow of the river, both normal and flood, not needed or used. By "stored water" is meant the water impounded in the Roosevelt reservoir.

The actual maximum normal flow is the total amount to which the land is entitled, as shown by the table hereinafter referred to, plus the estimated loss in carriage, and amounts in all to approximately 58,000 miners' inches. The total practicable carrying capacity of all the various canals is roughly 87,000 miners' inches. The practical carrying capacity of the Tempe canal, through which is diverted the water supplying the parcels of land generally not in the water users' association, and therefore not to be entitled by contractual relations with the Government to the benefits of the stored water, is roughly 16,000 miners' inches.

The amount of water necessary for proper and economical irrigation and cultivation of a given amount of land is perhaps the most difficult of satisfactory solution of all the numerous questions arising in the case. The views expressed by the various witnesses are widely divergent. Theoretically for many years last past, under the agreement as to diversion, the land entitled to water under the Tempe and San Francisco canals has been supplied therewith upon a basis of 64 miners' inches constant flow to each quarter section, measured at the head of the Tempe canal. In reality the land has not had any such fixed quantity nor its equivalent. At times it has had more, at times less. For the greater part of the time more land in the valley has been attempted to be cultivated than the water available would supply. Under the distributing agreement before referred to, land older in cultivation and prior in right shared with later land the supply of water available during the low stages of the river, and each had diverted for large portions of many years less than the equivalent of the 64 miners' inches. No record extending over any appreciable period of time has ever been kept as to the effect of a given amount of water on a given amount of land, nor has the amount of water required for a given amount of land been determined by any series of experiments with any constant or varying quantity of water. The character of the soil differs in different parts of the valley, some land requiring more water by reason of its character than other land of a different soil. These differences in soil are not in land lying in defined boundaries and thus perhaps susceptible of differentiation, but are found all over the valley in such position and placement as to make it impracticable to segregate them. The amount of water necessary successfully and economically to cultivate a given product, such as alfalfa, is greater than that necessary for another, such as grain; and so through a long list of various products. These products are likewise scattered throughout the valley and are not embraced each within its own separate confines. The duty of water, by which expression I mean the amount of water necessary for the successful and economical cultivation of the land, in reality, therefore, differs with the different crops and with the different soils to be found in the valley under the conditions as they exist. But one standard, however, can be taken, since the variations as to crops and soil cannot practically be followed by a varying standard as to the duty of water dependent upon such variations of crop and soil; nor can the matter of the amount required be left to the judgment and demand of the individual land owner dependent upon the crop he may plant. To avoid confusion and to promote a certainty of division and distribution of the water, the standard to be taken must be determined by the Court, and must be such as will apply to all land and all crops, and which, while it will permit by economical use of sufficient water for the cultivation of the land in great part at least to the crop requiring the most water, will still be not too much for the land owner who intends to cultivate a portion of his land to the crop requiring a less amount of water. Such a standard, while perhaps not permitting of a precise conformity with existing conditions, can for the present at least experimentally be tried, and hereafter changed as it may be found to be inadequate or too great. I believe that 48 miners' inches constant flow to the quarter section of land, measured and delivered at the land, is sufficient under ordinary conditions for the proper, economical and successful irrigation of the average product as grown in the district. I therefore fix upon and determine such to be the duty of water for the purposes of this case, subject, however, to an increase or decrease of such standard upon application to the Court in this suit hereafter as conditions may require and develop after due trial of such amount as such standard.

When practicable, measurement of the water to be delivered should be made at the entrance of the lateral to each quarter section. When such measurement cannot be so made, and until so made, the measurement shall be made at or near the point of diversion of the water from the river, except as hereinafter provided. When the water is not measured at the land, there must be added to the 48 miners' inches constant flow found to be the amount necessary for the cultivation of a quarter section of land, an amount necessary to cover the loss from evaporation and seepage from the point of diversion from the river to the land. Like the duty of water, this estimated loss by evaporation and seepage has not been determined in this valley by any series of experiments or otherwise. In fixing upon an amount to be added to supply such loss by evaporation and seepage, I am guided by the testimony as to the use of water in the valley in the past, by expert testimony, and by testimony as to experiments made elsewhere. Taking into consideration the average flow in the canal, the different seasons of the year, the wasteful ordinary open earth channel now in use, the extent of the area exposed to evaporation and the greater loss by seepage in the laterals, and the fact that the loss also applies to the water to be added, it is believed that one per centum added for each mile of carriage from the point of diversion from the river at the head of the canal to the termination of such canal in its main course, will approximately supply the loss by evaporation and seepage in the volume of the water so delivered for general distribution. Until the further order of the Court, and until such amount which is hereby fixed upon shall be found to be inadequate or too great, to the water to be diverted to each canal for use upon the land under it entitled thereto when measured at the head of the canal, there shall be added for loss by evaporation and seepage one per centum of the amount of water diverted for each mile of such canal length in its main course.

The main course of a canal as here used is defined to be its course from its head to the point where the canal ceases to be a main canal and becomes in effect a distributing lateral.

The water for the land on the north side of the river is supplied through the Arizona canal and the Joint Head, and the land so supplied forms one system. The length of the Arizona canal in its main course is 36 miles, and this is also approximately the length in main course of the canals of the Grand, the Maricopa, and the Salt, measured from the head of the Arizona canal. To ascertain the amount of water to be delivered for this system, therefore, when measured at the head of the Arizona canal, there shall be added one per cent of such amount for each mile of such length of canal, to-wit, 36 per cent. The length of the Maricopa and Salt River Valley canals from the Joint Head to the end of their main course is 6 miles. For water diverted at the Ioint Head there shall be added one per cent for each mile of such carriage, to-wit, 6 per cent.

On the south side of the river the land lying under the various canals is served by the canals independent of each other. The land, therefore, does not form one general system, but there are several systems, each under separate canals. The Utah, the Mesa, the Consolidated and the Highland canals no longer maintain independent heads. The water for these canals is diverted from the river at the Granite Reef dam. The water for these canals, to which the land lying under them is entitled, is to be measured at the Granite Reef dam until a system of measuring at the land is adopted. The amount to be added to the water diverted and measured to these canals for loss is therefore to be determined by the distance from the Granite Reef dam to the end of the main canal of each of these systems. This distance is found to be for these canals as follows:

The Utah, 15 miles. Amount to be added, 15 per cent.

The Mesa, 14 miles. Amount to be added, 14 per cent.

The Consolidated, 21 miles. Amount to be added, 21 per cent.

The Highland, 7 miles. Amount to be added, 7 per cent.

The Tempe canal maintains an independent head and diverts a portion of the water it carries through such head. The water so diverted is to be measured under present conditions at the present place of measurement, to-wit, a point about three hundred yards below its present head gates. To the water so diverted and measured the amount to be added for loss in subsequent carriage is to be determined by the distance from such place of measurement to the end of the main canal. This distance is hereby fixed upon as 11 miles, and the amount is, therefore, 11 per cent. A portion of the water for the Tempe canal, by a determination of Court heretofore had, has been diverted in the past at the Consolidated Head (and recently at the Granite Reef dam) and carried to the Tempe canal through the Tempe cross-cut from the Consolidated canal. So long as this method of diversion and carriage is maintained the portion of the water for the Tempe canal so diverted and carried shall be measured in such cross-cut at the place of measurement heretofore maintained, to-wit, a point about one-third mile above its junction with the Tempe canal. The amount to be added to such water for loss in subsequent carriage is to be determined by the distance from such measuring station to the end of the main canal. This distance is hereby fixed upon as 11 miles, and the amount is, therefore, 11 per cent.

The Broadway and San Francisco canals receive their water from the Tempe canal. The amount of water these canals are entitled to receive for the land lying under them is to be measured at the point of delivery to the San Francisco canal just below the Hayden mill. The amount to be added for loss to such water in subsequent carriage is to be determined by the distance from such point of measurement to the end of each of their main canals, respectively. Such distance is found to be, for the San Francisco canal, 8 miles; for the Broadway canal, 10 miles, and the amount is therefore 8 per cent and 10 per cent, respectively.

One of the essentials to the establishment of a continuing right to the use of water is a reasonably constant use. The evidence in the case shows that with respect to a large body of the land in question cultivation by irrigation has been continuous year by year from the various dates of the first reclamation of the several parcels down either to the present time or to a time sufficiently near to the present time as will permit of a determination with reasonable certainty as to the intention of the land owner with respect to a continuing cultivation. In many other instances the evidence shows that though such cultivation may not have been carried on in each and every year, the cultivation has been reasonably constant to such time, and there has been no intent to discontinue definitely such cultivation. No distinction as to right of present use of the normal flow, except that of priority, is perceived between such various parcels of land. They are entitled according to their relative dates of reclamation, and by years, to the use of the normal flow of the water in the river to the extent necessary for their economical cultivation. They form a distinct class preferred in their rights to the use of such water over and above the other parcels of land in the suit. For the purposes of this suit they may be designated as land in class A. A description of these parcels of land listed by years of date of appropriation appears in tabulated form in the tables designated 2 and 3 hereto attached, being tables for the land on the North Side and South Side respectively; they include all land now being cultivated or upon which cultivation was continued to as late a date as during the year of 1903. Where land has been cultivated in the past, but such cultivation discontinued prior to the new date of appropriation under which it appears in the table, the dates of such prior cultvation will be found in the table under the column entitled "Remarks." This column also gives the last date of cultivation, so far as the proof before the Court shows, when such cultivation, though not to the year 1909, is later than the year of 1902.

The evidence shows that with respect to a large amount of land, water in the past was applied thereto and the land cultivated in some instances for one or two years and in other instances for a longer period of time, in some instances constantly, in others intermittently, but in all such instances cultivation of the land had entirely ceased for a number of years, and in every instance more than five years, prior to the beginning of the taking of testimony in this suit. A large portion of the land with this history was first brought into cultivation on the north side of the river shortly after the completion of the Arizona canal. and on the south side shortly after the completion of the Highland and Consolidated canals; some land with a similar history is also found under the older canals. Generally speaking, the cultivation of such land was begun during times of plenty and discontinued during times of scarcity of the flow in the river. The hope of a sufficient continuous supply of water was followed by the realization of the fact of insufficient supply. A financial loss was the certain result of an attempt to cultivate with insufficient uncertain supply of water for irrigation, and one by one, the supply of water failing to equal the necessary demand, cultivation of these parcels of land was discontinued. The failure of these land owners to continue after such appropriation to make a reasonably constant diversion and application of water so appropriated to their land came about, not of their wish to discontinue cultivation nor because there was not at certain seasons of the year plenty of water available for such cultivation, but because no certainty of supply could be counted upon at times when such supply was essential. Such appropriation of water by these land owners as was made was, speaking broadly, an appropriation, not of the flow of the river in its lower stages, for such flow had already been appropriated by others, but of the flow in the higher stages of the water in the river over and above the flow necessary for the cultivation of the land in class A, unavailable in the past to such land owners for practical and efficient continued use because of the lack of storage facilities, but now shortly to be available by means of the impounding dam constructed by the Government. Such parcels of land to which water has hitherto been applied for the purpose of cultivation, but upon which the use of water was definitely discontinued before the year 1903, and has not been since resumed. may be designated as land in class B, and appear in the descriptive lists of such parcels showing the duration of cultivation, hereto attached. marked 4 and 5, embracing the land on the North Side and South Side respectively. These parcels of land in class B having discontinued in the past the use of the water to which otherwise they might now be entitled by reason of the appropriation made for them. no new appropriation of later date having been made by a new and continued use of water upon the land, have no right that can now be established to the normal flow of water in the river appropriated by the land in class A. Their attempted appropriation. however. of the surplus water, discontinued because of lack hitherto of storage facilities, gives them equitably a preferential right over the land in class C (hereinafter described) in a right of application to the Government for stored water, where the owners of such land in class B are members of the water users' association, and by reason thereof may enter into contractual relations with the Government with respect thereto.

The third class of land is that which may be known as land in class C. It is such land as is situated within the irrigable district lying under the canals above mentioned, or their possible extensions, not included in classes A or B, upon which no cultivation has been had or as to which no appropriation or attempt at appropriation of the flow in the river at or above the Joint Head, has been made in the past. They are not entitled to the establishment of any right of appropriation in this suit.

The land in these three classes may be found upon the map hereto attached, marked Map No. 2, in colors as thereon designated.

By agreement entered into between the United States and the Water Users Association, the members of the latter, whether owners of land in classes A, B or C, are to be entitled to the benefits of the stored water in the Roosevelt reservoir, in such extent of acreage as the project shall serve. These benefits are to be formally obtained by those entitled thereto after the completion of the dam and upon the formal opening thereafter by the Government of this reclamation project, by contractual obligations then to be entered into by the members of the Water Users' Association with the Government. The stored water is to be distributed to those who shall have the right thereto, proportionally according to the acreage of the land, and irrespective of any priority of irrigation or cultivation of such land. Under the decision herein the owners of land in class A and in class B, because of the cultivation in the past of their land, and the facts as found, have a preferential right over the owners of land in class C to apply for and obtain from the Government a right to their proportionate share of the stored water needed by them. This preferential right to the owners of land in classes A and B is not a right to the water itself, nor does it give to those applying for and obtaining such right a priority in use or in extent of use to the stored water over owners of land in class C who may also apply and receive a similar right to the water. The preference given is merely and only that of a right to make application and have listed as sharers in the stored water the land in classes A and B before the owners of land in class C, whose land, if listed, will be listed subject to such prior right of application. Such priority of application, in order to be effective, must be availed of and be asserted both as to the owners of land in class A and the owners of land in class B within a reasonable time in order that certainty as to existing rights of all the land in the valley, as well to the surplus and stored as to the normal supply of water, may be speedily and definitely ascertained and determined. Such reasonable time is hereby fixed as one year from the formal opening by the United States Government of this reclamation project. Within such time all the owners of the land in classes A and B, in order to avail themselves of such prior right, must apply therefor to the United States Government or its reclamation officials in charge of this project, under such rules and regulations governing such application as shall be promulgated by such officials; and on and after such date all the parcels of land in classes A and B for which application for such stored water shall not have been made, or which for good cause shall not have had such application therefor granted, shall cease to have any such preferential right of application over and above the land in class C.

Attached hereto and made a part of this decision are a number of tables, the contents and purposes of which are as follows:

Table 6 is a table showing the acreage of land in classes A and B by townships and sections, followed by summaries thereof.

Table 7 is a table showing the acreage of land in class A on the North Side by townships and years of first cultivation under present appropriation.

Table 8 is a table similar to table 7, but for the South Side land.

Table 9 is a table showing the amount of the acreage of land in class A brought into cultivation year by year from 1869 to 1909, inclusive. In this table the first column shows the year of first cultivation, the second column the total acreage to such date and the increase in cultivation in that year, the third column similarly the acreage on the North Side, the fourth on the South Side, and the remaining columns such acreage under each of the various canals on the South Side.

Table 10 is a table showing the amount of water upon the basis established as the duty of water herein to which the parcels of land in class A lying on the North Side of the river, and the parcels of land in such class lying on the South Side of the river, and such parcels in such class under each of the canals lying on the South Side of the river, are entitled at the various stages of the river up to 45,325 miners' inches, the maximum amount necessary under such standard for the total acreage thereof. Such water in the river at its various stages of flow will be diverted for distribution to this land according to this table, subject to such graduation and interpolation thereof by the Commissioner as may be necessary, in the varying increase of the water, to give to the various parcels of land entitled to the increase their proportionate share thereof. When the flow in the river equals the maximum amount necessary for the irrigation of the total acreage of the land in class A, plus the loss for carriage, all such land, of course, can be supplied. When the flow in the river is less than the maximum amount, the amount available shall be distributed to the various canals for those parcels of land first entitled thereto according to their relative dates of priority by years as shown in the table. All flood and stored water shall be shared by those entitled to it, and who can avail of it, irrespective of dates of priority.

The amount of water in the river available for distribution is to be computed by taking the daily flow in the Verde river and adding thereto the amount of the daily flow in the Salt river. The daily flow in the Salt river shall not be impounded by the Government, by means of the Roosevelt dam, in the reservoir, except when the total intake in such reservoir, including the estimated loss thereto by seepage and evaporation between such intake and the conflux with the Verde river, added to the flow of the Verde river shall exceed the amount called for in table 10, plus the amount to be added thereto for loss by evaporation and seepage in the canals, unless at the request or with the assent of the users of such water whose land is entitled thereto; and no water user entitled thereto shall be deprived against his consent of his proportionate share of the normal flow of the river by reason of such impounding dam. The Government, in times of flood water, shall not by impounding water in the reservoir lessen the proportionate share of such flood water of any individual land owner not a member of the water users' association, and against his consent, nor shall it lessen the proportionate share of the Tempe and San Francisco canals, or of either of them, to such flood water available to such canals, so as to deprive such canals of such proportion of such flood water desired when the land lying under such canals is in need of such water or any portion thereof, and can avail of it, and when such canal company shall notify the Commissiooner of its desire to divert such water or any portion thereof. The various parcels of land in the valley in cultivation are entitled to share equally, according to acreage, in the use of the flood water available; the proportionate share in the flood water of the Tempe and San Francisco canals is therefore to be measured by their relative acreage under cultivation, since the share of the land under the other canals, listed in the association, in the flood water in the Salt river can now be stored for them in the Roosevelt reservoir. The acreage under the Tempe canal is found to be approximately 16 per cent of the total acreage in cultivation. The acreage under the San Francisco canal is found to be approximately 3 per cent of the total acreage in cultivation. The amount of flood water to which the Tempe and San Francisco canals shall be entitled to receive, as above stated, is, therefore, 16 per cent and 3 per cent, respectively, of the total amount of flood water available.

The officials of the United States Government in charge of the reclamation project, the reservoir, and the impounding and diversion dams hereinbefore mentioned, shall be at all times under the direction and control of the Court with respect to the impounding, diversion and distribution of the flow of the water in the river, and they shall make such reports, daily and otherwise, of existing conditions as shall reasonably be required by the Commissioner and as shall show the amount of the flow into the reservoir and in the river, and shall cause to be diverted into the various canals or otherwise such amount or proportion of the water as the Commissioner shall direct.

Frank P. Trott, Esq., long the efficient Water Commissioner of this Court, is hereby selected and designated as the Water Commissioner to execute and carry out the provisions of the decree herein. In the exercise of such duty the Commissioner is authorized to enter upon the reservoir and the impounding and diversion dams constructed by the Government, and their gates and appliances, and also upon the canals herein mentioned, their dams, gates, laterals, and other structures and appliances whenever necessary to ascertain existing conditions, or to control, supervise, or regulate the proper delivery, carriage, or distribution of the water to be diverted by the canals under the decision and decree herein, and is authorized to establish such measuring boxes, and to make such rules and regulations as may be expedient and proper to ensure the delivery, carriage, and distribution of the water in accordance with the rights of the persons entitled thereto, as found by the decision and decree herein. The managements of the various canals shall cause to be made to the Commissioner, daily or otherwise as he shall direct, such reports and information as shall show the amount of water in their various canals, and shall cause such measurements of such amounts to be made at such places as the Commissioner shall direct, as may be necessary to obtain such information, and shall make such changes in the measurement, carriage and distribution of the water as the Commissioner shall direct. The Commissioner shall report from time to time to the Court as directed, as to his action, and shall apply to the Judge of the Court for such further or specific directions as to his powers or duties whenever such directions shall be necessary or proper for the effective carrying out of the provisions of the decree herein. At any time any party to this suit, or any canal company acting as the carrier of the water distributed, may apply to the Court or the Judge thereof for an interpretation, modification, enlargement, or annulment of any order, direction, or action of the Commissioner in the carrying out of the provisions of the decree. The Commissioner shall receive for his services a salary in the sum of Three Thousand Dollars ($3,000.00) per annum, to be paid monthly on the first of each and every month on behalf of the parcels of land entitled to the regular flow of the river, by the owners of the canals, the carriers of such water to such land, or their successors in interest, and proportionately to the acreage served, as follows:

From the United States for the land on the North Side of the river	.608	thereof, to-wit	$152.00
From the Tempe canal for land served by it	.161	thereof, to-wit	40.25
From the San Francisco canal	.027	thereof, to-wit	6.75
From the Broadway canal	.003	thereof, to-wit	.75
From the Utah canal	.074	thereof, to-wit	18.50
From the Mesa canal	.109	thereof, to-wit	27.25
From the Highland canal	.003	thereof, to-wit	.75
From the Consolidated canal	.015	thereof, to-wit	3.75
Total	1.000		$250.00

The Commissioner shall keep an account of the necessary expenditures made by him in the proper exercise of his duty, and shall make a report of the same to the Court from time to time, and such expenditures, when allowed and approved by the Court, shall be paid by the various canal companies in the same relative proportion as the salary of the Commissioner is paid by them.

Until the further order of the Court or the Judge thereof, the Commissioner, in the execution of the decision and decree herein, shall not see to the actual application of the water to the various parcels of land entitled to it. He shall from day to day ascertain the amount of water available for distribution and the land entitled to it, according to the right thereto of the various parcels in the order of their priority as shown by table 10, and shall order and supervise the diversion to the various canals supplying such parcels of land, at such points in the river, and in such manner as shall most economically subserve, and as shall be expedient, the various amounts to which such parcels of land are entitled to have diverted at the various stages of the water available, as shown in the table. The actual application of the water to the various parcels of land entitled thereto shall be made by the management of the various canals in such manner and under such reasonable rules and regulations as to rotation and delivery as they shall establish, subject always, however, to the control and regulation of the Court. The Commissioner shall also, when necessary, similarly supervise and direct the diversion and distribution to the Tempe, San Francisco and Broadway canals of the flood water to which they are entitled.

All users of water and the agency by which such water is diverted and delivered for use, are restricted in the diversion, carriage, and use of the water to methods reasonably adapted to its conservation to the end that the water made free of use to the public shall not be wasted. The methods of application of the water to the purpose for which it is appropriated shall be of such a character as to insure as small a consumption of water as is reasonably consistent with the accomplishment of such purpose. Under the present method of diversion, distribution, and use of the water, there is in some instances an unnecessary loss of water. Whenever and wherever practicable, the Commissioner is directed to decrease such loss by causing more economical methods or means of diversion, carriage, distribution, and use to be adopted.

Whenever, for the economical conservation, diversion, or distribution of the water, it shall be desirable and expedient that the water to be delivered to any canal system for distribution to the land under it entitled thereto, be carried thereto from the point of diversion in the river for such delivery by another canal, or by a number of other canals, such canal or canals, upon a written order by the Commissioner, shall carry such water in its or their canals and deliver the same to the canal entitled to receive it for distribution, subject, however, to a payment by such latter canal of such proper charges for such diversion and carriage as may be agreed upon, or as shall be determined by the Court or Judge, but no such order upon any such canal company for such carriage shall be made by the Commissioner without the signed approval thereon of the Judge.

The Hayden mill has established a right to the use of water for power purposes only, dating from the year 1874, in a maximum amount of eleven hundred (1,100) miners' inches. The method of diversion and carriage of the water shall be such as will enable the mill, when the supply is sufficient, to make use of such water as it is entitled to.

For more than forty years the Indians living on the reservation on the north side of the river, known as the Salt River Reservation, in township two north, range five east, have had delivered to them from the river for the cultivation of their land 500 miners' inches of water, irrespective of the amount of water in the river, whether scarce or plenty, and such water has been measured and delivered to them for the last twenty years before the segregation and division of any water to other water users. This land has acquired a prior right over and above all others to this amount of 500 inches. The amount of land to which this water has been applied is about 2,500 acres. This amount of water is insufficient properly to cultivate this amount of land. The evidence shows that for the cultivation thereof at least 700 miners' inches is necessary. Strictly, the additional 200 inches necessary could be decreed to these lands only after others prior in right had received the water to which they are entitled. In consideration, however, of the fact that the 500 inches to which the land at low stages is entitled is not increased, even when at the higher stages of the river the land by its acreage and early date of reclamation might be entitled to more than such 500 inches, and in order to avoid the practical difficulty of a method of distribution which would combine a definite fixed quantity at all stages with a varying quantity given according to priority, by consent of all parties in the suit, 700 miners' inches of water is to be given the Indians for use upon these lands at all stages in the river, and prior to the distribution and diversion of the remaining water in the river, such water to be measured at the lateral ditch or ditches to such land at their point of diversion from the Arizona canal. Certain other parcels of land in this reservation not embraced in the area above mentioned. have also been put in cultivation from time to time by these Indians, but these parcels are not included in the area for which the 700 inches are appropriated, but form a part of the land in class B entitled only to the right to obtain water appertaining to the land in that class, and are found in the tabulated statement of such land.

For many years last past a number of Indians living on land within the Camp McDowell Indian Reservation, situated along the Verde river above its conflux with Salt river, have cultivated such land by means of water diverted from the Verde river. The extent of such cultivation is approximately 1,300 acres. The maximum amount of water to which this land is entitled is 390 miners' inches constant flow. As a matter of fact, for some years last past, because of the insufficient means of diversion of the water from the river, and for other causes, these Indians have not been able to divert from the river the amount of water necessary for the proper irrigation of the land. It is the expressed purpose and intention of the Government within the next year to remove these Indians from this reservation to the Salt River Reservation, and to have them settle upon land within that reservation to be irrigated by means of the proportionate share in the stored water in the Roosevelt reservoir, to which such land, as land in class B or class C may acquire the right to share. In the expectation of this change of domicile and discontinuance of use of water as at present made from the Verde river by these Indians, and until the further order of the Court upon application with respect thereto in this suit, if hereafter necessary, the present diversion and use of water upon the said land in the Camp McDowell reservation by these Indians may be maintained.

Evidence has been given in the suit with respect to the cultivation of land on the south side of the river in sections 25, 26, 27, 28, 29 and 35, township 1 north, range 2 east, and 30 acres in section 30, township 1 north, range 3 east. The facts show that the cultivation of these various parcels of land was either by independent ditches from the river not embraced in this suit or by waste water. There is no such evidence of appropriation of water to these parcels of land as will permit of an establishment of their right to water diverted from the river in the canals that have their heads at or above the Joint Head, to which the issues in this suit are confined. This land, as likewise other land in the western portion of the valley not embraced in this suit, has had, and may still be entitled to have, for its source of supply the water rising in the river below the Joint Head, which supply is not within the issues here. These parcels of land, however, while not, under the testimony, entitled to a decree establishing their proportionate right of water under class A, or their right to a preferred application under class B, where they have been or shall be listed in the water users' association and become thereby privileged to enter into contractual relations with the Government with respect to the stored water, are entitled to the rights appertaining to land in class C.

Water has been applied for a number of years upon several tracts of land otherwise uncultivated for rows of ornamental and shade trees growing thereon. Such an appropriation is a valid one. The evidence shows that under ordinary conditions of planting, water sufficient for five acres of land is sufficient for one mile of such rows of trees. In determining the amount of water to be delivered to such trees, such standard of measurement has been taken.

Proof has been given in this case and the fact established of an appropriation of water to the land described as southeast quarter of section 23, township 1 north, range 3 east, by means of a subterranean flow of water, independent of the water in the river, through a ditch leading from the source of such supply in section 20, township 1 north, range 4 east. The issues in this case being confined to the right to the use of the flow in the Salt river, no decree herein as to the right of this land to an appropriation of this independent subterranean flow can be given.

In addition to the owners of the parcels of land situated in the Salt River valley under these canals, there have been made parties defendant to this suit owners of parcels of land lying in the Verde valley, along the Verde river and irrigated by water from it, some fifty miles above its conflux with the Salt river. The demurrers and pleas to the jurisdiction interposed by these defendants have been overruled. No testimony, however, as to the exact extent of cultivation of the land in the Verde valley owned by these defendants or the dates of the reclamation of the various parcels of such land and the application of water thereto has been given. It is not possible, therefore, in this decree to establish the rights of such land owners and such land to the use of the water in the Verde river in relation to the rights to such water of the land in the Salt River valley. From the general testimony in respect to the cultivation in the Verde valley, it seems that such cultivation, though in actual point of time and relative date of priority, in some instances later than that of land in the Salt River valley, is not of sufficient area and acreage at the present time to interfere seriously with the prior rights, if any, of the land in the Salt River valley. Such being the case, it does not seem desirable to delay the promulgation of the decree herein to await such testimony, nor at the present time under existing conditions does there seem to be a necessity for a determination of such relative priorities, if any, of rights between the two widely separated areas of land. The owners of the land in the Verde valley are party defendants to this suit, and it is conceived that if hereafter conditions shall arise by increased cultivation or otherwise, which shall make it necessary for a determination of the rights of the land in the Verde valley to the water in the Verde river as against the rights of the land to which water is by the decree herein shown to be entitled, the necessary steps for such determination can hereafter be taken, and such rights and their relation to those hereby decreed may be established by a supplemental decree hereafter to be entered in this suit.

Evidence has been given of the existence of a number of pumping plants by means of which the supply of water from the river to which the land is entitled in times of scarcity is supplemented by an underground supply thus made available. In other instances water so pumped is the only means of supply. As there is no evidence that the water so pumped materially lessens the flow in the river, such rights as the land and the owners of such plants may have in the water so pumped will not be interfered with by this decree, but as the establishment of such rights, if any, is not within the issues herein, no finding will be made with respect thereto.

At the date of this decision the Highland canal has been definitely discontinued as a carrying canal, its place as such carrier having been taken by the Eastern canal, serving the land heretofore served by the Highland.

The unit of measurement of a miners' inch, as the expression is used herein, is defined to be one-fortieth part of one cubic foot of water flowing per second of time.

The standard of a given number of miners' inches constant flow as the duty of water is taken because of the familiarity therewith of the water users in the valley, and because I know of no other well-known adaptable standard of measurement. In practical and economical use of water for irrigation and cultivation, however, no parcel of land is given a constant flow, but the water for a number of parcels is given to each in rotation, thus giving a larger, a more serviceable and a more economical head of water.

The various tables and maps attached hereto have been prepared under my direction by the Water Commissioner, Frank P. Trott, Esq., who in many ways has been of material assistance to me in the preparation of this decision.

The decision and decree in this case, from the nature thereof, is of necessity a continuing one. The Court retains jurisdiction of the case and of the issues embraced therein. From time to time, as conditions may require an enlargement or modification of the decision and decree, application for such modification or enlargement may be made to the Court, and if granted, the same shall be entered at the foot of the decree herein.

In order to afford an opportunity to make such changes and such preparation as may be necessary to carry out and conform to the provisions of this decision and decree, the same shall not be effective as of this date, but the same shall be effective on and after April 1st, 1910.

Dated, Phoenix, March 1, 1910.

EDWARD KENT,
Judge.

TABLE No. 1.

A table showing the monthly average precipitation in Phoenix for fourteen years (from 1896 to 1909, inclusive) and the monthly daily average amount of water in miners' inches that was received from Salt River by the canals of Salt River Valley for the same periods of time.

MONTHS	Precipitation	Tempo, San Francisco and Broadway	Mesa and Consolidated	Utah	Mesa, Consolidated and Utah	Highland	Arizona and appropriators...	Joint Head..........	Total, less 500 for Indians.....	Total on the South Side......	Total on the North Side......
January	0.98	6,531	3,576	1,860	5,436	109	8,458	3,017	23,551	12,076	11,475
February	0.83	7,372	5,025	2,950	7,975	189	11,185	4,243	30,964	15,536	15,428
March	0.54	8,779	5,380	3,508	8,888	265	12,917	4,407	35,256	17,932	17,224
April	0.44	7,866	5,546	3,095	8,641	192	15,107	4,769	36,575	16,699	19,876
May	0.04	6,634	4,445	2,275	6,720	88	9,911	3,603	26,956	13,442	13,514
June	0.09	4,963	2,164	1,539	3,703	....	6,308	2,523	17,497	8,666	8,831
July	1.25	4,708	2,577	1,700	4,277	62	7,741	2,662	19,450	9,047	10,403
August	1.10	7,539	4,477	2,756	7,233	86	14,934	4,311	34,103	14,858	19,245
September	0.96	6,640	3,995	2,234	6,229	52	11,559	3,579	28,059	12,921	15,138
October	0.35	5,699	2,645	2,046	4,691	48	8,056	2,678	21,172	10,438	10,734
November	0.83	6,186	2,933	2,362	5,295	59	10,925	2,780	25,245	11,540	13,705
December	0.74	6,216	2,832	1,951	4,783	16	8,116	2,607	21,738	11,015	10,723
Average	0.68	6,594	3,800	2,356	6,156	97	10,425	3,432	26,714	12,847	13,867

TABLE No. 1 A.

A table showing the annual precipitation in Phoenix for fourteen years (from 1896 to 1909, inclusive) and the annual daily average amount of water in miners' inches that was received from Salt River by the canals of Salt River Valley for the same periods of time.

YEAR.	Precipitation	Tempo, San Francisco and Broadway	Mesa and Consolidated	Utah	Mesa, Consolidated and Utah	Highland	Arizona and appropriators...	Joint Head..........	Total, less 500 for Indians.....	Total on the South Side......	Total on the North Side......
1896	10.48	7,318	4,715	3,106	7,821	201	14,927	3,557	33,824	15,340	18,484
1897	9.87	7,100	5,625	2,680	8,305	428	12,272	4,881	32,986	15,833	17,153
1898	5.95	7,065	4,386	2,322	6,708	178	11,486	3,491	28,928	12,951	14,977
1899	5.19	6,050	2,481	1,968	4,449	43	8,958	2,800	22,300	10,542	11,758
1900	5.29	4,237	1,462	1,240	2,702	14	5,848	1,855	14,656	6,953	7,703
1901	4.87	6,580	3,871	2,695	6,566	175	12,411	2,559	28,291	13,321	14,970
1902	6.87	4,471	1,787	1,507	3,294	31	7,413	1,442	16,651	7,796	8,855
1903	6.61	5,441	2,419	2,110	4,529	33	10,094	1,723	21,820	10,003	11,817
1904	5.57	4,476	1,830	1,319	3,149	3	7,647	1,482	16,757	7,628	9,129
1905	19.73	6,498	4,035	2,040	6,075	33	7,109	3,035	22,750	12,606	10,144
1906	8.55	9,092	5,000	2,726	7,726	177	6,783	5,971	29,749	16,995	12,754
1907	8.17	7,881	5,125	2,883	8,008	....	10,291	5,895	32,075	15,889	16,186
1908	10.68	7,827	5,159	2,815	7,974	....	13,691	5,626	35,118	15,801	19,317
1909	6.17	8,286	5,297	3,579	8,876	45	17,154	3,727	38,088	17,207	20,881
Average	8.15	6,394	3,800	2,356	6,156	97	10,435	3,432	26,714	12,847	13,867

TABLE No. 2.

A descriptive list of Class A land on north side of Salt River.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Indian Land—				
SE ¼	20	2 N R 5 E	160	
S ½ of N ½	21		160	
S ½ of	21		320	
SW ¼	22		160	
W ½ of	27		320	
N ½ of	28		320	
N ½ of NE ¼	29		80	
E 13 a. of SE ¼ of SE ¼	29		13	
NE ¼	31		160	
S ½ of	31		320	
N ½ of	32		320	
Total acreage of the Indian land			2333	
Year 1869—				
N ½ of NW ¼	3	1 N R 3 E	80	
E ½ of	4		320	
SW ¼ of	4		160	
S ½ of	8		320	
E ½	9		320	
NW ¼	9		160	
S 120 a. of SW ¼	9		120	
E ½ of	10		320	
N ½ of NW ¼	10		160	
SW ¼	10		80	
All of	11		640	
60 a. in SW cor. of NW ¼	12		60	
S ½ of NW ¼	14		80	
NE ¼	17		160	
70 a. N of River in SE ¼	17		70	
NE ¼	33	2 N R 2 E	160	
Total			3210	
Year 1870—				
SE ¼	1	1 N R 2 E	160	
E ½ of NE ¼	13		80	
SW ¼	14		160	
SW ¼	5	1 N R 3 E	160	
SE ¼	7		160	
E ½ of SW ¼ and SW ¼ of SW ¼	7		120	
15 a. in NW cor. of NE ¼	16		15	
NW ¼	17		160	
NE ¼	18		160	
N ½ of SE ¼	18		80	
N ½ of NW ¼ and SE ¼ of NW ¼	18		120	
N ½ of SW ¼	18		80	
Total			1455	
Year 1871—				
S 50 a. of SW ¼	11	1 N R 2 E	50	
E ½	12		320	
NW ¼	12		160	
SE ¼ except 40 a. in River	13		120	
NE ¼ of NW ¼ and NE ¼ of NW ¼ of NW ¼	13		50	
SW ¼	13		160	
N 100 a. of NE ¼	14		100	

TABLE No. 2—(Continued.)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1871—(Continued)—				
SE ¼	14	1 N R 2 E	160	
NW ¼	14		160	
SE ¼ except 30 a. in NE corner	2	1 N R 3 E	130	
130 a. S of S. R. V. Canal in SW ¼	2		130	
NW ¼	4		160	
E ½	5		320	
NW ¼	5		160	
E ½	6		320	
80 a. N of Grand Ave. in NW ¼	6		80	
5 a. S of Grand Ave. in NW ¼ of NW ¼	6		5	
20 a. S of Grand Ave. in SE ¼ of NW ¼	6		20	
20 a. in E part of N. Capitol Addition	6		20	
N ½	7		320	
NW ¼	16		160	
30 a. N of River in SW ¼	16		30	
SW ¼	34	2 N R 3 E	160	
Total			3295	
Year 1872—				
S 70 a. of NE ¼	11	1 N R 2 E	70	
SW ¼	12		160	
SE ¼	16		160	
SE ¼	17		160	
NE ¼	20		160	
E ½ of NE ¼	3	1 N R 3 E	80	
SE ¼	31	2 N R 3 E	160	
E ½	32		320	
NW ¼	32		160	
E ½ of SW ¼ and NW ¼ of SW ¼	32		120	
S ½	33		320	
Total			1870	
Year 1873—				
E 60 a. N of River in NE ¼	25	1 N R 1 E	60	
E ½ of NW ¼	20	1 N R 2 E	80	
N ½	8	1 N R 3 E	320	
Total			460	
Year 1874—				
SE ¼	11	1 N R 2 E	160	
S 100 a. of NE ¼	16		100	
SW ¼ except 15 a. rough	17	1 N R 3 E	145	
Total			405	
Year 1875—				
60 a. S of Maricopa Canal in SE ¼	34	2 N R 3 E	60	
Total			60	
Year 1876—				
W ½ of SE ¼	2	1 N R 2 E	80	
SW ¼	2		160	
SW ¼	9		160	
NE ¼	10		160	
N 120 a. of NW ¼	10		120	
NW ¼	11		160	
SW ¼ except 10 a. rough	15		150	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1876—(Continued)—				
NW ¼ except 10 a. in SW cor.	17	1 N R 2 E	150	
N ½ of SE ¼	20		80	
NW ¼	22		160	
NE ¼	14	1 N R 3 E	160	
N ½ of SE ¼	14		80	
N ½ of SW ¼	14		80	
Total			1700	
Year 1877—				
NE ¼	1	1 N R 2 E	160	
N ½	2		320	
NE ¼	9		160	
W ½	16		320	
NE ¼	18		160	
SE ¼	29	2 N R 3 E	160	
N ½	31		320	
SW ¼	31		160	
Total			1760	
Year 1878—				
SW ¼	1	1 N R 2 E	160	
All of	3		640	
NE ¼	4		160	
All of	6		640	
N 110 a. of SW ¼	11		110	
NW ¼	18		160	
NW ¼ of NE ¼	22		40	
Lots 1, 2, 7 and 8, Montezuma Place, in SE ¼ of SW ¼	3	1 N R 3 E	30	
NW ¼ of SW ¼	3		40	
NW ¼ except 60 a. in SW cor.	12		100	
NE ¼ of NW ¼	14		40	
N ½ of NE ¼	15		80	
NE ¼ except 15 a. in NW cor.	16		145	
E ½	25	2 N R 2 E	320	
SW ¼	25		160	
S ½	26		320	
S ½	35		320	
SW ¼ of SW ¼	29	2 N R 3 E	40	
S ½ of SE ¼	30		80	
SW ¼	30		160	
NW ¼	33		160	
Total			3905	
Year 1879—				
NW ¼	1	1 N R 2 E	160	
NW ¼	4		160	
NE ¼	7		160	
N ½	8		320	
NW ¼	9		160	
30 a. N of Maricopa Canal in NE cor of SE ¼	2	1 N R 3 E	30	
NW ¼	2		160	
30 a. N of S. R. V. Canal in SW ¼	2		30	
50 a. N of River in SW ¼	13		50	
S ½	27	2 N R 2 E	320	
SE ¼	34		160	
SE ¼	36		160	
SE ¼ except 10 a. in NW cor.	19	2 N R 3 E	150	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1897—(Continued)—				
S ½	20	2 N R 3 E	320	
25 a. in SW cor. of SE ¼	27		25	
E ½	28		320	
NW ¼ except 50 a. in SW cor.	28		110	
SW ¼	28		160	
N ½	29		320	
NE ¼	30		160	
Total			3435	
Year 1880—				
All of	1	1 N R 1 E	640	
All of	12		640	
NE ¼	13		160	
E ½ of SE ¼	2	1 N R 2 E	80	
S ½	4		320	
W ½	7		320	
SW ¼	8		160	
SW ¼	17		160	
W ½ of NW ¼	20		80	
60 a. N of River in N ½ of NE ¼	21		60	
120 a. N of River in NW ¼	21		120	
SW ¼	1	1 N R 3 E	160	
45 a. in SW cor. of NW ¼	1		45	
NW ¼ of NW ¼	14		40	
SW ¼	22	2 N R 1 E	160	
S ½ of NE ¼	26		80	
SE ¼	26		160	
W ½	26		320	
All of	35		640	
All of	36		640	
20 a. S of Grand Canal in NW ¼	26	2 N R 2 E	20	
S ½ of	28		320	
SE ¼	29		160	
55 a. S of Grand Canal in NW ¼	29		55	
SW ¼	29		160	
E ½ of	32		320	
NW ¼	32		160	
E ½	33		320	
NE ¼	34		160	
N ½	35		320	
W ½	36		320	
140 a. S of Grand Canal in SW ¼	19	2 N R 3 E	140	
SW ¼ except 10 a. in NE cor.	21		150	
SW ¼ except 30 a. in NE cor.	27		130	
NW ¼	30		160	
NE ¼ except 15 a. in NE cor.	34		145	
Total			8025	
Year 1881—				
E ½	11	1 N R 1 E	320	
NW ¼	11		160	
SW ¼ except S ½ of SW ¼ of SW ¼	11		140	
NE ¼	5	1 N R 2 E	160	
SW ¼	5		160	
NE ¼	12	1 N R 3 E	160	
N 120 a. of SE ¼	12		120	
S ½ of NE ¼	25	2 N R 1 E	80	
SE ¼	25		160	
NW ¼ except 50 a. in NE cor.	25		110	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1881—(Continued)—				
SW ¼	25	2 N R 1 E	160	
All of	28		640	
All of	33		640	
E ½ of	34		320	
NW ¼	34		160	
SW ¼	34		160	
All of	31	2 N R 2 E	640	
NW ¼	33		160	
W ½ of	34		320	
NE ¼	36		160	
SW ¼ of NW ¼ except 5 a. in NE cor.	27	2 N R 3 E	35	
Total			4965	
Year 1882—				
E ½ of NE ¼	2	1 N R 1 E	80	
W ½ of NE ¼	2		80	82-04
SE ¼	2		160	
W ½ of	2		320	82-04
All of	3		640	
N ½ of	10		320	
SE ¼	5	1 N R 2 E	160	
NW ¼	5		160	
NW ¼ of SW ¼	7	1 N R 3 E	40	
90 a. S of Grand Canal in SE ¼	14	2 N R 1 E	90	
100 a. S of Grand Canal in NW ¼	14		100	
SW ¼	14		160	
All of	15		640	
E ½ of	20		320	
SW ¼	20		160	
E ½ of	21		320	
W ½ of	21		320	82-04
E ½ of	22		320	
NW ¼	22		160	
NE ¼	23		160	
SW ¼	23		160	
SE ¼ except 40 a. in NE cor.	24		120	
SW ¼	24		160	
N ½ of NE ¼	25		80	
50 a. in NE cor of NW ¼	25		50	
All of	27		640	
E ½ of	29		320	
SW ¼	29		160	
E ½ of	32		320	
S ½ of NE ¼	30	2 N R 2 E	80	
SE ¼	30		160	
NW ¼ except 15 a. in NE cor.	30		145	
SW ¼	30		160	
SW ¼	32		160	
SW ¼	33		160	
NW ¼	34	2 N R 3 E	160	
Total			7745	
Year 1883—				
N ½ of NE ¼	9	1 N R 1 E	80	
S ½ of NE ¼	9		80	83-05
SE ¼	9		160	
NE ¼	19	1 N R 2 E	160	
SW ¼	12	1 N R 3 E	160	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1883—(Continued)—				
NE ¼ of NW ¼	15	1 N R 3 E	40	
NW ¼ of NW ¼	15		40	
SW ¼ of NW ¼	15		40	
NW ¼ of SW ¼	15		40	
5 a. in NW cor. of SW ¼ of SW ¼	15		5	
SE ¼	22	2 N R 1 E	160	
NW ¼	23		160	
N ½ of NE ¼	26		80	
50 a. in SW cor. of NW ¼	28	2 N R 3 E	50	
Total			1255	
Year 1884—				
N ½	5	1 N R 1 E	320	
E ½	6		320	
W ½	6		320	84-04
NE ¼	14		160	
SE ¼	18	1 N R 2 E	160	
SE ¼ except 15 a. in NW cor. of SW ¼	3	1 N R 3 E	145	
25 a. in NE cor. of SW ¼	3		25	
40 a. S of Grand Canal in NW ¼	20	2 N R 3 E	40	
Total			1490	
Year 1885—				
N 90 a. of NE ¼	11	1 N R 2 E	90	
N 60 a. of NE ¼	16		60	
S ½ of SE ¼	18	2 N R 1 E	80	
SW ¼	31		160	
N ½ of N ½ of SE ¼	30	2 N R 3 E	40	
SW ¼ except 20 a. in NE cor.	35		140	
Total			570	
Year 1886—				
S ½	7	1 N R 1 E	320	
N ½ of SE ¼	19	1 N R 2 E	80	
E ½ of SE ¼	9	2 N R 1 E	80	
SW ¼ of SE ¼	9		40	
S ½	16		320	
95 a. on E side of NE ¼	19		95	
SE ¼ except 20 a. on W side	19		140	
SE ¼	31		160	
All of	21	2 N R 2 E	640	
40 a. S of Grand Canal in NE ¼	26		40	
SW ¼ of SE ¼	16	2 N R 3 E	40	
NE ¼	17		160	
N 60 a. of SE ¼	17		60	
E ½ of SW ¼	17		80	
NE ¼ except 20 a. in SW cor.	20		140	
W 20 a. N of Grand Canal in SW ¼ of NW ¼	20		20	
45 a. S of Grand Canal in W ½ of SE ¼	21		45	
NW ¼ of SW ¼	29		40	
Total			2500	
Year 1887—				
20 a. in SE ¼ of NW ¼ and W ½ of NW ¼	13	1 N R 3 E	100	
S ½ of NE ¼	15		80	
N ½ of SE ¼	15		80	
NW ¼	15	2 N R 2 E	160	
SW ¼	19		160	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1887—(Continued)—				
S ½ of NW ¼	23	2 N R 2 E	80	
N ½ of SW ¼	23		80	
S 30 a. of SE ¼ of NW ¼	17	2 N R 3 E	30	
S ½ of NW ¼	25		80	
S ½ of N ½ of SE ¼	30		40	
10 a. for Trees	29	2 N R 4 E	10	
NE ¼ of NE ¼	25	3 N R 1 E	40	
S ½ of NE ¼	25		80	
E ½ of SE ¼	25		80	
W ½ of SE ¼	25		80	87-05
E ½ of SW ¼	25		80	
50 a. N of Grand Ave. in E ½ of SE ¼	36		50	
N ½ of NW ¼ of NE ¼	30	3 N R 2 E	20	
S 10 a. of SE ¼ of NE ¼	30		10	
E ½ of NE ¼ of SE ¼ and S ½ of SE ¼ except 5 a. in NW cor.	30		95	
E ½	34		320	
NE ¼ of NE ¼	36		40	
E ½ of SE ¼	36		80	
NE ¼ of NE ¼	31	3 N R 3 E	40	
NW ¼	31		160	87-03
Total			2075	
Year 1888—				
N ½ of SE ¼ except 10 a. in SE cor.	10	1 N R 2 E	70	
S ½ of SE ¼	10		80	
SW ¼	10		160	
E ½	15		320	
NW ¼	15		160	
SE ¼ of SE ¼ of SW ¼	6	1 N R 3 E	10	
SE ¼ of NW ¼ of SE ¼	7	1 N R 4 E	10	
40 a. N of River in E ½ of SW ¼	7		40	
50 a. N of River in W ½ of SW ¼	7		50	88-03
W ½ of NE ¼	4	2 N R 2 E	80	
W 30 a. of S W¼ of SE ¼	4		30	
W ½	4		320	
N ½	5		320	
W ½ of SW ¼	5		80	
E ½	6		320	
80 a. N of Grand Ave. in NW ¼	6		80	
20 a. S of Grand Ave. in SE ¼ of NW ¼	6		20	
SW ¼	6		160	
NW ¼ of NW ¼	8		40	
E ½	9		320	
NW ¼ of NW ¼ of NW ¼	9		10	
N ½ of SW ¼	9		80	
NW ¼ of NE ¼	10		40	
E 60 a. of S ½ of NW ¼	10		60	
NW ¼ of NE ¼	11		40	
W ½ of NW ¼ of NW ¼	13		20	
N ½ of NW ¼ of NE ¼	14		20	
SW ¼	14		160	
NW ¼ of NW ¼ and NW ¼ of NE ¼ of NW ¼	23		50	
W ½ of NW ¼	6	2 N R 3 E	80	
W ½ of SW ¼	6		80	
SE ¼ of SE ¼	25		40	
5 a. in NE cor. of SW ¼ of SE ¼	25		5	
S ½ of NE ¼	36		80	
S ½ of NW ¼	36		80	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1888—(Continued)—				
S ½	23	2 N R 4 E	320	
E ½ of SE ¼ and NW ¼ of SE ¼	27		120	
NE ¼ of NE ¼ of SW ¼ of SE ¼	27		5	
W ½	34	3 N R 2 E	320	
Total			4280	
Year 1889—				
N ½ of SE ¼	10	1 N R 1 E	80	
N ½ of SW ¼	10		80	
50 a. N of River in NE ¼	23	1 N R 2 E	50	
NE ¼ of NW ¼ and NW ¼ of NW ¼	23		60	
10 a. in NE cor. of SE ¼ of SE ¼ and 30 a. N of River in S ½ of SE ¼	14	1 N R 3 E	40	
N ½ of NE ¼ and W ½ of SW ¼ of NE ¼	1	2 N R 1 E	100	
SE ¼	1		160	
NE ¼ of SE ¼	2		40	
NE ¼ of NE ¼	11		40	
S ½ of NE ¼	11		80	
NE ¼ of NE ¼	13		40	
SW ¼ of NE ¼	13		40	
NE ¼ of NE ¼	14		40	
W ½ of NE ¼	2	2 N R 2 E	80	
SE ¼ of SE ¼	2		40	
W ½ of SE ¼	2		80	
W ½ of NW ¼	2		80	
W ½ of SW ¼	2		80	
E ½	3		320	
SW ¼	3		160	
W ½ of NE ¼	7		80	
NW ¼	7		160	
NE ¼ of NE ¼ of SW ¼	7		10	
SE ¼ of SW ¼	7		40	
SW ¼ of NW ¼ of SW ¼	7		10	
S ½ of NE ¼ of SE ¼	8		20	
10 a. N of Grand Ave. in NW cor of SE ¼	8		10	
W ½ of NW ¼	11		80	
All of	16		640	
E 100 a. of NE ¼	17		100	
SE ¼	17		160	
SW ¼ of NW ¼	17		40	
N ½	20		320	
W ½ of SW ¼	20		80	
N ½ of NE ¼	22		80	
NW ¼ of SW ¼	22		40	
5 a. for Trees in Alhambra	26		5	
NE ¼ except 20 a. on N side	27		140	
35 a. S of Grand Canal in NW ¼	27		35	
W ½ of NW ¼	19	2 N R 3 E	80	
N ½ of NW ¼ of SE ¼	36		20	
SW ¼ of SE ¼	36		40	
N ½ of SW ¼	36		80	
50 a. S of Ariz. Canal in NE ¼	28	2 N R 4 E	50	
W 55 a. in N ½ of SE ¼	28		55	
30 a. S of Ariz. Canal in SE ¼ of NW ¼	28		30	
15 a. in NE cor. of SW ¼	28		15	
NE ¼ of SE ¼	30		40	
SE ¼ of SE ¼	30		40	
NE ¼ except 10 a. rough	22	3 N R 1 E	150	
NE ¼ of SE ¼	22		40	
80 a. S of Grand Ave. in SE ¼	22		80	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1889—(Continued)—				
5 a. for trees in NW ¼ of NW ¼	26	3 N R 1 E	5	Peoria
5 a. for trees in NE ¼ of NE ¼	27		5	Peoria
SE ¼ of NE ¼	27		40	
SW ¼ of SW ¼	7	3 N R 2 E	40	
S 60 a. of E ½ of SE ¼	31		60	
NW ¼ of SE ¼	31		40	
N ½ of SW ¼	31		80	
NW ¼ of SW ¼ of SW ¼	31		10	
NE ¼	32		160	
SE ¼	33		160	
S 40 a. of SW ¼	33		40	
E ½ of NW ¼	35		80	
W ½ of SW ¼	36		80	
Total			5260	
Year 1890—				
S40 a. of NW ¼	10	1 N R 2 E	40	
S ½ of SW ¼ of SE ¼	12	1 N R 3 E	20	
E ½ of NE ¼	2	1 N R 4 E	80	
10 a. in NW cor. of NE ¼ of NE ¼	6		10	
NW ¼ of NE ¼	6		40	
W ½ of SW ¼	6		80	
S ½ of SE ¼	2	2 N R 1 E	80	
E ½ of NE ¼	7	2 N R 2 E	80	
N ½ of SE ¼	10		80	
E ½ of NW ¼ of NW ¼	13		20	
S ½ of SE ¼	14		80	
E ½ of SE ¼	15		80	
NW ¼	28		160	
N 60 a. of W ½ of SW ¼	4	2 N R 3 E	60	
S ½ of SE ¼	15		80	
SW ¼ of SW ¼	15		40	
NE ¼ of NE ¼ and S ½ of NE ¼	22		120	90-04
NW ¼ of NE ¼	22		40	
NE ¼ of SE ¼	22		40	
NW ¼ of SE ¼ and S ½ of SE ¼	22		120	90-05
NW ¼ of NW ¼	22		40	
E ½ of SE ¼	27		80	
15 a. in NE cor. of SW ¼ of SE ¼	27		15	
NE ¼ of SW ¼	29		40	
SE ¼ of SW ¼	29		40	
5 a. in SW cor. of NE ¼ of SE ¼	19	2 N R 4 E	5	
S ½ of SE ¼ except 5 a. in NE cor.	19		75	
SW ¼	22	3 N R 1 E	160	
5 a. in SE cor. of NE ¼	26		5	
50 a. S of Ariz. Canal in E ½ of SE ¼	25	3 N R 2 E	50	
S 60 a. of E ½ of SE ¼ and S ½ of SW ¼ of SE ¼	32		80	90-04
N ½ of NE ¼ of SE ¼ and N 60 a. of W ½ of SE ¼	32		80	90-03
NE ¼	35		160	
W ½ of NW ¼	36		80	
N ½ of NE ¼	13	1 N R 1 W	80	
Total			2340	
Year 1891—				
SE ¼ of NW ¼	15	1 N R 3 E	40	
N ½ of SE ¼	14	2 N R 2 E	80	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1891—(Continued)—				
SE ¼	19	2 N R 2 E	160	
N ½ of SE ¼ of NE ¼	35	2 N R 3 E	20	
NE ¼ of NE ¼	36		40	
SE ¼ of SE ¼	36		40	
S ½ of SE ¼ of SW ¼ and SW ¼ of SW ¼	36		60	
SW ¼	26	3 N R 1 E	160	
SE ¼ of SE ¼	27		40	
E ½ of SE ¼	35	3 N R 2 E	80	
SE ¼ of NE ¼ and W ½ of NE ¼	31	3 N R 3 E	120	
NE ¼ of NW ¼ of SW ¼ and W ½ of W ½ of SW ¼	32		50	
Total			890	
Year 1892—				
N ½ of SE ¼	13	1 N R 1 E	80	
W ½ of SW ¼ of SE ¼	13		20	
E ½ of NW ¼ and NW ¼ of NW ¼	13		120	
NE ¼	1	1 N R 3 E	160	
NE ¼ except 10 a. in SE cor.	2		150	
E ½ of NE ¼ of SE ¼	11	2 N R 1 E	20	
S ½ of SE ¼	11		80	
E ½	12		320	
N 60 a. of W ½ of NW ¼	12		60	
NE ¼ of SW ¼	12		40	
NW ¼	32		160	
SW ¼	32		160	
NW ¼ of SW ¼ and W ½ of SW ¼ of SW ¼	12	2 N R 2 E	60	
NW ¼ of NE ¼ of NW ¼ and NW ¼ of NW ¼	14		60	
E ½ of SW ¼ and SW ¼ of SW ¼	17		120	
NE ¼ of NE ¼	18		40	92-04
SE ¼ of NE ¼	18		40	92-04
W ½ of NE ¼	18		80	
E 60 a. of N ½ of SE ¼	18		60	
SE ¼ of SE ¼	18		40	
S ½ of SW ¼ of NW ¼ of SE ¼	18		5	
NE ¼	19		160	
N ½ of NE ¼	30		80	
15 a. in NE cor. of NW ¼	30		15	
W ½ of NW ¼	23	2 N R 3 E	80	
100 a. N of Maricopa Canal in SE ¼	34		100	
S ½ of NE ¼	24	2 N R 4 E	80	
N ½ of N ½ of SE ¼	24		40	
S ½ of NW ¼	14	3 N R 1 E	80	
N ½ of SW ¼	14		80	
50 a. in E part of N ½ of NW ¼ and SE ¼ of NW ¼	22		90	
S 30 a. of NW ¼ of NE ¼ and N 10 a. of SW ¼ of NE ¼	27		40	
N 25 a. of SE ¼ of NE ¼	36		25	
SW ¼ of NE ¼	36		40	
80 a. strip running SW through center of SW ¼	30	3 N R 2 E	80	
W ½	32		320	
Total			3185	
Year 1893—				
SW ¼ of NE ¼	6	1 N R 4 E	40	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1893—(Continued)—				
100 a. S of Grand Canal in NW ¼	7	1 N R 4 E	100	
SE ¼ of SE ¼	16	2 N R 3 E	40	
NW ¼ of SE ¼	16		40	
W 30 a. of NW ¼ of NW ¼	27		30	
E ½ of NW ¼	35		80	
NW ¼ of NE ¼	36		40	
NE ¼ of SE ¼ and S ½ of NW ¼ of SE ¼	36		60	
S ½ of N ½ of NW ¼	36		40	
NW ¼ of SE ¼	30	2 N R 4 E	40	
W ½ of NW ¼ of NE ¼	36		20	
W ½ of NW ¼ of SE ¼	36		20	
NW ¼	36		160	
N ½ of SW ¼	36		80	
SW ¼ of SW ¼	36		40	
N ½ of SW ¼	36	3 N R 1 E	80	
N 60 a. of E ½ of NE ¼ and W ½ of NE ¼	31	3 N R 2 E	140	
S ½ of NW ¼	31		80	
Total			1130	
Year 1894—				
50 a. N of Grand Canal in W part of NW ¼	1	1 N R 3 E	50	
W ½ of NE ¼	3		80	
S ½ of NW ¼	3		80	
Blk. 5, Montezuma Place, in SW ¼	3		10	
W ½ of NW ¼	6	1 N R 4 E	80	94-04
N ½ of NE ¼ of SW ¼	15	2 N R 3 E	20	
N ½ of SE ¼ of NE ¼ of SW ¼	15		5	
NW ¼ of SW ¼	15		40	
NE ¼ of NE ¼ of NE ¼	23		10	
NW ¼ of SE ¼ of NW ¼	23		10	
NW ¼ except 10 a. in SE cor.	24	2 N R 3 E	150	
N 60 a. of E ½ of SW ¼	34	3 N R 1 E	60	
N ½ of NW ¼ and E 30 a. of S ½ of NW ¼	35		110	
N ½ of SW ¼	20	3 N R 2 E	80	
W ½ of NW ¼	35		80	
30 a. in SW cor of SW ¼	33	3 N R 3 E	30	
Total			895	
Year 1895—				
S 60 a. of NE ¼	14	1 N R 2 E	60	
NW ¼ of SE ¼	2	2 N R 1 E	40	
N 25 a. of SE ¼ of NW ¼	16		25	
NE ¼	24		160	
S ½ of SE ¼ of NW ¼	5	2 N R 3 E	20	
E ½ of SW ¼	5		80	
S 60 a. of W ½ of SW ¼	5		60	
10 a. for trees along Cantral Avenue	5		10	
All of	18		640	
NW ¼ of NE ¼ of NE ¼, S ½ of NE ¼ of NE ¼ and SE ¼ of NE ¼	23		70	95-05
NE ¼ of SE ¼ and S ½ of SE ¼	23		120	
SW ¼	23		160	
NW ¼ of NE ¼ of SW ¼	24		10	
NW ¼ of NW ¼ of SW ¼ and S ½ of NW ¼ of SW ¼	24		30	
5 a. in NW cor. of SW ¼ of SW ¼	24		5	
SE ¼ of NW ¼	27		40	
35 a. S of Ariz. Canal in S ½ of SE ¼	22	2 N R 4 E	35	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1895—(Continued)—				
E ½ of NE ¼	35	3 N R 1 E	80	
S ½ of SE ¼ of SW ¼	35		20	
W 15 a. of N ½ of SW ¼ of NW ¼	36		15	
SW ¼ of SW ¼ of SW ¼	30	3 N R 3 E	10	
Total			1690	
Year 1896—				
NE ¼	4	2 N R 1 E	160	
SE ¼ of NW ¼	13		40	
S ½ of NE ¼	7	2 N R 3 E	80	
SW ¼ of NE ¼ of SW ¼	15		10	
S ½ of NW ¼	26	2 N R 4 E	80	
10 a. for trees in NW ¼ of NW ¼	26		10	Scottsdale
NE ¼ of NW ¼ of SW ¼	32		10	Cemetery
NE ¼ of SW ¼	31	3 N R 3 E	40	96-04
SW ¼ of SW ¼	31		40	96-04
Total			470	
Year 1897—				
SE ¼	7	1 N R 2 E	160	80-87, 97-09
SE ¼	9		160	73-74-76-80, 97-09
N 15 a. of W ½ of NW ¼ of NE ¼	8	2 N R 3 E	15	
S ½ of S ½ of NW ¼ of NE ¼	8		10	
NE ¼ except 30 a. in NE ¼	16		130	
NW ¼ of NE ¼ of NW ¼ and NW ¼ of NW ¼	16		50	
S ½ of NW ¼	16		80	
W ½ of SE ¼ of SW ¼	16		20	
W ½ of SW ¼	16		80	
25 a. in SW cor. of SE ¼	35		25	
SE ¼ of SW ¼	19	2 N R 4 E	40	
NE ¼ of NW ¼ of NE ¼	26		10	
N ½ of SW ¼ of SE ¼	30		20	
NE ¼ of NE ¼ of NE ¼	36	3 N R 1 E	10	
Total			810	
Year 1898—				
SW ¼ of NW ¼	18	2 N R 2 E	40	
S ½ of SW ¼ of SW ¼	4	2 N R 3 E	20	
W ½ of SE ¼ of SW ¼	15		20	
30 a. in central part of SW ¼ of NE ¼	23		30	98-04
N ½ of SE ¼ of SW ¼	36		20	
W ½ of SE ¼	35	3 N R 2 E	80	
W ½ of SE ¼ of SW ¼ of SW ¼	30	3 N R 3 E	5	
Total			215	
Year 1899—				
E ½ of NE ¼	22	1 N R 2 E	80	
30 a. N of river in SW ¼ of SE ¼	22		30	
SW ¼ of SE ¼ of NW ¼	23	2 N R 3 E	10	
E ½ of NE ¼ of NE ¼	35		20	
NE ¼ of NW ¼	26	3 N R 1 E	40	
W ½ of SE ¼ of SW ¼	7	3 N R 2 E	20	
Total			200	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1900—				
NW ¼ of NE ¼	8	1 N R 1 E	40	
E ½ of SE ¼ of SW ¼	8	2 N R 3 E	20	
15 a. in W part of SW ¼ of SW ¼	10		15	
N ½ of NW ¼ of SE ¼	23		20	00-04
NE ¼ of NE ¼ of NE ¼	25		10	
E ½ of SW ¼ of SW ¼	19	2 N R 4 E	20	
10 a. in SW cor. of SW ¼	20		10	
SW ¼	30		160	
SE ¼ of SE ¼ except 5 a. in SE cor.	31		35	
SW ¼ of NW ¼	26	3 N R 1 E	40	
Total			370	
Year 1901—				
N ½ of SW ¼	18	1 N R 2 E	80	
50 a. N of river in E part of NE ¼	21		50	
N 60 a. of E ½ of NW ¼	8	2 N R 3 E	60	
SE ¼ of SE ¼ of NW ¼	8		10	
W ½ of SE ¼ of NW ¼	15		20	
E ½ of SE ¼	21		80	
10 a. in NE cor. of NE ¼ of SE ¼	28	2 N R 4 E	10	
SE ¼	28	3 N R 2 E	160	91-92, 01-09
NE ¼ of SW ¼	28		40	89-90, 01-09
W ½ of NW ¼ of NE ¼	36		20	
Total			530	
Year 1902—				
E ½ of SW ¼	13	1 N R 1 E	80	
NW ¼ of SW ¼	13		40	
70 a. in N ½ of SE ¼	16	1 N R 3 E	70	
30 a. S of Ariz. Canal in SE ¼	4	2 N R 3 E	30	
E ½ of NW ¼	19		80	
W ½ of NW ¼ of NW ¼	21		20	
NE ¼ of SE ¼	35		40	
E ½ of SE ¼ of NE ¼	36	3 N R 2 E	20	
Total			380	
Year 1903—				
5 a. in SE cor. of SE ¼ of NW ¼	10	1 N R 3 E	5	
15 a. N of river in S ½ of SW ¼	14		15	
E ½ of NE ¼	24	2 N R 2 E	80	
SE ¼	24		160	
E ½ of SE ¼ of SE ¼	6	2 N R 3 E	20	
Total			280	
Year 1904—				
NE ¼	16	2 N R 1 E	160	90-94-04-07
S ½ of SW ¼	15	2 N R 2 E	80	91-95-04-09
NW ¼	19		160	
W ½ of NE ¼ of SE ¼	16	2 N R 3 E	20	
N ½ of NE ¼ of NW ¼ and SE ¼ of NE ¼ of SW ¼	16		30	
SE ¼ of SE ¼ of SW ¼	16		10	
NW ¼ of NE ¼ of NE ¼ and NE ¼ of NW ¼ of NE ¼	26		20	86-87-04-09
S ½ of NW ¼ of NE ¼	27		20	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1904—(Continued)—				
15 a. in SE cor. of NE ¼ of SE ¼	28	2 N R 4 E	15	04-05
N ½ of NW ¼	14	3 N R 1 E	80	
Total			595	
Year 1905—				
S ½ of NW ¼ of NE ¼ and N ½ of SW ¼ of NE ¼	13	1 N R 3 E	40	
S ½ of NW ¼ of NE ¼	26	2 N R 3 E	20	
W ½ of NW ¼	26		80	
N ½ of NW ¼ of SW ¼	26		20	
S ½ of SW ¼	14	3 N R 1 E	80	
W ½ of SW ¼ of SW ¼	20	3 N R 2 E	20	
SE ¼ of SW ¼	36		40	
Total			300	
Year 1906—				
SE ¼	4	1 N R 1 E	160	
40 a. in W ½ of NW ¼ and 30 a. in NW ¼ of SW ¼	24		70	
S ½ of SW ¼ of NE ¼	13	1 N R 2 E	20	
SE ¼	1	1 N R 3 E	160	
65 a. in NE part of NW ¼	1		65	
SW ¼ of SW ¼ of SW ¼	1	2 N R 1 E	10	92-99
S ½ of NE ¼ of NE ¼ and NW ¼ of NE ¼	15	2 N R 2 E	60	92-93
SW ¼ of SE ¼	18		40	92-97
40 a. bet. Grand and Aprs. Canals in NE ¼	26		40	
SE ¼ of SW ¼	4	2 N R 3 E	40	
E ½ of SW ¼ of NW ¼	15		20	
NW ¼ of NW ¼ of SE ¼	21		10	
E ½ of SE ¼	31	3 N R 3 E	80	
Total			775	
Year 1907—				
All of	16	1 N R 1 E	640	84-85
N ½ of NE ¼ of NE ¼	17		20	84-87
E ½ of NE ¼ of SE ¼	17		20	
W ½ of NW ¼	17		80	
S ½ of SW ¼ of SW ¼	21		20	
NE ¼ of NE ¼	17	1 N R 2 E	40	72-74, 90-91
E ½ of NW ¼	6	1 N R 4 E	80	94-01
NW ¼ of NW ¼ of SW ¼	1	2 N R 1 E	10	
25 a. in SE cor. of SW ¼	8		25	
W ½ of NE ¼ of SE ¼	11		20	92-00
SW ¼ of NW ¼	16		40	
N ½ of SE ¼	18		80	
NW ¼	20		160	
NW ¼	29		160	
W ½ of NE ¼	31		80	
NW ¼	3	2 N R 2 E	160	89-00
NW ¼ of NE ¼ of SW ¼ and S ½ of NE ¼ of SW ¼	7		30	89-97
E 10 a. N of Grand Ave. in NW ¼ of SE ¼	8		10	89-97
NE ¼ of NW ¼ of NW ¼ and S ½ of NW ¼ of NW ¼	9		30	88-01
NE ¼ of NW ¼ and S ½ of NW ¼	9		120	88-99
S ½ of SW ¼	9		80	88-96
E ½ of NE ¼	13		80	93-93

TABLE No. 2—(Continued—

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1907—(Continued)—				
N ½ of SW ¼	15	2 N R 2 E	80	92-97
N 15 a. of W ½ of NW ¼ of SE ¼	13		15	
40 a. bet. Grand and Aprs. Canals in W ½ of NW ¼	25		40	
60 a. S of Grand Canal in S ½ of NW ¼	25		60	86-90
50 a. S of Grand Ave. and N of Grand Canal in W ½ of NW ¼	26		50	
NE ¼ of NW ¼	27		40	
W ½ of NE ¼	5	2 N R 3 E	80	
W ½ of SE ¼	5		80	
N 60 a. of E ½ of NW ¼	5		60	
E ½ of NE ¼ of SW ¼	8		20	92-93
5 a. in SW cor. of SE ¼ of NW ¼ and 5 a. in SE cor. of SW ¼ of NW ¼	14		10	
SW ¼ of SW ¼ of NW ¼	15		10	
SE ¼ of NE ¼ of NE ¼	16		10	
SW ¼ of NE ¼ of SW ¼	16		10	97-98
10 a. N of Grand Canal in SE ¼	19		10	
20 a. N of Grand Canal in SW ¼	19		20	
N ½ of NE ¼ of NW ¼	20		20	
E 10 a. N of Grand Canal in S W¼ of NW ¼	20		10	
N ½ of NE ¼ of NW ¼	27		20	
S ½ of NW ¼ of SE ¼ and N ½ of SW ¼ of SE ¼	24	2 N R 4 E	40	92-99
S ½ of NE ¼ of NE ¼	36	3 N R 1 E	20	
25 a. N of Grand Ave. in NW part of SE ¼	36		25	
W ½ of SE ¼	36	3 N R 2 E	80	87-93
E ½ of NW ¼	36		80	
W ½ of SE ¼	31	3 N R 3 E	80	
SE ¼ of SW ¼	31		40	
E ½ of SW ¼ and 30 a. in E ½ of W ½ of SW ¼	32		110	
SE ¼ of SE ¼	32		40	
E ½ of E ½	1	1 N R 1 W	160	
NW ¼ of NW ¼	1		40	
S ½ of NE ¼	13		80	
SE ¼	13		160	
N ½ of NE ¼	24		80	
Total			3665	
Year 1908—				
NE ¼ of NE ¼ and S ½ of NE ¼	8	1 N R 1 E	120	83-88
NW ¼ of SW ¼ of NW ¼	13		10	
All of	18		640	86-96
N ½ of NE ¼ of NE ¼	20		20	
NW ¼ of NE ¼ and S ½ of NE ¼	17	1 N R 2 E	120	72-74, 90-91
SE ¼ of SW ¼	18		40	01-02
SW ¼ of SW ¼	19		40	86-02
SE ¼ of SE ¼ of NE ¼	2	1 N R 3 E	10	
NE ¼ of SW ¼ of SW ¼	3		10	
E ½ of SW ¼ of NE ¼	1	2 N R 1 E	20	89-97
N ½ of NW ¼ of NW ¼	3		20	93-94
E ½ of SE ¼	10		80	86-91
NW ¼ of NE ¼	11		40	00-01
NW ¼ of SW ¼	13		40	92-96
E ½ of NE ¼ of NE ¼	18		20	
NW ¼ of SE ¼ of SW ¼ and S ½ of SE ¼ of SW ¼	18		30	94-02
30 a. N of Grand Canal in SE ¼	24		30	98-99

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1908—(Continued)—				
E ½ of	30	2 N R 1 E	320	84-93
E ½ of NW ¼	2	2 N R 2 E	80	89-99
E ½ of SW ¼	2		80	89-00
E ½ of NE ¼	4		80	88-02
W 25 a. of SE ¼ of SE ¼	4		25	88-02
SE ¼	5		160	88-99
E ½ of SW ¼	5		80	88-99
SE ¼	7		160	89-97
SE ¼ of SE ¼	8		40	89-99
20 a. S of Grand Ave. in NW ¼ of SE ¼	8		20	89-99
SW ¼ of SE ¼	8		40	89-99
S 10 a. S of Grand Ave. in S ½ of NW ¼	8		10	89-99
SW ¼	8		160	89-99
NE ¼ of NE ¼	10		40	99-01
SE ¼ of NE ¼	10		40	88-92
N ½ of SW ¼ of NE ¼	10		20	88-92
N ½ of NW ¼ and W ½ of SW ¼ of NW ¼	10		100	88-00
SW ¼	10		160	88-92
E ½ of	12		320	88-92
NW ¼	12		160	88-90
E ½ of SW ¼ of S W ¼	12		20	92-00
SW ¼ of NW ¼	13		40	90-93
NE ¼ of NE ¼ and S ½ of NW ¼ of NE ¼	14		60	88-00
S ½ of NE ¼	14		80	92-98
S ½ of NW ¼	14		80	92-98
W 60 a. of NE ¼	17		60	89-97
E ½ of NW ¼ and E ½ of NW ¼ of NW ¼	17		100	89-97
NW ¼ of SW ¼	17		40	92-97
NE ¼ of SW ¼	18		40	92-01
E ½ of SW ¼	20		80	89-02
W 60 a. of NW ¼	24		60	96-98
W 60 a. of SW ¼	24		60	96-98
NW ¼ of NE ¼	26		40	89-93
NE ¼ of NE ¼ of NW ¼	26		10	
20 a. in NW cor. of NW ¼	4	2 N R 3 E	20	
E ½ of NW ¼	6		80	88-92
E ½ of SW ¼	6		80	88-92
NE ¼ of NE ¼	7		40	96-97
S 10 a. of NE ¼ of NE ¼ and S ½ of NE ¼	8		90	92-93
W ½ of W ½ of SE ¼	8		40	92-93
SW ¼ of SE ¼ of NW ¼	8		10	92-93
N ½ of NW ¼ of NW ¼	8		20	92-93
SW ¼ of SE ¼ of SW ¼	8		10	92-93
SE ¼	9		160	92-93-94-96
S ½ of SE ¼ of NE ¼ of SW ¼ and E ½ of SE ¼ of SW ¼	15		25	98-00
E ½ of NE ¼ of SE ¼	16		20	
S 100 a. of SE ¼	17		100	86-96
N ½ of NE ¼ of NW ¼	17		20	
S ½ of N ½ of SW ¼ of NW ¼ and SE ¼ of SW ¼ of NW ¼	17		20	
SW ¼ of S W¼	17		40	86-96
S ½ of NW ¼ of SE ¼	23		20	00-02
E ½ of SE ¼ of NW ¼	23		20	
E 30 a. of SE ¼ of SE ¼	25		30	90-95
S ½ of NE ¼ of NE ¼	26		20	86-87
5 a. in SW cor. of SE ¼ of NW ¼ and 5 a. in NW cor. of NE ¼ of SW ¼	26		10	

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1908—(Continued)—				
E ½ of SE ¼ of NE ¼	27	2 N R 3 E	20	00-02
N ½ of N ½ of NW ¼	36		40	93-00
10 a. in NW cor. of SE ¼ of SE ¼	22	2 N R 4 E	10	
NE ¼ of NE ¼	24		40	91-92
NW ¼ of NE ¼	24		40	92-96
S ½ of NE ¼	27		80	91-92
S ½ of SW ¼ of SE ¼	30		20	97-98
SE ¼ of SW ¼	36		40	93-00
SE ¼	12	3 N R 1 E	160	
SE ¼ of NE ¼	15		40	90-91
E ½ of SE ¼ and S ½ of SW ¼ of SE ¼	15	3 N R 1 E	100	88-98
N 60 a. of W ½ of SE ¼	15		60	90-91
SW ¼ of NW ¼	22		40	92-97
SW ¼ of SW ¼	23		40	
NW ¼ of NE ¼	25		40	87-88
NE ¼ of SE ¼	33		40	
S 15 a. of E ½ of NW ¼ of NW ¼	33		15	92-00
15 a. in center of SW ¼	33		15	92-95
NW ¼ of NE ¼	36		40	90-91
N 120 a. of NE ¼ except N ½ of NW ¼	30	3 N R 2 E	100	87-93
SE ¼ of SE ¼ of NE ¼	31		10	95-98
W ½ of NE ¼ of NW ¼	31		20	95-98
S 15 a. of NE ¼ of SW ¼ and N 10 a. of SE ¼ of SW ¼	33		25	89-98
SW ¼	35		160	91-02
W ½ of SE ¼ of NE ¼	36		20	91-02
NE ¼ of SW ¼	36		40	87-93
All S of Ariz. Canal in SW ¼ except W 15 a. of S ½ of SW ¼ of SW ¼	30	3 N R 3 E	50	92-94
E ½	12	1 N R 1 W	320	90-93
S ½ of NE ¼	24		80	
Total			6735	
Year 1909—				
SE ¼	5	1 N R 1 E	160	85-89
N 50 a. of SE ¼	8		50	86-87
N 25 a. of NW ¼ of NE ¼	17		25	84-87
SE ¼	8	1 N R 2 E	160	78-99
N 60 a. of W ½ of NE ¼	13		60	70-89
SE ¼ of SW ¼	19		40	
NE ¼ of SW ¼	15	1 N R 3 E	40	95-00
SE ¼ of NE ¼	2	2 N R 1 E	40	92-95
S ½ of NW ¼ of NW ¼	3		20	93-94
N ½ of SE ¼	4		80	96-02
NW ¼ of NW ¼ of NW ¼	4		10	99-00
NE ¼ of NE ¼ of NE ¼	5		10	90-93
E ½ of NW ¼	12		80	92-00
S ½ of SW ¼	12		80	92-02
SE ¼ of NE ¼ and W ½ of NE ¼	14		120	82-02
70 a. N of Grand Canal in SE ¼	14		70	82-02
60 a. N of Grand Canal in NW ¼	14		60	82-02
NE ¼ of SW ¼ and NE ¼ of SE ¼ of SW ¼	18		50	
45 a. strip N and S through W ½ of NE ¼	19		45	86-90
20 a. on W side of SE ¼	19		20	
E ½ of E ½ of SW ¼	19		40	
E ½ of NE ¼	31		80	
N ½	1	2 N R 2 E	320	92-94, 00-01
E ½ of NE ¼	2		80	89-99

TABLE No. 2—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1909—(Continued—				
NE ¼ of SE ¼	2	2 N R 2 E	40	89-99
E 60 a. of N ½ of SE ¼, E 15 a. of SE ¼ of SE ¼ and E 10 a. of SW ¼ of SE ¼	4		85	88-02
20 a. S of Grand Ave. in NW ¼ of NW ¼	6		20	92-01
SW ¼ of NW ¼	6		40	92-01
S ½ of SE ¼	10		80	89-90, 00-01
E ½ of NW ¼	11		80	89-98
SW ¼ of NE ¼	11		40	88-01
SE ¼ of SE ¼ and W ½ of SE ¼	11		120	88-91
N ½ of SW ¼	11		80	88-97
E ¼ of SW ¼	12		80	88-90
N ½ of N ½ of NE ¼ of NE ¼	15		10	92-96
W ½ of SE ¼ except 40 a. in central part	15		40	93-96
SE ¼ of SW ¼ and W ½ of SW ¼	18		120	92-01
N ½ of SE ¼	20		80	89-02
20 a. in SW cor. of NE ¼	22		20	89-95
80 a. N of Grand Ave. in SE ¼	22		80	89-95
65 a. N of Grand Ave. in NW ¼	22		65	89-95
40 a. S of Grand Ave. in NW ¼	22		40	89-95
N ½ of SW ¼ of SW ¼	22		20	89-95
NE ¼	23		160	87-92
SE ¼	23		160	87-95
SE ¼ of NE ¼ of NW ¼ and W ½ of NE ¼ of NW ¼	26		30	88-92
W ½ of SE ¼ of SE ¼ and W ½ of SE ¼	6	2 N R 3 E	100	92-93
N 30 a. of W ½ of E ½ of SW ¼	8		30	
SW ¼ of SW ¼ of NW ¼	17		10	
NW ¼ of SW ¼	17		40	
E ½ of NE ¼	19		80	95-99
SE ¼ of SE ¼ of NW ¼	21		10	91-93
SE ¼ of SW ¼	24		40	00-01
NW ¼ of NW ¼ of NE ¼	26		10	86-87
SE ¼ of NE ¼ of NW ¼	27		10	
SW ¼ of SW ¼	32		40	72-95
S 60 a. of E ½ of SE ¼ and S ½ of SW ¼ of SE ¼	24	2 N R 4 E	80	92-93
SW ¼ of SW ¼ of NE ¼	26	3 N R 1 E	10	
SE ¼ of SW ¼	27		40	91-97
S ½ of SW ¼ of SW ¼	35		20	
10 a. S of Grand Ave. in NW cor. of SE ¼	36		10	90-91
10 a. N of Grand Ave. in SE cor. of NW ¼	36		10	
All S of Arizona Canal in	27	3 N R 2 E	320	87-88
SE ¼ of SW ¼ and W ½ of SW ¼	28		120	89-90
N 25 a. of NE ¼ of SW ¼	33		25	89-98
N 60 a. of W ½ of SW ¼	33		60	89-98
S ½ of N ½ of SE ¼ of SW ¼	33		10	89-98
Total			4305	
Total acreage of Northside Class A land			91,813	

TABLE No. 3.

A descriptive list of Class A land on south side of Salt River.

BROADWAY CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1870—				
S ½ of NE ¼	25	1 N R 2 E	80	
N 140 a. of NE ¼	30	1 N R 3 E	140	
NW ¼ except 15 a. in NW cor.	30		145	
Total			365	
Year 1883—				
S ½ of N ½ of NE ¼	25	1 N R 2 E	40	
Total			40	
Year 1896—				
N ½ of N ½ of NE ¼	25	1 N R 2 E	40	
Total			40	
Year 1905—				
S 20 a. of NE ¼	30	1 N R 3 E	20	
Total			20	
Total acreage under Broadway Canal			465	

SAN FRANCISCO CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1873—				
70 a. S of river in SE ¼	19	1 N R 3 E	70	
20 a. S of river in NE ¼	20		20	
SE ¼	20		160	
130 a. S of river in SW ¼	20		130	
SE ¼	21		160	
10 a. S of river in NW ¼	21		10	
SW ¼	21		160	
S 90 a. of the SE ¼	22		90	
S 110 a. of the SW ¼	22		110	
75 a. S of river in SW ¼	23		75	
N ½ of	27		320	
N ½ of	28		320	
Total			1625	
Year 1875—				
N ½ of	29	1 N R 3 E	320	
Total			320	
Year 1878—				
SE ¼	24	1 N R 3 E	160	
S 150 a. of SW ¼	24		150	
N 145 a. of SE ¼	27		145	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1878—(Continued)—				
N 150 a. of the SW ¼	27	1 N R 3 E	150	
SE ¼	28		160	
Total			765	
Year 1879—				
70 a. S of river in NE ¼	24	1 N R 3 E	70	
25 a. S of river in NW ¼	24		25	
Total			95	
Year 1880—				
W ½ of NW ¼	19	1 N R 4 E	80	
Total			80	
Year 1883—				
NW ¼ except 5 a. rough land	25	1 N R 3 E	155	
70 a. N of Canal in SW ¼	25		70	
S ½ of NW ¼ of NE ¼ and S ½ of NE ¼	26		100	
N 125 a. of the SE ¼	26		125	
S 150 a. of the NW ¼	26		150	
N 140 a. of the SW ¼	26		140	
Total			740	
Year 1887—				
95 a. W of Canal in NE¼	25	1 N R 3 E	95	
Total			95	
Year 1903—				
SE ¼	29	1 N R 3 E	160	
40 a. in northern part of NE ¼	32		40	
Total			200	
Year 1904—				
N ½ of SW ¼	28	1 N R 3 E	80	
E 30 a. of SW¼	29		30	
Total			110	
Total acreage under San Francisco Canal			4030	

TEMPE CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1871—				
110 a. S of river in SE ¼	8	1 N R 5 E	110	
60 a. S of river in SW ¼	8		60	
60 a. S of Wallace ditch in SW ¼	9		60	
80 a. N and W of Tempe Canal in NE ¼	17		80	
NW ¼	17		160	
60 a. N and W of Tempe Canal in SW ¼	17		60	
110 a. S of river in NE ¼	18		110	
20 a. S of river in NW ¼	18		20	
SW ¼	18		160	
Total			820	

TABLE No. 3—(Continued—

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1872—				
140 a. S of river in SE ¼	13	1 N R 4 E	140	
70 a. S of river in SW ¼	13		70	
145 a. S of river in SE ¼	14		145	
110 a. S of river in SW ¼	14		110	
25 a. N of Hayden ditch in SE ¼	15		25	
SW ¼ of SE ¼	15		40	
20 a. S of river in NW ¼	15		20	
50 a. in NW part of SW ¼	15		50	
S ½ of SW ¼	15		80	
SE ¼	17		160	
125 a. S of river in SW ¼	17		125	
N ½ of NE ¼	20		80	
N ½ of NW ¼	20		80	
NE ¼	21		160	
NE ¼	22		160	
SE ¼ except 15 a. in SE cor.	22		145	
NW ¼	22		160	
SW ¼ except 15 a. in SE cor.	22		145	
W ½ of	23		320	
NE ¼	24		160	
N ½ of SE ¼	24		80	
S ½ of	26		320	
W ½ of	27		320	
SE ¼	28		160	
W ½ of	28		320	
SE ¼	29		160	
NE ¼	33		160	
N ½ of	34		320	
N ½ of	35		320	
50 a. in NW cor. of NE ¼	19	1 N R 5 E	50	
NW ¼	19		160	
85 a. W of Tempe Canal in SW ¼	19		85	
Total			4830	
Year 1873—				
SW ¼	24	1 N R 4 E	160	
SE ¼ except 10 a. in SE cor.	18	1 N R 5 E	150	
Total			310	
Year 1875—				
20 a. S of river in NE ¼	16	1 N R 4 E	20	
SE ¼	16		160	
SW ¼	25		160	
SE ¼	34		160	
Total			500	
Year 1876—				
SW ¼	16	1 N R 4 E	160	
SE ¼	20		160	
NE ¼	23		160	
S ½ of SE ¼	24		80	
S ½ of NW ¼	24		80	
NE ¼	27		160	
SW ¼	35		160	
Total			960	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1877—				
10 a E of San Francisco Canal in NE cor of NE ¼	19	1 N R 4 E	10	
SE ¼	23		160	
E ½ of	25		320	
NW ¼	25		160	
N ½	26		320	
SE ¼	27		160	
S ½ of NE ¼	28		80	
All of	11	1 S R 4 E	640	
Total			1850	
Year 1878—				
SW ¼	20	1 N R 4 E	160	
E ½ of SE ¼ of SW ¼	21		20	
NE ¼ except 40 a. in NW cor.	29		120	
NW ¼ except 10 a. in SW cor.	33		150	
SW ¼	34		160	
SE ¼	35		160	
N ½ of NW ¼ of NE ¼	36		20	
NW ¼	36		160	
W ½ of SW ¼	36		80	
Total			1030	
Year 1879—				
15 a. S of river in NW ¼	16	1 N R 4 E	15	
N ½ of	2	1 S R 4 E	320	
NE ¼	14		160	
W ½ of	14		320	
Total			815	
Year 1880—				
NE ¼ of NE ¼ except 10 a. in NE cor.	19	1 N R 4 E	30	
NW ¼ of NE ¼ except 10 a. in NW cor.	19		30	
Total			60	
Year 1881—				
N ½ of NW ¼	24	1 N R 4 E	80	
70 a. in W part of NW ¼	29		70	
SW ¼	29		160	
100 a. N of Tempe Canal in SE ¼	33		100	
W ½ of NW ¼	1	1 S R 4 E	80	
NE ¼	3		160	
80 a. E of Tempe Canal in NW ¼	3		80	
40 a. in NE cor. of SW ¼	3		40	
E ½	15		320	
Total			1090	
Year 1883—				
N ½ of NE ¼ and SW ¼ of NE ¼	30	1 N R 4 E	120	
NW ¼	30		160	
NE ¼	22	1 S R 4 E	160	
Total			440	
Year 1884—				
SW ¼	19	1 N R 4 E	160	
N ½ of SE ¼	21		80	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1884—(Continued)—				
N ½ of SW ¼	21	1 N R 4 E	80	
20 a. in SW cor. of SE ¼	30	1 N R 5 E	20	
100 a. W of Tempe Canal in NW ¼	30.		100	
SW ¼ except 5 a. in NE cor.	30		155	
S ½	2	1 S R 4 E	320	
120 a. E of Kyrene ditch in NW ¼	22		120	
Total			1035	
Year 1885—				
NW ¼	31	1 N R 5 E	160	
All of	23	1 S R 4 E	640	
Total			800	
Year 1886—				
45 a. N of Tempe Canal in SW ¼	31	1 N R 5 E	45	
E ½ of	1	1 S R 4 E	320	
E ½ of NW ¼	1		80	
SW ¼	1		160	
SE ¼ except 5 a. in SW cor.	3		155	
Total			760	
Year 1887—				
65 a. E of S. F. Canal in NE ¼	25	1 N R 3 E	65	
SE ¼	25		160	
90 a. S of S. F. Canal in SW ¼	25		90	
15 a. in SE cor. of SE ¼	22	1 N R 4 E	15	
15 a. in SE cor. of SW ¼	22		15	
120 a. N of Tempe Canal in NE ¼	32		120	
120 a. N of Tempe Canal in NW ¼	32		120	
SE ¼	36		160	
E ½ of SW ¼	36		80	
20 a. in SW cor of SW ¼	31	1 N R 5 E	20	
E ½ of NE ¼	10	1 S R 4 E	80	
E ½ of SE ¼	10		80	
All of	24		640	
All of	26		640	
Total			2285	
Year 1888—				
SE ¼ of NE ¼	30	1 N R 4 E	40	
S ½	30		320	
N ½ of NE ¼	31		80	
N ½ of NW ¼	31		80	
10 a. in NE cor. of SW ¼	33		10	
NE ¼ except N ½ of NW ¼	36		140	
All of	13	1 S R 4 E	640	
SE ¼	22		160	
NW ¼	25		160	
SW ¼ except 10 a. in SE cor.	25		150	
NE ¼	27		160	
Total			1940	
Year 1829—				
N ½ of	35	1 N R 3 E	320	
NE ¼	34	1 S R 4 E	160	
Total			480	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1890—				
35 a. S of S. F. Canal in SE ¼	26	1 N R 3 E	35	
20 a. S of S. F. Canal in SW ¼	26		20	
Cementery in NE ¼ of NW ¼	29	1 N R 4 E	15	
W ½ of NE ¼	10	1 S R 4 E	80	
W ½ of SE ¼	10		80	
All of	12		640	
SE ¼	14		160	
NE ¼ except 60 a. in SE cor.	25		100	
SE ¼	27		160	
Total			1290	
Year 1891—				
15 a. S of S. F. Canal in SE ½	27	1 N R 3 E	15	
10 a. S of S. F. Canal in SW ¼	27		10	
N ½ of	34		320	
SE ¼	19	1 N R 4 E	160	
S ½ of NE ¼	31		80	
S ½ of NW ¼	31		80	
SW ¼	27	1 S R 4 E	160	
SE ¼	34		160	
SW ¼	35		160	
Total			1145	
Year 1892—				
NE ¼	36	1 N R 3 E	160	
NW ¼ except 20 a. in SE cor.	36		140	
Total			300	
Year 1895—				
130 a. N of Tempe Canal in SE ¼	35	1 N R 3 E	130	
110 a. N of Tempe Canal in SW ¼	35		110	
Total			240	
Year 1896—				
110 a. N of Tempe Canal in SE ¼	34	1 N R 3 E	110	
110 a. N of Tempe Canal in SW ¼	34		110	
SW ¼	34	1 S R 4 E	160	
Total			380	
Year 1897—				
SE ¼	33	1 S R 4 E	160	
Total			160	
Year 1906—				
NW ¼	21	1 N R 4 E	160	
W ½ of SE ¼ of SW ¼	21		20	
SW ¼ of SW ¼	21		40	
Total			220	
Year 1907—				
W ½ of SE ¼	28	1 S R 4 E	80	
130 a. E of railroad in SW ¼	28		130	
110 a. in NE ¼	32		110	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1907—(Continued)—				
SE ¼	32	1 S R 4 E	160	
NW ¼	33		160	
Total			640	
Total acreage under Tempe Canal			24,380	

UTAH CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1871—				
50 a. N of Wallace ditch in SW ¼	9	1 N R 5 E	50	
Total			50	
Year 1877—				
NE ¼	2	1 N R 5 E	160	
SE ¼ except 40 a. in SE cor.	2		120	
W ½	2		320	
100 a. S of river in NE ¼	3		100	
SE ¼	3		160	
110 a. S of river in SW ¼	3		110	
NE ¼	10		160	
40 a. N of Utah Canal in SE ¼	10		40	
NW ¼	10		160	
70 a. N of Utah Canal in SW ¼	10		70	
NW ¼ except 40 a. in SE cor.	11		120	
20 a. in NW cor. of NE ¼	11		20	
Total			1540	
Year 1878—				
35 a. in NW cor. of NE ¼	1	1 N R 5 E	35	
N ½ of NW ¼	1		80	
S ½ of NW ¼ except 20 a. in SE cor.	1		60	
20 a. in NW cor. of SW ¼	1		20	
Indian Reservation south of river in	35 & 36	2 N R 5 E	1115	
Total			1310	
Year 1879—				
W 55 a. of SW ¼	33	1 N R 5 E	55	
Total			55	
Year 1880—				
40 a. E of Tempe Canal in NE part of NE ¼	9	1 N R 5 E	40	
Total			40	
Year 1882—				
SW ¼	20	1 N R 5 E	160	
NW ¼	29		160	
Total			320	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1884—				
S ½	32	1 N R 5 E	320	
Total			320	
Year 1885—				
40 a. in SE cor. of SE ¼	4	1 N R 5 E	40	
90 a. W of Tempe Canal in NE ¼	9		90	
100 a. S of river in NW ¼	9		100	
SE ¼	19		160	
NW ¼	20		160	
NE ¼	31		160	
SW ¼ of SE ¼	31		40	
Total			750	
Year 1886—				
NE ¼	30	1 N R 5 E	160	
SE ¼ except 20 a. in SW cor.	30		140	
60 a. E of Tempe Canal in NW ¼	30		60	
5 a. in NE cor. of SW ¼	30		5	
Total			365	
Year 1887—				
NE ¼ except 50 a. in NW cor.	19	1 N R 5 E	110	
75 a. E of Tempe Canal in SW ¼	19		75	
SE ¼ of SE ¼	31		40	
95 a. E of Tempe Canal in SW ¼	31		95	
N ½ of	5	1 S R 5 E	320	
Total			640	
Year 1888—				
W ½ of NW ¼	3	1 S R 5 E	80	
W ½	4		320	
S ½	5		320	
N ½	6		320	
All of	7		640	
All of	8		640	
NE ¼	17		160	
SE ¼ except 15 a. in SE cor.	17		145	
W ½	17		320	
NE ¼	18		160	
SE ¼ except 20 a. in SE cor.	18		140	
W ½	18		320	
Total			3565	
Year 1889—				
S ½ of	6	1 S R 5 E	320	
Total			320	
Year 1890—				
15 a. in SE cor. of NE ¼	8	1 N R 5 E	15	
N ½ of SE ¼	31		80	
SE ¼	4	1 S R 5 E	160	
Total			255	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1892—				
NE ¼	4	1 S R 5 E	160	
NE ¼ except 50 a. in eastern part	16		110	
NW ¼	16		160	
Total			430	
Year 1893—				
W ½ of SW ¼	3	1 S R 5 E	80	
NE ¼	9		160	
SE ¼ except 35 a. in SE cor.	9		125	
W ½	9		320	
Total			685	
Year 1894—				
20 a. in NW cor. of SE ¼	16	1 S R 5 E	20	
N 100 a. of SW ¼	16		100	
Total			120	
Year 1898—				
25 a. in SE part of NE ¼	9	1 N R 5 E	25	
10 a. in SE cor. of SE ¼	34	2 N R 5 E	10	
Total			35	
Year 1900—				
65 a. E of Tempe Canal in N ½ of SE ¼	9	1 N R 5 E	65	
Total			65	
Year 1905—				
NE ¼ except 50 a. in eastern part	19	1 S R 5 E	110	
NW ¼	15		160	
Total			270	
Year 1909—				
30 a. S of river in SW ¼	30	2 N R 6 E	30	
Total			30	
Total acreage under Utah Canal			11,165	

MESA CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1878—				
SW ¼	14	1 N R 5 E	160	
120 a. S of Mesa Canal in SE ¼	15		120	
S ½	21		320	
All of	22		640	
N ½	27		320	
SW ¼	27		160	
NE ¼	28		160	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1878—(Continued)—				
NE ¼ except 20 a. in SE cor.	31	2 N R 6 E	140	
NW ¼ except 10 a. in NW cor.	31		150	
SW ¼ except 5 a. in SE cor.	31		155	
Total			2325	
Year 1879—				
80 a. E of Mesa Canal in NW ¼	14	1 N R 5 E	80	
NE ¼	21		160	
W ½	23		320	
NW ¼	25		160	
E ½	33		320	
E 105 a. of SW ¼	33		105	
All of	34		640	
Total			1785	
Year 1880—				
S 60 a. of NE ¼	14	1 N R 5 E	60	
SE ¼	14		160	
20 a. in SE cor. of SW ¼	15		20	
E ½	20		320	
NW ¼	21		160	
NW ¼ of SE ¼ and S ½ of SE ¼	24		120	
S ½ of NW ¼ of NW ¼	24		20	
E ½ of SW ¼	24		80	
E ½	26		320	
SW ¼	26		160	
SE ¼	27		160	
SE ¼	28		160	
W ½	28		320	
NW ¼	33		160	
Total			2220	
Year 1881—				
S ½ of SW ¼ except 20 a. in SE cor.	15	1 N R 5 E	60	
SW ¼	25		160	
NW ¼	26		160	
N ½ of NE ¼	29		80	
SE ¼	29		160	
Total			620	
Year 1882—				
15 a. in SW cor. of SW ¼	13	1 N R 5 E	15	
SW ¼	16		160	
SE ¼	17		160	
NW ¼ of NE ¼	25		40	
NW ¼	35		160	
Total			535	
Year 1883—				
SE ¼	16	1 N R 5 E	160	
S ½ of NE ¼	29		80	
N ½	32		320	
NE ¼	35		160	
Total			720	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1884—				
SW ¼	29	1 N R 5 E	160	
SW ¼	35		160	
Total			320	
Year 1885—				
NE ¼	23	1 N R 5 E	160	
W ½ of SW ¼	24		80	
NE ¼ of NE ¼	25		40	
Total			280	
Year 1886—				
NE ¼ except 40 a. in NE cor.	24	1 N R 5 E	120	
S ½ of NE ¼	25		80	
W ½ of SE ¼	25		80	
Total			280	
Year 1887—				
S 145 a. of NE ¼	16	1 N R 5 E	145	
NW ¼	16		160	
SE ¼	23		160	
E ½	3	1 S R 5 E	320	
Total			785	
Year 1888—				
E ½ of SE ¼	25	1 N R 5 E	80	
NW ¼	36		160	
E ½ of NW ¼	3	1 S R 5 E	80	
Total			320	
Year 1889—				
S 70 a. W of canal in SW ¼	11	1 N R 5 E	70	
NE ¼	36		160	
NW ¼ of SE ¼	36		40	
W ½ of NE ¼	30	1 N R 6 E	80	
SE ¼	30		160	
NW ¼	30		160	
All of	31		640	
NE ¼	12	1 S R 5 E	160	
Total			1470	
Year 1890—				
SW ¼	36	1 N R 5 E	160	
S ½	6	1 S R 6 E	320	
Total			480	
Year 1891—				
N ½ of SW ¼	15	1 N R 5 E	80	
W ½ of NE ¼	1	1 S R 5 E	80	
10 a. in NW cor. of SE ¼	1		10	
W ½	1		320	
Total			490	
Year 1892—				
80 a. W of Mesa Canal in NW ¼	14	1 N R 5 E	80	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1892—(Continued)—				
SE ¼	35	1 N R 5 E	160	
SW ¼ of SE ¼	36		40	
20 a. in SW cor. of SE ¼	19	1 N R 6 E	20	
15 a. in SW cor. of NW ¼	19		15	
SW ¼ except 20 a. in NE cor.	19		140	
SW ¼	30		160	
S ½	2	1 S R 5 E	320	
E ½ of SW ¼	3		80	
NE ¼ of SE ¼	10		40	
N ½	11		320	
NW ¼	12		160	
NE ¼ of NE ¼	6	1 S R 6 E	40	
N ½ of SW ¼	7		80	
Total			1655	
Year 1893—				
S 60 a. of the SE ¼	10	1 N R 5 E	60	
Cemetery in SE ¼ of SW ¼	10		20	
40 a. N of Mesa Canal in SE ¼	15		40	
E ½ of NW ¼	24		80	
N ½ of NW ¼ of NW ¼	24		20	
SW ¼ of NW ¼	24		40	
Total			260	
Year 1894—				
15 a. in NE cor. of NE ¼	1	1 N R 5 E	15	
Total			15	
Year 1896—				
W ½ of NW ¼	2	1 S R 5 E	80	
Total			80	
Year 1897—				
S ½ of SW ¼ except 15 a. in SW cor.	13	1 N R 5 E	65	
NE ¼ of SE ¼	24		40	
Total			105	
Year 1898—				
NE ¼ except 20 a. in NW cor.	15	1 N R 5 E	140	
NW ¼ except 10 a. in NE cor.	15		150	
40 a. in NW part of NW ¼	32	1 N R 6 E	40	
Total			330	
Year 1900—				
30 a. in SW cor. of SW ¼	29	1 N R 6 E	30	
S ½ of NE ¼	10	1 S R 5 E	80	
NW ¼	10		160	
Total			270	
Year 1905—				
NE ¼	2	1 S R 5 E	160	
W ½ of SE ¼	10		80	
S ½	11		320	

TABLE No. 3—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1905—(Continued—)				
NW ¼ of NE ¼	7	1 S R 6 E	40	
NW ¼	7		160	
Total			760	
Year 1906—				
N ½ of NE ¼ of SE ¼	12	1 S R 5 E	20	
Total			20	
Year 1907—				
E ½ of SE ¼ of SW ¼	17	1 N R 5 E	20	
N ½ of SW ¼ and SE ¼ of SW ¼	10	1 S R 5 E	120	97-00
SW ¼ of SW ¼	10		40	
Total			180	
Year 1908—				
50 aS of canal in N ½ of NE ¼	14	1 N R 5 E	50	
W ½ of SE ¼ of SW ¼ and E ½ of SW ¼ of SW ¼	17		40	
N ½ of NE ¼	10	1 S R 5 E	80	92-94
Total			170	
Total acreage under Mesa Canal			16,475	

CONSOLDATED CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1892—				
All of	21	1 S R 5 E	640	
SW ¼	27		160	
E ½	23		320	
SW ¼	28		160	
Total			1280	
Year 1893—				
W ½ of	10	2 S R 5 E	320	
W ½	15		320	
Total			640	
Year 1897—				
NE ¼	33	1 S R 5 E	160	
NE ¼ of NW ¼ and S ½ of NW ¼	33		120	
Total			280	
Year 1907—				
N 90 a. of SW ¼	15	1 S R 5 E	90	
10 a. in SW cor of SW ¼	15		10	
10 a. in NW cor. of NW ¼	22		10	
Total			110	

TABLE No. 3—(Continued)—

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1908—				
20 a. W of canal in NE ¼	27	2 S R 5 E	20	
Total			20	
Total acreage under Consolidated Canal			2330	

HIGHLAND CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Remarks.
Year 1892—				
SE ¼	12	1 N R 5 E	160	
E ½ of SW ¼	12		80	
Total			240	
Year 1901—				
NE ¼	12	1 N R 5 E	160	
Total			160	
Year 1905—				
25 a. in SW ¼ of NW ¼	7	1 N R 6 E	25	
Total			25	
Total acreage under Highland Canal			425	

Summary of Class A land on the Southside under the following named canals:

Broadway Canal	465	acres
San Francisco Canal	4,030	"
Tempe Canal	24,380	"
Utah Canal	11,165	"
Mesa Canal	16,475	"
Consolidated Canal	2,330	"
Highland Canal	425	"
Total	59,270	acres

TABLE No. 4.

A descriptive list of Class B land on North Side of Salt River.

DESCRIPTION.	Sec.	Township.	Acres.	Years cultivated.
NE ¼ and W ½	4	1 N R 1 E	480	83-89
S 30 a. of N ½ of SE ¼	8		30	86-87
NW ¼	9		160	83-85
SW ¼	9		160	84-85
SW ¼ of SW ¼	10		40	89-02
NE ¼ of SW ¼ of NW ¼ and S ½ of SW ¼ of NW ¼	13		30	92-00
S 60 a. of E ½ of NE ¼ and S 55 a. of W ½ of NE ¼	17		115	84-87
E ½ of NW ¼	17		80	84-87
SE ¼ of NE ¼ of SE ¼	10	1 N R 2 E	10	88-90
NW ¼	19		160	90-91
NE ¼ of SW ¼	19		40	88-92
SW ¼	20		160	80-85
125 a. N of river in NW ¼	30		125	72-99
S ½ of SW ¼ of SW ¼	3	1 N R 3 E	20	76-85
55 a. S of Grand Ave. in W ½ of NW ¼	6		55	71-88
SW ¼ except 20 a. in E part of NE ¼ and 10 a. in SE cor.	6		130	71-88
N 40 a. of SW ¼	9		40	69-89
S ½ of NW ¼ except 5 a. in SE cor.	10		75	69-94
NE ¼ of NW ¼	13		40	87-91
S ½ of SE ¼	18		80	70-98
SW ¼ of NW ¼	18		40	70-98
E ½ of SE ¼	2	1 N R 4 E	80	90-95
Indian Reservation—				
200 a. unlocated in	12		200	
200 a. unlocated in	4	1 N R 5 E	200	
400 a. unlocated in	5		400	
200 a. unlocated in	6		200	
200 a. unlocated in	7		200	
SE ¼ of NE ¼	1	2 N R 1 E	40	89-97
NW ¼	1		160	89-90
SW ¼ except 10 a. in NW cor. and 10 a. in SW cor.	1		140	92-99
SW ¼ of NE ¼	2		40	00-01
S 40 a. of SE ¼	3		40	95-96 CR
SW ¼ of SW ¼	3		40	93-94 CR
60 a. in E ½ of NW ¼	4		60	98-99 CR
50 a. in W part of NW ¼	4		50	99-00 CR
75 a. in E part of SW ¼	4		75	99-00 CR
E ½ of E ½ of NE ¼	8		40	96-98 CR
W ½ of E ½ of NE ¼	8		40	98-99 CR
NW ¼ of SE ¼	9		40	86-87
NE ¼	10		160	92-93 CR
NW ¼ of SE ¼	11		40	92-02
130 a. in SW ¼	11		130	92-93 CR
S ½ of SW ¼ of NW ¼	12		20	92-00
NW ¼ of SW ¼	12		40	92-02
SE ¼ of NE ¼	13		40	89-98
NW ¼ of NE ¼	13		40	89-98
SE ¼	13		160	92-96
NE ¼ of NW ¼ and W ½ of NW ¼	13		120	96-99
NE ¼ of SW ¼ and S ½ of SW ¼	13		120	92-96
10 a. in SW cor. of NE ¼ of SE ¼	24		10	98-99
NE ¼ of NW ¼	24		40	91-92 CR
S 20 a. of the NW ¼	24		20	82-84
E ½ of NW ¼	30		80	84-93
NW ¼	31		160	86-91
W ½ of NW ¼ of SE ¼	4	2 N R 2 E	20	88-02

TABLE No. 4—(Continued)

DESCRIPTION.	Sec.	Township.	Acres.	Years cultivated.
N ½ of NW ¼ of SW ¼, SE ¼ of NW ¼ of SW ¼ and SW ¼ of SW ¼	7	2 N R 2 E	70	89-97
E ½ of NE ¼	8		80	91-01
W ½ of NE ¼	8		80	89-99
N ½ of NE ¼ of SE ¼	8		20	89-99
60 a. N of Grand Ave. in E ½ of NW ¼	8		60	89-99
N 50 a. S of Grand Ave. in S ½ of NW ¼	8		50	89-99
S ½ of SW ¼ of NE ¼	10		20	88-92
E ½ of NE ¼	11		80	88-01
NE ¼ of SE ¼	11		40	88-91
S ½ of SW ¼	11		80	88-97
W ½ of NE ¼	13		80	89-90
SE ¼	13		160	89-90
E ½ of NW ¼	13		80	90-93
SW ¼	13		160	89-90
S ½ of N ½ of NE ¼ of NE ¼	15		10	92-96
S ½ of NE ¼	15		80	97-02 CR
W ½ of NW ¼ of NW ¼	17		20	87-97
E ½ of NW ¼ and NW ¼ of NW ¼	18		120	92-01
S ½ of SE ¼	20		80	89-02
S ½ of NE ¼ except 20 a. in SW cor.	22		60	89-95
80 a. S of Grand Ave. in SE ¼	22		80	89-95
15 a. N of Grand Ave. in NW ¼ of NW ¼	22		15	89-98
W 40 a. S of Grand Ave. in W ½ of NW ¼	22		40	89-98
E ½ of SW ¼ and S ½ of SW ¼ of SW ¼	22		100	89-95
NE ¼ of NE ¼ of NW ¼ and S ½ of NE ¼ of NW ¼	23		30	88-91
S ½ of SW ¼	23		80	87-91
NE ¼ of NE ¼	26		40	89-93
25 a. N of Grand Canal in SE ¼ of NW ¼	26		25	89-93
20 a. N of Grand Ave. in NW ¼ of NW ¼	26		20	89-95
20 a. N of Appropriators Canal in NE ¼	27		20	89-95
All N of Grand Canal in NW ¼ except 40 a. S of Appropriators Canal in E ½	27		85	89-99
NE ¼	28		160	90-00
150 a. N of Grand Canal in NE ¼	29		150	92-02
NE ¼ of NW ¼	29		40	92-02
NE ¼	6	2 N R 3 E	160	88-92
NE ¼ of SE ¼	6		40	88-92
NW ¼ of NE ¼	7		40	96-97
SE ¼	7		160	89-92
E 45a. of N 60 a. of NE ¼	8		45	92-93
E 120 a. of SE ¼	8		120	92-93-99
S 60 a. of W ½ of NW ¼	8		60	92-93
W ½ of SW ¼	8		80	92-93
NW ¼ of NW ¼ of NW ¼	9		10	92-93
S ½ of SE ¼ of SW ¼	13		20	99-02
W ½ of NE ¼	19		80	95-99
20 a. S of Grand Canal in SW cor. of NE ¼	20		20	86-90
NE ¼	21		160	91-93
25 a. N of Grand Canal in E part of NW ¼ of SE ¼	21		25	91-93
E 60 a. of N ½ of NW ¼	21		60	91-93
SE ¼ of NW ¼ except 10 a. in SE cor.	21		30	91-93
SW ¼ of NW ¼ except 5 a. in SW cor.	21		35	91-93
E ½ of NW ¼ and SW ¼ of NW ¼	22		120	90-02
SW ¼	22		160	90-02
20 a. in E part of NW ¼ of NE ¼	23		20	98-02
E ½ of NE ¼ except 10 a. in the NE cor.	25		70	00-02
SW ¼ of NE ¼	25		40	00-02
N ½ of NW ¼ of SW ¼	25		20	95-96
NE ¼ of NE ¼ of NE ¼	26		10	86-87

TABLE No. 4—(Continued)—

DESCRIPTION.	Sec.	Township.	Acres.	Years cultivated.
S ½ of NE ¼	26	2 N R 3 E	80	86-87
SE ¼	26		160	86-88
E ½ of NW ¼ except 5 a. in SW cor.	26		75	86-87
E ½ of SW ¼ except 5 a. in NW cor.	26		75	86-87
S 60 a. of W ½ of SW ¼	26		60	86-87
NE ¼ of NE ¼	27		40	88-95
N ½ of NW ¼ of NE ¼	27		20	88-95
W 60 a. of S ½ of NE ¼	27		60	88-95
NW ¼ of SE ¼	27		40	88-95
W ½ of NE ¼ of NE ¼ and E ½ of E ½ of NW ¼ of NE ¼	35		30	99-00
S ½ of SE ¼ of NE ¼	35		20	91-92
W 30 a. of NW ¼ of NE ¼ and SW ¼ of NE ¼	35		70	97-98
W 30 a. of SE ¼ of SE ¼ and W ½ of SE ¼	12	2 N R 4 E	110	91-95
SE ¼ of SW ¼	12		40	91-95
15 a. in SE ¼ of NW ¼	19		15	98-99
SW ¼ of SW ¼ of SW ¼	19		10	95-96 CR
NE ¼ of NW ¼ of NE ¼	23		10	95-96 CR
SW ¼ of NW ¼	24		40	97-98 CR
W ½ of SW ¼	24		80	96-97 CR
E ½ of SW ¼ of NE ¼	26		20	96-98
E ½ of NW ¼ of SE ¼	26		20	96-97
30 a. in NW ¼ of NW ¼	26		30	94-95 CR
E ½ of NW ¼ of SW ¼	26		20	96-97
N ½ of NE ¼	27		80	91-92 CR
SW ¼ of SE ¼ except 5 a. in NE cor.	27		35	96-98
N ½ of NW ¼ of SW ¼	27		20	92-94
N ½ of SW ¼	29		80	98-99
N ½ of	30		320	94-97
NW ¼ of NW ¼ of SW ¼	32		10	96-97 CR
SW ¼ of NW ¼ of SW ¼	32		10	93-96 CR
NE ¼	34		160	93-94 CR
W ½ of SE ¼	34		80	93-94 CR
E ½ of NW ¼ of NE ¼ and SW ¼ of NE ¼	36		60	93-99
S ½ of	28	2 N R 5 E	320	Indian Reservation.
W 67 a. of S ½ of NE ¼	29		67	
S ½ of SE ¼	29		80	
120 a. in W ½ of	29		120	
S ½ of	22		320	
70 a. S of Arizona Canal in SW ¼	1	3 N R 1 E	70	92-99
10 a. in SE cor. of NE ¼	2		10	93-95 CR
N ½ of SE ¼	2		80	90-98 CR
NW ¼ of NW ¼	2		40	94-95 CR
10 a. in SE cor. of SW ¼	2		10	90-91 CR
20 a. in SE ¼ of SE ¼	16		20	94-97 CR
20 a. N of Grand Ave. in NW ¼ of SE ¼	22		20	89-96
NW ¼	24		160	94-97 CR
30 a. in SE cor. of NW ¼	25		30	95-96 CR
SW ¼ of SW ¼ of SW ¼	25		10	96-98 CR
E ½ of NE ¼ except 5 a. in SE cor.	26		75	94-97 CR
SE ¼	26		160	96-97 CR
NW ¼ of NW ¼ except 5 a. for trees	26		35	89-90
NE ¼ of NE ¼ except 5 a. for trees	27		35	89-90
S ½ of N ½ of SW ¼ of NE ¼ and N ½ of S ½ of SW ¼ of NE ¼	27		20	92-00
N 10 a. of NE ¼ of SE ¼	27		10	99-00
NW ¼ of NW ¼ of NW ¼	27		10	98-99 CR
NE ¼ of NW ¼	34		40	98-99 CR
NE ¼ of NW ¼ of NW ¼	34		10	90-99 CR

TABLE No. 4—(Continued)—

DESCRIPTION.	Sec.	Township.	Acres.	Years cultivated.
S 15 a. of SE ¼ of NE ¼	36	3 N R 1 E	15	92-00 CR
S 70 a. W of railroad in SE ¼	36		70	90-91
NE ¼ of NW ¼	36		40	90-91
E ½	20	3 N R 2 E	320	90-92
50 a. S of Arizona Canal in W ½ of SE ¼	25		50	90-92
45 a. S of Arizona Canal in SW ¼	25		45	90-92
All of	29		640	87-90 SW ¼ to 98
N ½ of S ½ of SE ¼ of NE ¼ and S ½ of SW ¼ of NE ¼	30		30	87-93
W 60 a. of N ½ of SE ¼	30		60	87-93
5 a. in NW cor. of SW ¼ of SE ¼	30		5	87-93
NE ¼ of NE ¼ of NW ¼	30		10	98-99
SW ¼ of SE ¼ of NE ¼	31		10	95-98 CR
N ½ of NE ¼ of SE ¼	31		20	95-98 CR
SW ¼ of SE ¼	31		40	95-98
E ½ of NE ¼ of NW ¼	31		20	95-98
NW ¼ of NW ¼	31		40	95-98
SE ¼ of SW ¼	31		40	91-96 CR
SW ¼ of SW ¼ except 10 a. in NW cor.	31		30	91-96
N ½	33		320	89-95
NW ¼ of SW ¼	31	3 N R 3 E	40	90-93
Total acreage of Class B land on the North Side			14,792	

N. B. —"C. R." means canal company's records showing cultivation in the years specified.

TABLE No. 5.

A descriptive list of Class B land on South Side of Salt River.

SAN FRANCISCO CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Years cultivated.
130 a. S of river in SE ¼	23	1 N R 3 E	130	73-98
Total			130	

Since 1898 this land has been irrigated by water from a subterranean ditch having its head in SE ¼ of Sec. 20, T. 1 N., R. 4 E.

TEMPE CANAL.

DESCRIPTION.	Sec.	Township.	Acres.	Years cultivated.
40 a. S of river in S ½	18	1 N R 4 E	40	82-02
N 60 a. of E ½ of NW ¼	19		60	82-02
N ½ of NE ¼	28		80	77-88
10 a. E of Kyrene ditch in the SE cor. of NW ¼	15	1 S R 4 E	10	92-95
10 a. E of Kyrene ditch in the NE cor. of SW ¼	15		10	92-95
SW ¼	22		160	89-94
15 a. in NW cor. of SE ¼	25		15	96-98
NW ¼	27		160	89-92
50 a. in eastern part of NE ¼	28		50	91-93
E ½ of SE ¼	28		80	91-93
S ½ of NW ¼	34		80	96-97
NE ¼ except 20 a. in SE cor.	35		140	89-00
NW ¼	35		160	89-00
Total			1045	

UTAH CANAL.

DESCRIPTION	Sec.	Township.	Acres.	Years cultivated.
20 a. in NW cor. of NE ¼	20	1 S R 5 E	20	89-90
20 a. in SE cor. of SE ¼	20		20	89-90
NE ¼ of NW ¼	20		40	90-92
NW ¼ of NW ¼ except 10 a. in NW cor.	20		30	89-90
S ½ of NW ¼ except 10 a. in SE cor.	20		70	89-90
20 a. in NW cor. of SW ¼	20		20	89-90
Total			200	

MESA CANAL.

DESCRIPTION	Sec.	Township.	Acres.	Years cultivated.
40 a. in SW cor. of NW ¼	13	1 N R 5 E	40	97-00
N ½ of SW ¼	13		80	97-99
30 a. E of Tempe Canal in N ½ of SW ¼	17		30	87-91
10 a. in SW cor. of SW ¼	17		10	87-91
E ½ of SE ¼	36		80	89-02

TABLE No. 5—(Continued)

DESCRIPTION	Sec.	Township.	Acres.	Years cultivated.
35 a. in NW cor. of SE ¼	31	2 N R 6 E	35	89-98
40 a. in NW cor. of NW ¼	32		40	87-00
SE ¼ except 10 a. in NW cor.	1	1 S R 5 E	150	95-98
SE ¼ of NE ¼	6	1 S R 6 E	40	92-96
S ½ of SW ¼	7		80	92-98
Total			585	

CONSOLIDATED CANAL.

DESCRIPTION	Sec.	Township.	Acres.	Years cultivated.
100 a. unlocated in SW ¼	12	1 S R 5 E	100	93-94
NW ¼	13		160	96-97
E ½ of NW ¼	15		80	92-00
W ½ of NW ¼	15		80	92-95
W 60 a. of S ½ of SE ¼	15		60	97-98
E ½ of	22		320	92-00
W ½ of W ½	22		160	92-00
NE ¼	26		160	90-99
W ½	26		320	90-99
E ½	27		320	92-97
W ½ of NW ¼	27		80	92-97
NW ¼	28		160	92-98
S ½ of NW ¼	31		80	93-97
S ½ of	31		320	93-97
S ½ of	32		320	93-97
N ½ of NW ¼	34		80	97-01
All of	9	2 S R 5 E	640	95-98
W ½ of NE ¼	10		80	95-01
SE ¼	10		160	95-01
E ½ except 15 a. in SE ¼	15		305	93-01
Total			3985	

HIGHLAND CANAL.

DESCRIPTION	Sec.	Township.	Acres.	Years cultivated.
Unlocated 30 a. in E ½ of SW ¼	1	1 N R 5 E	30	95-00
N ½ of SE ¼ of NE ¼	11		20	99-00
W ½ of SW ¼	12		80	92-98
NE ¼	13		160	93-01
30 a. in SW cor. of SE ¼	12		30	90-91
NW ¼ except 40 a. in SW cor.	13		120	93-95
15 a. W of canal in S part of SE ¼	7	1 N R 6 E	15	95-96
20 a. in NW cor. of SW ¼	7		20	93-95
NE ¼ except 5 a. in NE cor.	18		155	95-96
NW ¼	18		160	95-00
E ½ of SW ¼	18		80	92-93
W ½ of SW ¼	18		80	97-98
NE ¼	19		160	95-99
SE ¼ except 20 a. in SW cor.	19		140	95-99
NW ¼ except 15 a. in SW cor.	19		145	95-99
20 a. in W part of NE ¼	20		20	92-02
E ½ of NW ¼	20		80	92-02
W ½ of NW ¼	20		80	92-96

TABLE No. 5—(Continued)

DESCRIPTION	Sec.	Township.	Acres.	Years cultivated.
E ½ of SW ¼	20	1 N R 6 E	80	96-97
70 a. W of canal in NW ¼	28		70	91-99
E ½ of NE ¼	30		80	89-96
N ½ of NE ¼	32		80	89-92
S ½ of NE ¼	32		80	89-99
SE ¼	32		160	89-02
NW ¼ of SE ¼	33		40	90-99
W ½ of	33		320	89-99
20 a. W of canal in SW ¼ of SW ¼	28	2 N R 6 E	20	90-95
60 a. in S ½ of SE ¼	29		60	90-95
20 a. in SE cor. of SW ¼	29		20	90-95
95 a. W of canal in NE ¼	32		95	90-95
90 a. E of Consolidated in NW ¼	32		90	90-95
40 a. N of Highland in SW ¼	32		40	90-95
N ½ of SE ¼ of SE ¼	24	1 S R 5 E	20	95-96
Unlocated 60 a. in NW ¼	25		60	90-96
W ½	4	1 S R 6 E	320	89-99
NE ¼ of NE ¼	5		40	99-02
SE ¼	5		160	89-99
W 100 a. in NW ¼	5		100	93-99
10 a. in E part of SW ¼	5		10	90-96
All of	8		640	89-99
S 35 a. of NE ¼ of NE ¼ and N 15 a. of SE ¼ of SE ¼	9		50	99-00
Unlocated 30 a. in NE ¼	16		30	90-93
Unlocated 10 a. in SE ¼	16		10	90-93
W ½	16		320	90-93
All of	17		640	89-99
All of	18		640	89-99
All of	20		640	89-99
40 a. W of canal in SW ¼	21		40	89-96
NW ¼	29		160	89-99
SW ¼	29		160	90-92
E ½ of	30		320	89-99
NW ¼	30		160	90-92
E ½ of	31		320	89-99
NW ¼	31		160	89-99
SW ¼	31		160	89-92
Unlocated 40 a. in SE ¼	1	2 S R 5 E	40	90-96
N ½ of NW ¼	1		80	92-94
Unlocated 60 a. in SW ¼	6	2 S R 6 E	60	90-96
Total			8150	

Summary of Class "B" land on the South Side that has been irrigated by means of the following named canals:

San Francisco canal	130	acres
Tempe canal	1,045	"
Utah canal	200	"
Mesa canal	585	"
Consolidated canal	3,985	"
Highland canal	8,150	"
Total	14,095	acres

TABLE No. 6.

A table showing acreage of Class A and Class B land by Townships and Sections.

T. 1 N., R. 1 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	640	640		640	640				
2	640	640		640	640				
3	640	640		640	640				
4	640	160	480	640	160	480			
5	480	480		480	480				
6	640	640		640	640				
7	320	320		320	320				
8	240	210	30	240	210	30			
9	640	320	320	640	320	320			
10	520	480	40	520	480	40			
11	620	620		620	620				
12	640	640		640	640				
13	540	510	30	540	510	30			
14	160	160		160	160				
16	640	640		640	640				
17	340	145	195	340	145	195			
18	640	640		640	640				
20	20	20		20	20				
21	20	20		20	20				
24	70	70		70	70				
25	60	60		60	60				
Total	9,150	8,055	1,095	9,150	8,055	1,095			

T. 1 N., R. 2 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	640	640		640	640				
2	640	640		640	640				
3	640	640		640	640				
4	640	640		640	640				
5	640	640		640	640				
6	640	640		640	640				
7	640	640		640	640				
8	640	640		640	640				
9	640	640		640	640				
10	640	630	10	640	630	10			
11	640	640		640	640				
12	640	640		640	640				
13	490	490		490	490				
14	640	640		640	640				
15	630	630		630	630				
16	640	640		640	640				
17	630	630		630	630				
18	600	600		600	600				
19	520	320	200	520	320	200			
20	560	400	160	560	400	160			
21	230	230		230	220				
22	310	310		310	310				

TABLE No. 6—(Continued)

T. 1 N., R. 2 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
23	110	110		110	110				
25	160	160					160	160	
30	125		125			125			
Total..	13,325	12,830	495	13,165	12,670	495	160	160	

T. 1 N., R. 3 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	640	640		640	640				
2	640	640		640	640				
3	600	580	20	600	580	20			
4	640	640		640	640				
5	640	640		640	640				
6	640	455	185	640	455	185			
7	640	640		640	640				
8	640	640		640	640				
9	640	600	40	640	600	40			
10	640	565	75	640	565	75			
11	640	640		640	640				
12	620	620		620	620				
13	230	190	40	230	190	40			
14	535	535		535	535				
15	485	485		485	485				
16	420	420		420	420				
17	535	535		535	535				
18	560	440	120	560	440	120			
19	70	70					70	70	
20	310	310					310	310	
21	330	330					330	330	
22	200	200					200	200	
23	205	75	130				205	75	130
24	405	405					405	405	
25	635	635					635	635	
26	570	570					570	570	
27	640	640					640	640	
28	560	560					560	560	
29	510	510					510	510	
30	305	305					305	305	
32	40	40					40	40	
34	540	540					540	540	
35	560	560					560	560	
36	300	300					300	300	
Total..	16,565	15,955	610	10,385	9,905	480	6,180	6,050	130

TABLE No. 6—T. 1 N., R. 4. E.—(Continued)

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
2	160	80	80	160	80	80			
6	330	330		330	330				
7	200	200		200	200				
12	200		200	200		200			
13	210	210					210	210	
14	255	255					255	255	
15	215	215					215	215	
16	355	355					355	355	
17	285	285					285	285	
18	40		40				40		40
19	530	470	60				530	470	60
20	480	480					480	480	
21	560	560					560	560	
22	640	640					640	640	
23	640	640					640	640	
24	640	640					640	640	
25	640	640					640	640	
26	640	640					640	640	
27	640	640					640	640	
28	640	560	80				640	560	80
29	525	525					525	525	
30	640	640					640	640	
31	320	320					320	320	
32	240	240					240	240	
33	420	420					420	420	
34	640	640					640	640	
35	640	640					640	640	
36	640	640					640	640	
Total	12,365	11,905	460	890	610	280	11,475	11,295	180

T. 1 N., R. 5 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	240	210	30				240	210	30
2	600	600					600	600	
3	370	370					370	370	
4	240	40	200	200		200	40	40	
5	400		400	400		400			
6	200		200	200		200			
7	200		200	200		200			
8	185	185					185	185	
9	430	430					430	430	
10	510	510					510	510	
11	230	210	20				230	210	20
12	480	400	80				480	400	80
13	510	80	430				510	80	430
14	590	590					590	590	
15	610	610					610	610	
16	625	625					625	625	
17	560	520	40				560	520	40
18	440	440					440	440	

TABLE No. 6—T. 1. N., R. 5 E.—(Continued)

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
19	640	640					640	640	
20	640	640					640	640	
21	640	640					640	640	
22	640	640					640	640	
23	640	640					640	640	
24	640	640					640	640	
25	640	640					640	640	
26	640	640					640	640	
27	640	640					640	640	
28	640	640					640	640	
29	640	640					640	640	
30	640	640					640	640	
31	640	640					640	640	
32	640	640					640	640	
33	640	640					640	640	
34	640	640					640	640	
35	640	640					640	640	
36	640	560	80				640	560	80
Total	18,900	17,220	1,680	1,000		1,000	17,900	17,220	680

T. 1. N., R. 6 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
7	60	25	35				60	25	35
17									
18	475		475				475		475
19	620	175	445				620	175	445
20	260		260				260		260
28	70		70				70		70
29	30	30					30	30	
30	640	560	80				640	560	80
31	640	640					640	640	
32	360	40	320				360	40	320
33	360		360				360		360
Total	3,515	1,470	2,045				3,515	1,470	2,045

T. 2 N., R. 1. E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	640	300	340	640	300	340			
2	240	200	40	240	200	40			
3	120	40	80	120	40	80			
4	435	250	185	435	250	185			
5	10	10		10	10				
8	105	25	80	105	25	80			
9	160	120	40	160	120	40			

TABLE No. 6—T. 2. N., R. 1 E.—(Continued)

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
10	240	80	160	240	80	160			
11	450	280	170	450	280	170			
12	640	580	60	640	580	60			
13	640	160	480	640	160	480			
14	640	640		640	640				
15	640	640		640	640				
16	545	545		545	545				
17									
18	260	260		260	260				
19	340	340		340	340				
20	640	640		640	640				
21	640	640		640	640				
22	640	640		640	640				
23	640	640		640	640				
24	540	470	70	540	470	70			
25	640	640		640	640				
26	640	640		640	640				
27	640	640		640	640				
28	640	640		640	640				
29	640	640		640	640				
30	400	320	80	400	320	80			
31	640	480	160	640	480	160			
32	640	640		640	640				
33	640	640		640	640				
34	640	640		640	640				
35	640	640		640	640				
36	640	640		640	640				
Total	16,645	14,700	1,945	16,645	14,700	1,945			

T. 2 N., R. 2 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	320	320		320	320				
2	640	640		640	640				
3	640	640		640	640				
4	640	620	20	640	620	20			
5	640	640		640	640				
6	640	640		640	640				
7	640	570	70	640	570	70			
8	640	350	290	640	350	290			
9	640	640		640	640				
10	640	620	20	640	620	20			
11	640	440	200	640	440	200			
12	640	640		640	640				
13	640	160	480	640	160	480			
14	620	620		620	620				
15	600	510	90	600	510	90			
16	640	640		640	640				
17	640	620	20	640	620	20			
18	640	520	120	640	520	120			
19	640	640		640	640				
20	640	560	80	640	560	80			
21	640	640		640	640				

TABLE No. 6—T. 2 N., R. 2 E.—(Continued)

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
22	640	345	295	640	345	295			
23	640	530	110	640	530	110			
24	360	360		360	360				
25	580	580		580	580				
26	640	555	85	640	555	85			
27	640	535	105	640	535	105			
28	640	480	160	640	480	160			
29	565	375	190	565	375	190			
30	640	640		640	640				
31	640	640		640	640				
32	640	640		640	640				
33	640	640		640	640				
34	640	640		640	640				
35	640	640		640	640				
36	640	640		640	640				
Total..	22,245	19,910	2,335	22,245	19,910	2,335			

T. 2 N., R 3 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
4	170	170		170	170				
5	390	390		390	390				
6	640	440	200	640	440	200			
7	320	120	200	320	120	200			
8	640	335	305	640	335	305			
9	170	160	10	170	160	10			
10	15	15		15	15				
13	20		20	20		20			
14	10	10		10	10				
15	290	290		290	290				
16	580	580		580	580				
17	560	560		560	560				
18	640	640		640	640				
19	640	560	80	640	560	80			
20	570	550	20	570	550	20			
21	625	315	310	625	315	310			
22	640	360	280	640	360	280			
23	570	550	20	570	550	20			
24	235	235		235	235				
25	250	120	130	250	120	130			
26	640	180	460	640	180	460			
27	585	425	160	585	425	160			
28	640	640		640	640				
29	640	640		640	640				
30	640	640		640	640				
31	640	640		640	640				
32	640	640		640	640				
33	640	640		640	640				
34	625	625		625	625				
35	490	370	120	490	370	120			
36	640	640		640	640				
Total..	14,795	12,480	2,315	14,795	12,480	2,315			

TABLE No. 6—(Continued)—T. 2 N., R 4 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
12	150		150	150		150			
19	165	140	25	165	140	25			
20	10	10		10	10				
22	45	45		45	45				
23	330	320	10	330	320	10			
24	440	320	120	440	320	120			
25									
26	190	100	90	190	100	90			
27	340	205	135	340	205	135			
28	175	175		175	175				
29	90	10	80	90	10	80			
30	640	320	320	640	320	320			
31	35	35		35	35				
32	30	10	20	30	10	20			
34	240		240	240		240			
36	420	360	60	420	360	60			
Total..	3,300	2,050	1,250	3,300	2,050	1,250			

T. 2 N., R. 5 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
20	160	160		160	160				
21	480	480		480	480				
22	160	160		160	160				
25									
26									
27	320	320		320	320				
28	640	320	320	640	320	320			
29	360	93	267	360	93	267			
31	480	480		480	480				
32	640	320	320	640	320	320			
34	10	10					10	10	
35 & 36..	1,115	1,115					1,115	1,115	
Total..	4,365	3,458	907	3,240	2,333	907	1,125	1,125	

T. 2 N., R. 6 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
28	20		20				20		20
29	80		80				80		80
30	30	30					30	30	
31	480	445	35				480	445	35
32	265		265				265		265
Total..	875	475	400				875	475	400

TABLE No. 6—(Continued)—R. 3 N., R. 1 E.

Sections	Acreage. Total	Acreage. Class A	Acreage. Class B	North Side Acreage. Total	North Side Acreage. Class A	North Side Acreage. Class B	South Side Acreage. Total	South Side Acreage. Class A	South Side Acreage. Class B
1	70		70	70		70			
2	140		140	140		140			
12	160	160		160	160				
14	320	320		320	320				
15	200	200		200	200				
16	20		20	20		20			
22	580	560	20	580	560	20			
23	40	40		40	40				
24	160		160	160		160			
25	440	400	40	440	400	40			
26	530	260	270	530	260	270			
27	240	165	75	240	165	75			
33	70	70		70	70				
34	110	60	50	110	60	50			
35	230	230		230	230				
36	450	325	125	450	325	125			
Total	3,760	2,790	970	3,760	2,790	970			

T. 3 N., R. 2 E.

Sections	Acreage. Total	Acreage. Class A	Acreage. Class B	North Side Acreage. Total	North Side Acreage. Class A	North Side Acreage. Class B	South Side Acreage. Total	South Side Acreage. Class A	South Side Acreage. Class B
7	60	60		60	60				
20	420	100	320	420	100	320			
25	145	50	95	145	50	95			
27	320	320		320	320				
28	320	320		320	320				
29	640		640	640		640			
30	410	305	105	410	305	105			
31	640	440	200	640	440	200			
32	640	640		640	640				
33	640	320	320	640	320	320			
34	640	640		640	640				
35	640	640		640	640				
36	580	580		580	580				
Total	6,095	4,415	1,680	6,095	4,415	1,680			

T. 3 N., R. 3 E.

Sections	Acreage. Total	Acreage. Class A	Acreage. Class B	North Side Acreage. Total	North Side Acreage. Class A	North Side Acreage. Class B	South Side Acreage. Total	South Side Acreage. Class A	South Side Acreage. Class B
30	65	65		65	65				
31	640	600	40	640	600	40			
32	200	200		200	200				
33	30	30		30	30				
Total	935	895	40	935	895	40			

TABLE No. 6—(Continued)—T. 1 N., R. 1 W.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	200	200		200	200				
12	320	320		320	320				
13	320	320		320	320				
24	160	160		160	160				
Total	1,000	1,000		1,000	1,000				

T. 1 S., R. 4 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	640	640					640	640	
2	640	640					640	640	
3	435	435					435	435	
10	320	320					320	320	
11	640	640					640	640	
12	640	640					640	640	
13	640	640					640	640	
14	640	640					640	640	
15	340	320	20				340	320	20
22	600	440	160				600	440	160
23	640	640					640	640	
24	640	640					640	640	
25	425	410	15				425	410	15
26	640	640					640	640	
27	640	480	160				640	480	160
28	340	210	130				340	210	130
32	270	270					270	270	
33	320	320					320	320	
34	560	480	80				560	480	80
35	460	160	300				460	160	300
Total	10,470	9,605	865				10,470	9,605	865

T. 1 S., R. 5 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	560	410	150				560	410	150
2	560	560					560	560	
3	640	640					640	640	
4	640	640					640	640	
5	640	640					640	640	
6	640	640					640	640	
7	640	640					640	640	
8	640	640					640	640	
9	605	605					605	605	
10	600	600					600	600	
11	640	640					640	640	
12	440	340	100				440	340	100

TABLE No. 6—T. 1 S., R. 5 E.—(Continued)

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
13	160		160				160		160
15	320	100	220				320	100	220
16	390	390					390	390	
17	625	625					625	625	
18	620	620					620	620	
19	270	270					270	270	
20	200		200				200		200
21	640	640					640	640	
22	480		480				480		480
23	10	10					10	10	
24	20		20				20		20
25	60		60				60		60
26	480		480				480		480
27	560	160	400				560	160	400
28	640	480	160				640	480	160
31	400		400				400		400
32	320		320				320		320
33	280	280					280	280	
34	80		80				80		80
Total	13,800	10,570	3,230				13,800	10,570	3,230

T. 1 S., R. 6 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
4	320		320				320		320
5	310		310				310		310
6	400	360	40				400	360	40
7	360	280	80				360	280	80
8	640		640				640		640
9	50		50				50		50
16	360		360				360		360
17	640		640				640		640
18	640		640				640		640
20	640		640				640		640
21	40		40				40		40
29	320		320				320		320
30	480		480				480		480
31	640		640				640		640
Total	5,840	640	5,200				5,840	640	5,200

T. 2 S., R. 5 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
1	120		120				120		120
9	640		640				640		640

TABLE No. 6—T. 2 S., R. 5 E.—(Continued)

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
10	560	320	240				560	320	240
15	625	320	305				625	320	305
27	20	20					20	20	
Total	1,965	660	1,305				1,965	660	1,305

T. 2 S., R. 6 E.

	Acreage.			North Side Acreage.			South Side Acreage.		
Sections	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
6	60		60				60		60
Total	60		60				60		60

Summary of Class A land, showing the total acreage, the total acreage on the North Side and the total acreage on the South Side.

	ACREAGE.		
TOWNSHIPS.	Total	North Side	South Side
1 N R 1 E	8,055	8,055	
1 N R 2 E	12,830	12,670	160
1 N R 3 E	15,955	9,905	6,050
1 N R 4 E	11,905	610	11,295
1 N R 5 E	17,220		17,220
1 N R 6 E	1,470		1,470
2 N R 1 E	14,700	14,700	
2 N R 2 E	19,910	19,910	
2 N R 3 E	12,480	12,480	
2 N R 4 E	2,050	2,050	
2 N R 5 E	3,458	2,333	1,125
2 N R 6 E	475		475
3 N R 1 E	2,790	2,790	
3 N R 2 E	4,415	4.415	
3 N R 3 E	895	895	
1 N R 1 W	1,000	1,000	
1 S R 4 E	9,605		9,605
1 S R 5 E	10,570		10,570
1 S R 6 E	640		640
2 S R 5 E	660		660
2 S R 6 E			
Total	151,083	91,813	59,270

TABLE No. 6—(Continued)

Summary of Class B land, showing the total acreage, the total acreage on the North Side and the total acreage on the South Side.

December 31, 1909. TOWNSHIPS.	ACREAGE. Total	North Side	South Side
1 N R 1 E.	1,095	1,095	
1 N R 2 E.	495	495	
1 N R 3 E.	610	480	130
1 N R 4 E.	460	280	180
1 N R 5 E.	1,680	1,000	680
1 N R 6 E.	2,045		2,045
2 N R 1 E.	1,945	1,945	
2 N R 2 E.	2,335	2,335	
2 N R 3 E.	2,315	2,315	
2 N R 4 E.	1,250	1,250	
2 N R 5 E.	907	907	
2 N R 6 E.	400		400
3 N R 1 E.	970	970	
3 N R 2 E.	1,680	1,680	
3 N R 3 E.	40	40	
1 N R 1 W.			
1 S R 4 E.	865		865
1 S R 5 E.	3,230		3,230
1 S R 6 E.	5,200		5,200
2 S R 5 E.	1,305		1,305
2 S R 6 E.	60		60
Total	28,887	14,792	14,095

Table of summaries of Class A and B land by Townships and Sections.

December 31, 1909	Cultivation Total Acreage of			North Side Acreage			South Side Acreage		
TOWNSHIPS	Total	Class A	Class B	Total	Class A	Class B	Total	Class A	Class B
T 1 N R 1 E	9,150	8,055	1,095	9,150	8,055	1,095			
T 1 N R 2 E	13,325	12,830	495	13,165	12,670	495	160	160	
T 1 N R 3 E	16,565	15,955	610	10,385	9,905	480	6,180	6,050	130
T 1 N R 4 E	12,365	11,905	460	890	610	280	11,475	11,295	180
T 1 N R 5 E	18,900	17,220	1,680	1,000		1,000	17,900	17,220	680
T 1 N R 6 E	3,515	1,470	2,045				3,515	1,470	2,045
T 2 N R 1 E	16,645	14,700	1,945	16,645	14,700	1,945			
T 2 N R 2 E	22,245	19,910	2,335	22,245	19,910	2,335			
T 2 N R 3 E	14,795	12,480	2,315	14,795	12,480	2,315			
T 2 N R 4 E	3,300	2,050	1,250	3,300	2,050	1,250			
T 2 N R 5 E	4,365	3,458	907	3,240	2,333	907	1,125	1,125	
T 2 N R 6 E	875	475	400				875	475	400
T 3 N R 1 E	3,760	2,790	970	3,760	2,790	970			
T 3 N R 2 E	6,095	4,415	1,680	6,095	4,415	1,680			
T 3 N R 3 E	935	895	40	935	895	40			
T 1 N R 1 W	1,000	1,000		1,000	1,000				
T 1 S R 4 E	10,470	9,605	865				10,470	9,605	865
T 1 S R 5 E	13,800	10,570	3,230				13,800	10,570	3,230
T 1 S R 6 E	5,840	640	5,200				5,840	640	5,200
T 2 S R 5 E	1,965	660	1,305				1,965	660	1,305
T 2 S R 6 E	60		60				60		60
Total	179,970	151,083	28,887	106,605	91,813	14,792	73,365	59,270	14,095

TABLE No. 7.

A table showing the acreage of the North Side Class A land by Townships and years.

YEARS	T 1 N R 1 E	T 1 N R 2 E	T 1 N R 3 E	T 1 N R 4 E	T 2 N R 1 E	T 2 N R 2 E	T 2 N R 3 E	T 2 N R 4 E	T 2 N R 5 E	T 3 N R 1 E	T 3 N R 2 E	T 3 N R 3 E	T 1 N R 1 W	Totals
Indian									2333					2333
1869			3050				160							3210
1870		400	1055											1455
1871		1280	1855				160							3295
1872		710	80				1080							1870
1873	60	80	320											460
1874		260	145											405
1875							60							60
1876		1380	320											1700
1877		1120					640							1760
1878		1910	435			1120	440							3905
1879		960	270			640	1565							3435
1880	1440	1300	245		2000	2315	725							8025
1881	620	320	280		2430	1280	35							4965
1882	1600	320	40		4760	865	160							7745
1883	320	160	325		400		50							1255
1884	1120	160	170				40							1490
1885		150			240		180							570
1886	320	80			825	680	585							2500
1887			260			480	150	10		410	565	200		2075
1888		790	10	100		2250	365	445			320			4280
1889	160	110	40		540	2890	220	230		320	750			5260
1890		40	20	210	80	500	715	80		165	450		80	2340
1891			40			240	160			200	80	170		890
1892	220		310		840	760	180	120		355	400			3185
1893				140			330	360		80	220			1130
1894			220	80			235			170	160	30		895
1895		60			225		1245	35		115		10		1690
1896					200		90	100				80		470
1897		320					410	70		10				810
1898						40	90				80	5		215
1899		110					30			40	20			200
1900	40						65	225		40				370
1901		130					170	10			220			530
1902	120		70				170				20			380
1903			20			240	20							280
1904					160	240	100	15		80				595
1905			40				120			80	60			300
1906	230	20	225		10	140	70					80		775
1907	780	40		80	575	795	360	40		45	160	270	620	3605
1908	790	200	20		600	2545	935	230		590	375	50	400	6725
1909	235	260	40		805	1890	370	80		90	535			4305
Total	8055	12,670	9905	610	14,700	19,910	12.480	2050	2333	2790	4415	895	1000	91.812

TABLE No. 8.

A table showing the acreage of the South Side Class A land by Township and years.

YEARS	T 1 N R 2 E	T 1 N R 3 E	T 1 N R 4 E	T 1 N R 5 E	T 1 N R 6 E	T 2 N R 5 E	T 2 N R 6 E	T 1 S R 4 E	T 1 S R 5 E	T 1 S R 6 E	T 2 S R 5 E	Totals
1870	80	285										365
1871				870								870
1872			4535	295								4830
1873		1625	160	150								1935
1874												
1875		320	500									820
1876			960									960
1877			1210	1540				640				3390
1878		765	1030	2075		1115	445					5430
1879		95	15	1840				800				2750
1880			140	2260								2400
1881			410	620				680				1710
1882				855								855
1883	40	740	280	720				160				1940
1884			320	915				440				1675
1885				1190				640				1830
1886				690				715				1405
1887		410	510	805				1440	640			3805
1888			670	240				1270	3645			5825
1889		320		270	1040			160	480			2270
1890		55	15	255				1220	160	320		2025
1891		345	320	80				480	410			1635
1892		300		520	335				2630	120		3905
1893				260					685		640	1585
1894				15					120			135
1895		240										240
1896	40	220						160	80			500
1897				105				160	280			545
1898				315	40	10						365
1899												
1900				65	30				240			335
1901				160								160
1902												
1903		200										200
1904		110										110
1905		20					25		830	200		1075
1906			220						20			240
1907				20				640	270			930
1908				90					80		20	190
1909							30					30
Total	160	6050	11,295	17,220	1445	1125	500	9605	10,570	640	660	59,270

TABLE No. 9.

A table of the acreage of Class A land, showing the year of first cultivation, the acreage for that year and the total acreage year by year up to and including the year 1909.

YEARS.	Total acreage	Total on North Side	Total on South Side	Broadway Canal	San Francisco Canal	Tempe Canal	Utah Canal	Mesa Canal	Consolidated Canal	Highland Canal
Indian	2,333	2,333								
1869	2,333	2,333								
	3,210	3,210								
1870	5,543	5,543								
	1,820	1,455	365	365						
1871	7,363	6,998	365	365						
	4,165	3,295	870			820	50			
1872	11,528	10,293	1,235	365		820	50			
	6,700	1,870	4,830			4,830				
1873	18,228	12,163	6,065	365		5,650	50			
	2,395	460	1,935		1,625	310				
1874	20,623	12,623	8,000	365	1,625	5,960	50			
	405	405								
1875	21,028	13,028	8,000	365	1,625	5,960	50			
	880	60	820		320	500				
1876	21,908	13,088	8,820	365	1,945	6,460	50			
	2,660	1,700	960			960				
1877	24,568	14,788	9,780	365	1,945	7,420	50			
	5,150	1,760	3,390			1,850	1,540			
1878	29,718	16,548	13,170	365	1,945	9,270	1,590			
	9,335	3,905	5,430		765	1,030	1,310	2,325		
1879	39,053	20,453	18,600	365	2,710	10,300	2,900	2,325		
	6,185	3,435	2,750		95	815	55	1,785		
1880	45,238	22,888	21,350	365	2,805	11,115	2,955	4,110		
	10,425	8,025	2,400		80	60	40	2,220		
1881	55,663	31,913	23,750	365	2,885	11,175	2,995	6,330		
	6,675	4,965	1,710			1,090		620		
1882	62,338	36,878	25,460	365	2,885	12,265	2,995	6,950		
	8,600	7,745	855				320	535		
1883	70,938	44,623	26,315	365	2,885	12,265	3,315	7,485		
	3,195	1,255	1,940	40	740	440		720		
1884	74,133	45,878	28,255	405	3,625	12,705	3,315	8,205		
	3,165	1,490	1,675			1,035	320	320		
1885	77,298	47,368	29,930	405	3,625	13,740	3,635	8,525		
	2,400	570	1,830			800	750	280		
1886	79,698	47,938	31,760	405	3,625	14,540	4,385	8,805		
	3,905	2,500	1,405			760	365	280		
1887	83,603	50,438	33,165	405	3,625	15,300	4,750	9,085		
	5,880	2,075	3,805		95	2,285	640	785		
1888	89,483	52,513	36,970	405	3,720	17,585	5,390	9,870		
	10,105	4,280	5,825			1,940	3,565	320		
1889	99,588	56,793	42,795	405	3,720	19,525	8,955	10,190		
	7,530	5,260	2,270			480	320	1,470		
1890	107,118	62,053	45,065	405	3,720	20,005	9,275	11,660		
	4,365	2,340	2,025			1,290	255	480		
	111,483	64,393	47,090	405	3,720	21,295	9,530	12,140		

TABLE No. 9—(Continued)

YEARS.	Total acreage...	Total on North Side....	Total on South Side....	Broadway Canal..........	San Francisco Canal..........	Tempe Canal....	Utah Canal....	Mesa Canal....	Consolidated Canal..........	Highland Canal..........
1891	111,483 2,525	64,393 890	47,090 1,635	405	3,720	21,295 1,145	9,530	12,140 490		
1892	114,008 7,090	65,283 3,185	48,725 3,905	405	3,720	22,440 300	9,530 430	12,630 1.655	 1,280	 240
1893	121,098 2,715	68,468 1,130	52,630 1,585	405	3,720	22,740	9,960 685	14,285 260	1,280 640	240
1894	123,813 1,030	69,598 895	54,215 135	405	3,720	22,740	10,645 120	14,545 15	1,920	240
1895	124,843 1,930	70,493 1,690	54,350 240	405	3,720	22,740 240	10,765	14,560	1,920	240
1896	126,773 970	72,183 470	54,590 500	405 40	3,720	22,980 380	10,765	14,560 80	1,920	240
1897	127,743 1,355	72,653 810	55,090 545	445	3,720	23,360 160	10,765	14,640 105	1,920 280	240
1898	129,098 580	73,463 215	55,635 365	445	3,720	23,520	10,765 35	14,745 330	2,200	240
1899	129,678 200	73,678 200	56,000	445	3,720	23,520	10,800	15,075	2,200	240
1900	129,878 705	73,878 370	56,000 335	445	3,720	23,520	10,800 65	15,075 270	2,200	240
1901	130,583 690	74,248 530	56,335 160	445	3,720	23,520	10,865	15,345	2,200	240 160
1902	131,273 380	74,778 380	56,495	445	3,720	23,520	10,865	15,345	2,200	400
1903	131,653 480	75,158 280	56,495 200	445	3,720 200	23,520	10,865	15,345	2,200	400
1904	132,133 705	75,438 595	56,695 110	445	3,920 110	23,520	10,865	15,345	2,200	400
1905	132,838 1,375	76,033 300	56,805 1,075	445 20	4,030	23,520	10,865 270	15,345 760	2,200	400 25
1906	134,213 1,015	76,333 775	57,880 240	465	4,030	23,520 220	11,125	16,105 20	2,200	425
1907	135,228 4,595	77,108 3,665	58,120 930	465	4,030	23,740 640	11,135	16,125 180	2,200 110	425
1908	139,823 6,925	80,773 6,735	59,050 190	465	4,030	24,380	11,135	16,305 170	2,310. 20	425
1909	146,748 4,335	87,508 4,305	59,240 30	465	4,030	24,380	11,135 30	16,475	2,330	425
Total acreage	151.083	91.813	59.270	465	4,030	24,380	11.165	16.475	2.330	425

TABLE No. 10.

A table of acres and miners' inches for Class A land, showing the total acreage year by year and water for the same at 48 miners' inches per quarter section or one miners' inch for every three and one-third acres.

YEARS	Total acreage and miners' inches	Total on North Side	Total on South Side	Broadway Canal	San Francisco Canal	Tempe Canal	Utah Canal	Mesa Canal	Consolidated Canal	Highland Canal
Indian	2,333	2,333								
	700	700								
1869	5,543	5,543								
	1,663	1,663								
1870	7,363	6,998	365	365						
	2,209	2,099	110	110						
1871	11,528	10,293	1,235	365		820	50			
	3,459	3,088	371	110		246	15			
1872	18,228	12,163	6,065	365		5,650	50			
	5,469	3,649	1,820	110		1,695	15			
1873	20,623	12,623	8,000	365	1,625	5,960	50			
	6,187	3,787	2,400	110	487	1,788	15			
1874	21,028	13,028	8,000	365	1,625	5,960	50			
	6,308	3,908	2,400	110	487	1,788	15			
1875	21,908	13,088	8,820	365	1,945	6,460	50			
	6,572	3,926	2,646	110	583	1,938	15			
1876	24,568	14,788	9,780	365	1,945	7,420	50			
	7,370	4,436	2,934	110	583	2,226	15			
1877	29,718	16,548	13,170	365	1,945	9,270	1,590			
	8,915	4,964	3,951	110	583	2,781	477			
1878	39,053	20,453	18,600	365	2,710	10,300	2,900	2,325		
	11,716	6,126	5,580	110	813	3,090	870	697		
1879	45,238	23,888	21,350	365	2,805	11,115	2,955	4,110		
	13,571	7,166	6,405	110	842	3,334	886	1,233		
1880	55,663	31,913	23,750	365	2,885	11,175	2,995	6,330		
	16,699	9,574	7,125	110	866	3,352	898	1,899		
1881	62,338	36,878	25,460	365	2,885	12,265	2,995	6,950		
	18,701	11,063	7,638	110	866	3,679	898	2,085		
1882	70,938	44,623	26,315	365	2,885	12,265	3,315	7,485		
	21,282	13,387	7,895	110	866	3,679	995	2,245		
1883	74,133	45,878	28,255	405	3,625	12,705	3,215	8,205		
	22,240	13,763	8,477	122	1,087	3,812	995	2,461		
1884	77,298	47,368	29,930	405	3,625	13,740	3,635	8,525		
	23,189	14,210	8,979	122	1,087	4,122	1,091	2,557		
1885	79,698	47,938	31,760	405	3,625	14,540	4,385	8,805		
	23,909	14,381	9,528	122	1,087	4,362	1,316	2,641		
1886	83,603	50,438	33,165	405	3,625	15,300	4,750	9,085		
	25,081	15,131	9,950	122	1,087	4,590	1,425	2,726		
1887	89,483	52,513	36,970	405	3,720	17,585	5,390	9,870		
	26,845	15,754	11,091	122	1,116	5,275	1,617	2,961		
1888	99,588	56,793	42,795	405	3,720	19,525	8,955	10,190		
	29,877	17,038	12,839	122	1,116	5,857	2,687	3,057		
1889	107,118	62,053	45,065	405	3,720	20,005	9,275	11,660		
	32,136	18,616	13,520	122	1,116	6,002	2,782	3,498		
1890	111,483	64,393	47,090	405	3,720	21,295	9,530	12,140		
	33,445	19,318	14,127	122	1,116	6,388	2,859	3,642		

TABLE No. 10—(Continued)

YEARS	Total acreage and miners' inches	Total on North Side	Total on South Side	Broadway Canal	San Francisco Canal	Tempe Canal	Utah Canal	Mesa Canal	Consolidated Canal	Highland Canal
1891	114,008	65,283	48,725	405	3,720	22,440	9,530	12,630	———	———
	34,203	19,585	14,618	122	1,116	6,732	2,859	3,789	———	———
1892	121,098	68,468	52,630	405	3,720	22,740	9,960	14,285	1,280	240
	36,329	20,540	15,789	122	1,116	6,822	2,988	4,285	384	72
1893	123,813	69,598	54,215	405	3,720	22,740	10,645	14,545	1,920	240
	37,144	20,879	16,265	122	1,116	6,822	3,193	4,364	576	72
1894	124,843	70,493	54,350	405	3,720	22,740	10,765	14,560	1,920	240
	37,453	21,148	16,305	122	1,116	6,822	3,229	4,368	576	72
1895	126,773	72,183	54,590	405	3,720	22,980	10,765	14,560	1,920	240
	38,032	21,655	16,377	122	1,116	6,894	3,229	4,368	576	72
1896	127,743	72,653	55,090	445	3,720	23,360	10,765	14,640	1,920	240
	38,323	21,796	16,527	134	1,116	7,008	3,229	4,392	576	72
1897	129,098	73,463	55,635	445	3,720	23,520	10,765	14,745	2,200	240
	38,730	22,039	16,691	134	1,116	7,056	3,229	4,424	660	72
1898	129,678	73,678	56,000	445	3,720	23,520	10,800	15,075	2,200	240
	38,903	22,103	16,800	134	1,116	7.056	3,240	4,522	660	72
1899	129,878	73,878	56,000	445	3,720	23,520	10,800	15,075	2,200	240
	38,963	22,163	16,800	134	1,116	7,056	3.240	4,522	660	72
1900	130,583	74,248	56,335	445	3,720	23,520	10,865	15,345	2,200	240
	39,175	22,274	16,901	134	1,116	7.056	3,260	4,603	660	72
1901	131,273	74,778	56,495	445	3,720	23,520	10,865	15,345	2,200	400
	39,382	22,433	16,949	134	1,116	7,056	3.260	4,603	660	120
1902	131,653	75,158	56,495	445	3,720	23,520	10,865	15,345	2,200	400
	39,496	22,547	16,949	134	1,116	7.056	3,260	4,603	660	120
1903	132,133	75,438	56,695	445	3,920	23,520	10,865	15,345	2,200	400
	39,640	22,631	17,009	134	1,176	7,056	3.260	4,603	660	120
1904	132,838	76,033	56,805	445	4,030	23,520	10,865	15,345	2,200	400
	39,852	22,810	17,042	134	1,209	7.056	3,240	4,603	660	120
1905	134,213	76,333	57,880	465	4,030	23,520	11,135	16,105	2,200	425
	40,264	22,900	17,364	140	1,209	7,056	3.340	4,832	660	127
1906	135,228	77,108	58,120	465	4,030	23,740	11,135	16,125	2,200	425
	40,568	23,132	17,436	140	1.209	7.122	3,240	4,838	660	127
1907	139,823	80,773	59,050	465	4,030	24,380	11,135	16,305	2,310	425
	41,947	24,232	17,715	140	1,209	7,314	3.340	4,892	693	127
1908	146,748	87,508	59.240	465	4,030	24.380	11,135	16,475	2,330	425
	44,024	26,252	17,772	140	1,209	7.314	3,340	4,943	699	127
1909	151,083	91,813	59,270	465	4,030	24,380	11,165	16,475	2,330	425
	45,325	27,544	17,781	140	1.209	7,314	3.349	4.943	699	127

EXHIBIT 178

TWO BRIDGE QUESTIONS

Answered Yesterday By District Attorney Bullard

THE FIRST AFFECTS TEMPE

'It Is Held That the County May Construct a Bridge Within Limits of a Municipality---And Location Must Be Detrmined By a Vote.

A few days ago the question was raised whether the county could undertake the construction of a county bridge wholly within the limits of an incorporated town, it having been brought to the notice of the board of supervisors that the city limits of Tempe include the proposed bridge site there.

This matter was referred to District Attorney Bullard, along with another question as to whether a majority of the votes cast should be necessary in order to determine the location of a bridge or whether a plurality would be sufficient.

The district attorney yesterday submitted the following opinion, that the law permits the construction of a bridge across "any non-navigable stream," even if it be in Tempe. It is also the opinion of the district attorney that a majority of all the votes cast at the election shall be required to determine the location of any bridge. The opinion follows:

"To the Honorable the Board of Supervisors of Maricopa County, Arizona Territory:

"Gentlemen:—By resolution, yesterday morning, you requested an opinion from me on the question as to whether or not, if the site of the proposed Tempe bridge is wholly within the corporate limits of the town of Tempe, if the board of supervisors would have the power to construct the bridge if the taxpayers of Maricopa county, at the coming election, should determine upon that location.

"There are two statutes in our code to be taken into consideration in determining this question:

"First—The general incorporation act of towns passed in the year 1891 by the legislature, and under which the town of Tempe is incorporated, which provides in subdivision 4 of paragraph 545 of the Revised Statutes of Arizona, 1901, as follows, amongst the powers granted to towns, incorporated under the act:

"'Fourth—To erect and maintain bridges, culverts, sidewalks and crossways; to prevent and punish for injuries thereto or obstructions thereon.'

"Also the general bridge law, viz.: Council bill No. 157, passed by the last legislature, which gives the board of supervisors the right, when directed by a vote of the people, to construct a bridge across any non-navigable stream in the county, at any point within the county, without limitation.

"Query: Does the provision of law provided for in section 545 prevent the board of supervisors from erecting a bridge within the corporate limits of a town or city where there is a general law allowing them to erect them within any part of the county, such as is provided by the act passed by the last legislature?

"I have examined exhaustively into, I think, every case directly decided upon this question that has been decided in the United States, including those cases cited to me by eminent counsel, who claim that the board has no right to construct this bridge within the corporate limits of the town of Tempe. The cases cited by them are as follows: A Colorado case reported in the 46 Pacific, page 474; a case reported in the 111 Illinois, 427, and the Texas case reported in American State Reports.

"The Illinois case goes off on the question that one town cannot compel an adjoining city to join it in the building of a bridge.

"The Texas case is one that relates solely to highways, holding that an overseer of a highway cannot be indicted for failing to improve a highway within the limits of an incorporated town, which doctrine is unquestionably correct, and would be correct under our system of law, for our statute provides that the county road funds cannot be expended for the purpose of improving highways within an incorporated city.

"On the other hand, the states of Iowa, Florida, New Jersey and Minnesota all hold, that, under laws similar to ours, that the county has a right to construct a bridge within the corporate limits of a city, especially where that bridge crosses a water course and benefits the entire county, and more especially when the bridge is to be constructed from a tax levied upon the entire people of the county, including the taxpayers of the city within whose corporate limits the bridge is to be constructed.

"The decision which has the greatest weight in my mind is the one reported in 21 Iowa, on page 119, a case almost on all fours with the one in question. This case was decided by Judge Dillon, who was then upon the bench of Iowa, and who is acknowledged by the authorities and all courts to be the greatest authority on municipal law in the United States. At the time this case was decided, Iowa had a general bridge law which provided that the supervisors could build bridges without limitation within the county, and provided that the cost of the building of such bridge should be met by a taxation on all of the taxpayers of the county.

"Iowa also at that time had a general incorporation act for towns and cities, the same as ours, which provided that city councils shall have the care, supervision and control of all public highways, bridges, streets and alleys and commons within the city. It will be noted that this provision is practically the same as that contained in paragraph 545 of our code. Therefore, as far as the law is concerned, in the Iowa case, the statutes were practically the same. The bridge sought to be built was over a large stream running through the city of Des Moines, Iowa, and the street on both sides of the bridge was Walnut street of said city, a street of the city of Des Moines, but which Walnut street connected with county highways.

"Referring to the section of the law which provided that city councils shall have control of all public highways, bridges, streets, alleys, etc., within the corporate limits, Judge Dillon said:

"'We do not think a fair construction of this general language requires us to hold that it ousts the county of the right, which we have shown it would otherwise possess, to bridge the Des Moines at the place in question. We briefly state the reasons for this opinion:

"'1. Many bridges in a city are purely local, across gutters or small streams, such, for example, as Bird's run, in Des Moines, and not connected with the public highways of the county, and to these this language may properly apply.'

"Again, further on in the opinion, he says:

"'But the chief, and it seems to our mind a most satisfactory, reason for the above opinion, to-wit, that the county can build the bridge within the corporate limits of the city, consists in the fact that the county bridge tax, provided for, is levied upon all of the taxable property of the county, upon that within the city the same as upon that without the city.

"'The burden is equal upon the city and county. Shall we ignore all equitable considerations, and hold that there shall be equality of burden but not of benefit? Shall we adjudge that the city has the capacity, nay, the duty, to pay but not the power to enjoy? The law is plain, that the county may levy a bridge tax upon the taxable property within the city; indeed, if it levies such a tax at all, it must levy it upon the property of the whole county, including the city.

"'The law thus obliging the citizens of Des Moines to pay a bridge tax, shall we hold them utterly disabled from participating in the advantages which are presumed to be the consideration of the tax? Such a construction would be wholly unwarranted, the language not imperatively requiring it.'

"Further on, the court, in reviewing his opinion, says:

"'If we should be mistaken in the view above taken, as to the power and right of the county to erect public bridges on public highways inside of the city, still we cannot be mistaken in saying that it is a matter of county duty to see that bridges across the water courses of the county are provided for.'

"It will be seen how pat this decision is with the situation of affairs in this election. The general bridge law provides that where the bridge is voted, that the tax shall be borne by all of the people of the county. The law is similar, or practically similar, to that, in this territory. The stream to be crossed is, as was in the Iowa case, running to and from the bridge, connect, as in the Iowa case with county roads. Therefore, all the reasons given by that eminent jurist, Judge Dillon, in the Iowa case, are equally applicable to the case upon which I am asked to render an opinion.

"Later than that, the supreme court of Iowa, in the 72 Iowa, page 124, reported in the 33 Northwestern, 605, at a much later date, reiterated the opinion rendered by Judge Dillon, and it is the law in Iowa today.

"New Jersey has also held that the fact that the city charter provided that they shall have jurisdiction of bridges and streets within the corporate limits of said city, does not prevent the board of supervisors from constructing a county bridge within the limits of an incorporated city where there is a general bridge law, providing that they might do so without limitation.

"Minnesota also holds the same doctrine. In the case of Greenman vs. The Board of Commissioners of Mower County, reported in 64 N. W., page 1112, the supreme court of Minnesota held that where a general law provided that the county commissioners of the county of Mower shall construct and build and keep in repair all bridges built in said county, except where the cost and expenditure shall be less than $100, that said county had a right to build a public bridge within the corporate limits of the city of Austin, despite the fact that there was also a general law which provided that the common council of said city of Austin shall have the care, supervision and control of all highways, bridges, streets, alleys and public squares and keep in repair bridges and the approaches to the same.

"It will be observed that in the state of Minnesota the law is practically the same as ours, and yet in this case the supreme court decided that the charter powers of the city did not limit the general power of the county to construct a bridge within the corporate limits of the city, and they further intimated that, though there was no repealing clause to the general law giving counties power to build bridges, which was passed after the city charter law, that the latter, by implication, repealed the former, though they did determine that it was not necessary to decide the question in that case.

"I find, further, another extremely well-reasoned case, decided by the supreme court of the state of Florida, to-wit, the case of Skinner vs. W. B. Henderson et al., commissioners of Hillsboro county, in which the supreme court of the state of Florida held that the state could not impose taxes except for county purposes, and that the building of a bridge within the corporate limits of a municipality in which the county outside of those limits is in nowise interested, the same being for the sole benefit and advantage of the city, being wholly within its corporate limits and entirely a municipal improvement, and is not a county purpose, but that the statute authorizing the city to build bridges within its limits does not necessarily revoke the authority given to the county by general statute without restriction as to locality to build a bridge within those limits. As there may be bridges serving only a city purpose, but there may be others demanded in the same territory for county purposes, and where the circumstances create this demand, and the bridge is for the use and benefit of the people of the county at large, or of some considerable portion of it, and intended and needed as well for those outside as for those inside the city, the authority of the county to build is not annulled by the local city statute.

"In view of these authorities, what is the decision of affairs in regard to the so-called Tempe bridge site?

"The proposed bridge to be constructed over a large water-course, to-wit, a large non-navigable stream. While it is true that it will, perhaps, entirely be constructed within the corporate limits of the town of Tempe, still the town of Tempe is moderate in size, unable to build a bridge of that character by itself, and the bridge, when constructed, will be connected within a quarter of a mile, if voted by the people, with one of the large main arteries throughout the county, to-wit, a county road. The bridge will, therefore, not only subserve the interests of the town of Tempe alone, but in reality will be used in a greater proportion by people outside of Tempe in the county of Maricopa than by the people of Tempe alone. Therefore, the main object of the bridge, if constructed, is for the subservance of the entire county interests, whether the bridge is located at Tempe or at some other point, all of the taxpayers of the county must pay for its construction, including the taxpayers of the town of Tempe.

"I am, therefore, of the opinion, and so hold, that the great weight and preponderance of authority, together with the best-reasoned cases, are to the effect that the mere fact that there is a statute giving an incorporated city the right to construct bridges within the limits of that incorporated city, does not prevent the county of Maricopa from constructing a bridge within the corporate limits of said city, where there is a general bridge law without limitation, as was passed by the last legislature.

"I should hesitate, if Judge Dillon stood alone in his opinion, to hold contrary to him, for the reason that he is recognized as one of the ablest lawyers in the United States upon this particular question; but, as I said before, outside of his decision, the great preponderance of authority is in conformance with the doctrine that under a general power to build bridges, that a county may build a bridge within the limits of an incorporated city, even where there is a statute giving that incorporated city power to build bridges within its limits. Such being the case, I unhesitatingly hold, that, if the voters of the county of Maricopa should determine to vote the Tempe site, that the board of supervisors would have authority and power to construct a bridge at that site, even though it is within the corporate limits of the town of Tempe. However, desiring the board of supervisors to understand that this opinion is solely upon the question of law, and not as to whether the Tempe site is or is not the most desirable one to vote for.

"Another question that has been submitted to me for my opinion is as to what number of votes it takes to authorize the board of supervisors to build a bridge at any site. As is generally understood by the public, there are three sites to be voted for—the Tempe site, the so-called Center street sit, and the so-called Agua Fria site. Each one of these three constitutes a separate proposition upon the ballot. In other words, the voters have three propositions to vote for. They may vote 'Yes' on all three, or they may vote 'No' on all three, or they may vote 'Yes' on either one or two of the three, and 'No' on the other proposition. The law, however, provides in section 4 of the act, upon the determination at such special election by a majority of the taxpayers voting at such election at which point or points such bridge or bridges shall be constructed, it shall be the duty of such supervisors to proceed forthwith to construct said wagon and foot-bridge across said stream at the point or points designated at such election. There can be no misconstruction of this statute whatever. The law does not say the majority of votes cast for a proposition; the law says that the site must be determined by a majority of the taxpayers voting at such election, not voting on each particular proposition, but voting at such election. Therefore, in order for a site to carry it must be favorably a majority of the votes of all of the persons voting at such election. In other words, if there are 1,000 persons who cast their votes at the forthcoming bridge election, in order for any site to carry, it must receive at least 501 votes. If there are 2,000 persons vote at said bridge election, any site, to carry, must have cast favorably for it 1,001 votes, and so on in proportion to the amount of votes cast. I would, however, advise, in order that there may be no confusion upon the question, that every voter who votes in this bridge election should vote 'Yes' or 'No' on all of the propositions submitted.

"This, I think, covers all of the questions requested of me.

"I have given these questions earnest thought and earnest investigation, for the reason that I know that in some directions, on each side, the feeling on this question is very hard, and I was earnest in my desire, as I always am, to be absolutely impartial in rendering an opinion, and I am thoroughly satisfied that the law I have announced in this opinion is the law which governs the questions submitted to me for an opinion. Very respectfully,

"G. P. BULLARD,

"District Attorney of Maricopa County, Arizona Territory."

CHEERFUL IN DEFEAT—Wayne Davis, the democratic candidate for city marshal last night after the count said that he was neither sore nor disappointed. He desired to thank his democratic friends and a large number of republican friends who has supported him. He was gratified at the showing he had made and said that he was glad that he had made the race. He was particularly glad that he had made a clean race.

EXHIBIT 179

Name	Type	Tons	Length	Beam	Launched	Disposition
Nina Tilden	stern	120	97	22	San Francisco July 1864[6]	Wrecked Sept. 1874
Retta	stern	. . .	36	6	Yuma, Ariz. 1900	Sunk Feb. 1905
St. Vallier	stern	92	74	17	Needles, Calif. Early 1899	Sunk Mar. 1909
San Jorge	screw	. . .	38	9	Yuma, Ariz. June 1901	To Gulf July 1901
Searchlight	stern	98	91	18	Needles, Calif. Dec. 1902	"Lost" Oct. 1916
Uncle Sam	side	40	65	16	Estuary, Mex. Nov. 1852	Sunk May 1853
Undine	stern	. . .	60	10	Green River, Utah Nov. 1901	Wrecked May 1902

[1]Rebuilt from gasoline-powered screw *City of Moab.*
[2]Renamed *Vista.*
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EXHIBIT 180

STREAMS

their dynamics and morphology

Earth and
Planetary Science
Series

Marie Morisawa

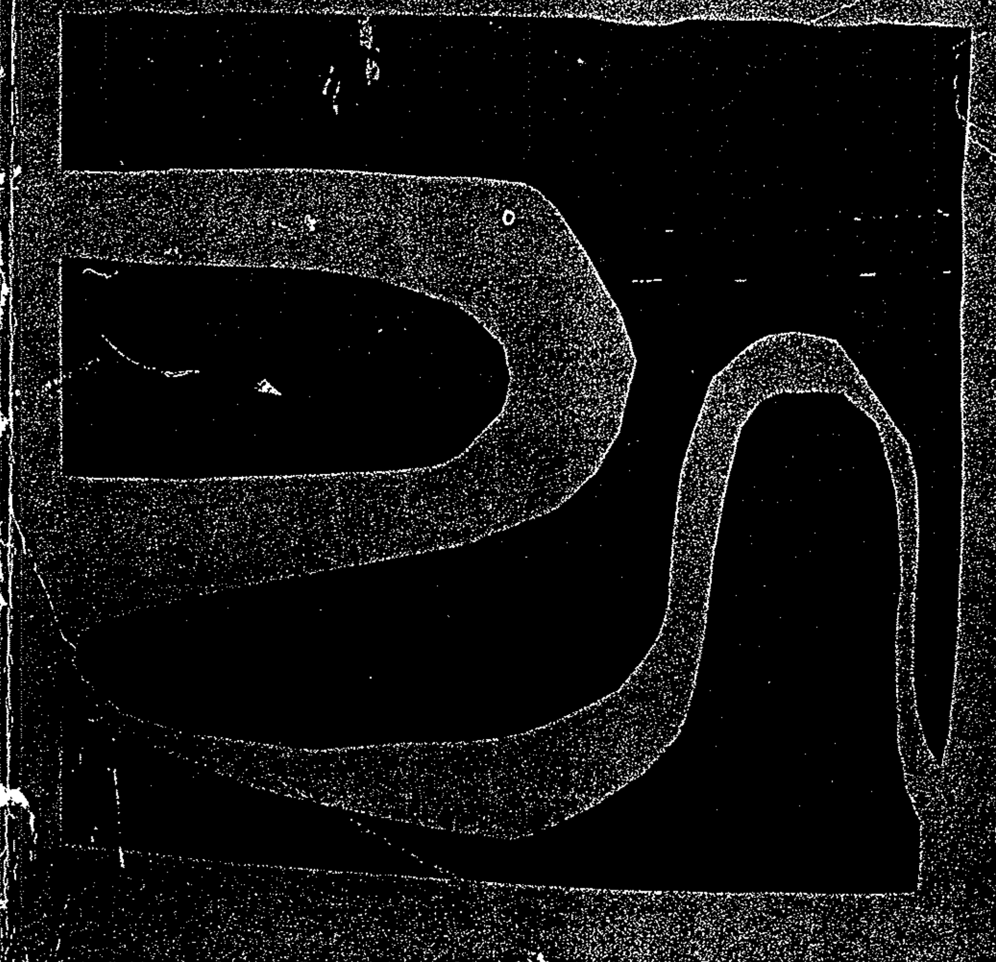

Plate 23 Braided channel of the North Platte River, Nebr.

to enable the stream to do its work. Deposition of the bars is an effective hydraulic device to increase velocity by narrowing the channel. Also, before the bar is built up above water level, deposition serves to decrease the depth of flow, thus increasing roughness and turbulence. Perhaps the real key to the cause of braiding is the proportion of bed load to available discharge.

Braided-channel morphology

Changes in channel morphology and slope occur along with the braiding. Channel width, i.e., the sum of the water surfaces, in a divided reach is greater than the width of the water surface before division. Of course, each divided channel is narrower than the original channel width. Depth of the water in each braided reach is less than the depth of the nonbraided channel. Although effective bottom velocity is greater in a divided reach because of decreased depth, it has been found that, as a result of turbulence, actual forward velocity of flow in naturally braided stretches is less. Moreover, braiding is generally associated with an increase in channel gradient.

Noting that a distinguishing characteristic of braided rivers is the steeper gradient, Leopold and Wolman plotted bank-full dis-

charge against channel slope for a number nels (Fig. 9.4). They found that they could tion such that points representing braidec and points representing meandering channe channels cannot be distinguished from the factor disregarded, this graph seems to indi: discharge, meanders occur at lower slopes

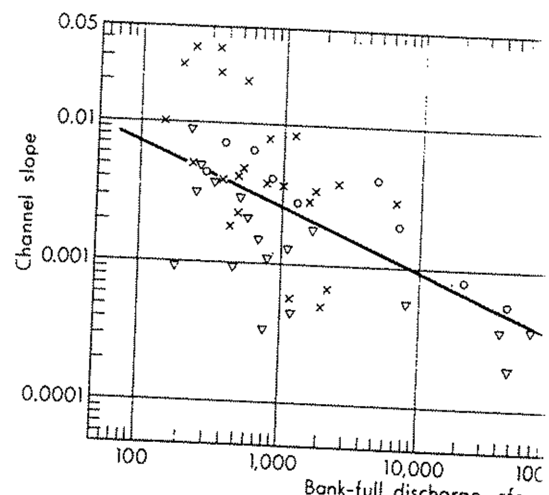

Fig. 9.4 Bank-full discharge plotted against chan braided, meandering, and straight stretches. [After (1957).]

a given slope, meanders will occur at a sm will braiding. This might also mean that with the stream for some reason cannot change, an will result in a change from a meandering to that with a given discharge, if a stream incr will also change its pattern from a meanderin However, it must be borne in mind that am bed load supplied to the river, in relation to seem to be important factors.

EXHIBIT 181

ARIZONA CLIMATE

The University of Arizona
1885
One Hundred Years
1985
A Proud Beginning

THE FIRST HUNDRED YEARS

Editors
WILLIAM D. SELLERS
RICHARD H. HILL
MARGARET SANDERSON-RAE

TABLE 2. Significant Wet and Dry Periods Observed in Arizona, 1895-1983*

Dry Periods (Month/Year)	Duration (Months)	Wet Periods (Month/Year)	Duration (Months)
3/1896 - 8/1896	6		
9/1898 - 12/1904	76		
		2/1905 - 10/1907	33
		1/1915 - 11/1917	35
		7/1919 - 10/1920	16
5/1928 - 3/1929	11		
		8/1931 - 7/1933	24
3/1934 - 10/1934	8		
		12/1940 - 12/1941	13
5/1943 - 11/1943	7		
3/1947 - 1/1948	11		
8/1950 - 7/1951	12		
8/1953 - 2/1954	6		
1/1956 - 7/1957	19		
2/1961 - 7/1961	6		
		12/1965 - 9/1966	10
2/1971 - 7/1971	6		
3/1972 - 9/1972	7		
		10/1972 - 8/1973	10
		3/1978 - 6/1980	28

*Dry period defined as PDSI $\leq$ -2.0 for 6 consecutive months;
wet period as PDSI $\geq$ +2.0 for 6 consecutive months.

EXHIBIT 182

PREDEVELOPMENT HYDROLOGY OF THE SALT RIVER INDIAN RESERVATION, EAST SALT RIVER VALLEY, ARIZONA

By B.W. Thomsen and J.J. Porcello

U.S. GEOLOGICAL SURVEY
Water–Resources Investigations Report 91–4132

Prepared in cooperation with the
U.S. BUREAU OF INDIAN AFFAIRS

Tucson, Arizona
November 1991

U.S. DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
375 South Euclid Avenue
Tucson, Arizona 85719

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Box 25425
Denver, Colorado 80225

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ILLUSTRATIONS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	*By*	*To obtain*
inch (in.)	25.40	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre	0.4047	hectare
mile per hour (mi/h)	1.609	kilometer per hour
square mile (mi^2)	2.590	square kilometer
acre-foot (acre-ft)	0.001233	cubic hectometer
acre-foot per acre (acre-ft/acre)	0.3047	cubic meter per square meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
gallon per minute (gal/min)	0.06309	liter per second
foot squared per day (ft^2/d)	0.0929	meter squared per day
foot per mile (ft/mi)	0.1894	meter per kilometer
degree Fahrenheit (°F)	(temp °F-32)/1.8	degree Celsius

Sea level: In this report "*sea level*" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called "*Sea Level Datum of 1929*."

PREDEVELOPMENT HYDROLOGY OF THE SALT RIVER INDIAN RESERVATION, EAST SALT RIVER VALLEY, ARIZONA

By

B.W. Thomsen and J.J. Porcello

ABSTRACT

Predevelopment hydrologic conditions in the Salt River Valley were investigated to provide information for the adjudication of water rights of users in the Gila River basin. Prior to development by non-Indian settlers, the Salt River was perennial through the Salt River Indian Reservation. The ground-water reservoir was filled to capacity or nearly so and was sustained mainly by infiltration of water from the Salt River. Water levels generally were 10 to 70 feet below the land surface. The direction of ground-water flow was from north to south in Paradise Valley and from east to west along the flood plain of the Salt River and in the area south of the river.

The average annual discharge of the Salt River before development was estimated to be 1,250,000 acre-feet and the median annual discharge 950,000 acre-feet. These estimates are based on recorded data with adjustments for results of tree-ring studies and estimates of upstream diversions and reservoir evaporation.

A ground-water flow model was developed to simulate ground-water flow, riverbed infiltration, mountain-front recharge, and evapotranspiration for purposes of evaluating predevelopment ground-water conditions. The model represents average conditions in the ground-water system before the system was affected by storage and diversion of streamflow upstream from the reservation. Average values for components of ground-water flow determined from the model for the study area include recharge by infiltration from the Salt River, 19,700 acre-feet per year; mountain-front recharge and subsurface inflow, 10,700 acre-feet per year; discharge to the Salt River near Tempe, 9,800 acre-feet per year; evapotranspiration from ground water, 13,300 acre-feet per year; and subsurface outflow, 7,300 acre-feet per year.

INTRODUCTION

In the 1860's and 1870's, non-Indian settlers arrived in Arizona in large numbers and began to divert water from the Salt River near the area that became the Salt River Indian Reservation. The Salt River Indian Reservation was established in 1879 along the Salt River in the eastern part of the Salt River Valley. The development and activities since that time have significantly changed the hydrology of the area. The flow of the Salt River and the recharge to the ground-water system on the reservation have been greatly diminished as a result of upstream storage and diversions. Water levels in wells have declined, and the direction of ground-water flow has changed as a result of pumping for irrigation in areas adjacent to the reservation. General adjudication to determine water rights of users in the Gila River watershed is being conducted in the superior courts of Arizona under authority established by Arizona Revised Statutes Title 45, Chapter 1, Article 6. To develop data pertinent to the adjudication process, the U.S. Bureau of Indian Affairs entered into a cooperative agreement with the U.S. Geological Survey to evaluate the hydrologic conditions that existed prior to the development of the area by non-Indian settlers.

Purpose and Scope

The purpose of this report is to describe the hydrologic conditions that existed in the area of the Salt River Indian Reservation prior to development by non-Indian settlers. Non-Indian settlers were diverting significant quantities of water from the Salt River near the reservation in the 1870's (Davis, 1897). Hydrologic data do not exist for the period prior to 1870; therefore, data collected since 1870 were used to evaluate predevelopment conditions, as described in the section entitled "Approach." The results of the evaluation represent long-term average hydrologic conditions.

Approach

The evaluation of the hydrologic conditions that existed prior to 1870 required estimating the surface flow of the Salt River upstream from the Salt River Indian Reservation and defining the ground-water system in and adjacent to the reservation. Estimates of average flow of the Salt River were based on recorded data with adjustments to represent predevelopment conditions. The adjustments were based on the recorded effects of development on river flows and mathematical evaluations of climatic trends. Studies of relations between streamflow and tree rings were used to help substantiate estimates of the predevelopment flow of the Salt River.

The ground-water system was evaluated by using a mathematical model. The model covers an area larger than the reservation (fig. 1) in order to encompass parts of the mountain ranges that form physical boundaries to much of the ground-water system. The model parameters were estimated from published values and recorded field data; each parameter was estimated independently. Evapotranspiration was calculated by using the oldest maps and photographs available to determine areas and types of vegetation and applying evapotranspiration rates determined in recent studies.

Location, Physiography, and Climate

The study area includes about 950 mi^2 in south-central Arizona, of which about 77 mi^2 is in the Salt River Indian Reservation (fig. 1). The area is characterized by broad desert plains dissected by many arroyos and separated by rugged relatively low mountains. The altitude of the

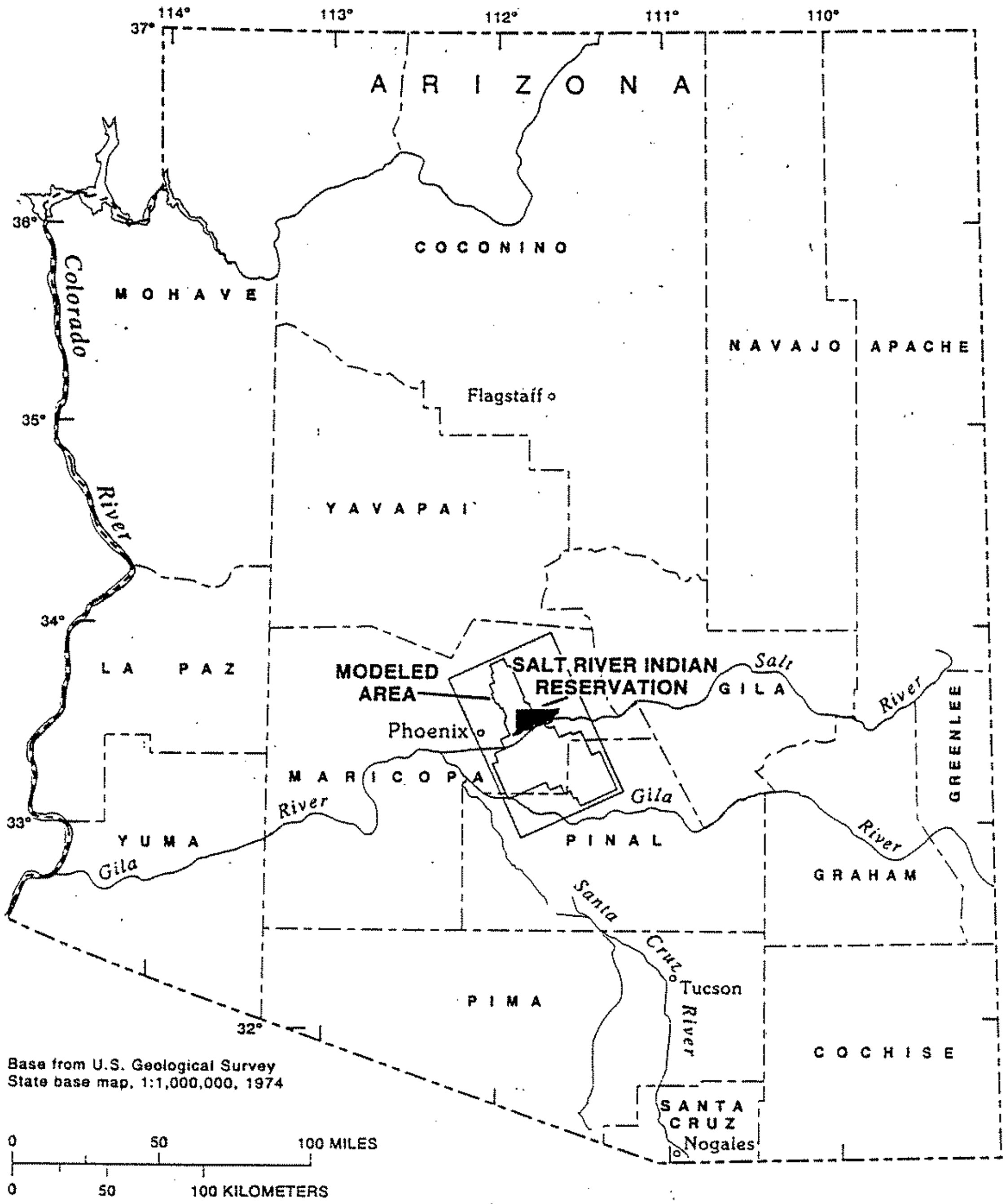


Figure 1.--Location of study area (shaded).

desert plains ranges from 2,200 ft above sea level north of the reservation to less than 1,200 ft at the southwest corner. The Phoenix and South Mountains, which are on the west side of the study area, reach altitudes of 2,500 ft. The McDowell and Superstition Mountains, which are on the east side, are at altitudes of about 4,000 and 5,000 ft, respectively. The major streams in the area are the Salt and Gila Rivers and Queen and Cave Creeks. The Salt River drains the northern part of the area, and the Gila River drains the southwestern part. Queen Creek, a tributary to the Gila River, drains the southeastern part, and Cave Creek crosses the northwest corner of the study area (fig. 2). The Salt River and its major tributary, the Verde River, drains more than 12,000 mi^2 north and northeast of the reservation (fig. 1) and, prior to the activities of the non-Indian settlers, contributed perennial flow through the study area.

The dominant native vegetation types are mesquite and saltbush along the washes and palo verde and cacti on the hills. Creosote bush covers most of the desert floor except where it has been replaced by cultivated farmland. Mesquite, cottonwood, and willow trees grew in places along the river when non-Indian settlers arrived (Lee, 1904) but most have been removed.

The climate is dry and incapable of supporting more than a minimum vegetative growth without irrigation. Summers are hot, and daily temperatures usually exceed 100°F from mid-June through August. Mean daily temperatures range from about 64°F to 105°F. The relative humidity generally is low, ranging from about 20 to 50 percent (Sellers and others, 1985).

Winters are mild, and average temperatures range from 30°F to 40°F in early morning and from 60°F to 80°F in the afternoons. Subfreezing temperatures occur on only a few days during an average year (Sellers and others, 1985). Mean daily temperatures range from about 33°F to 70°F.

Annual precipitation averages about 8 in. and results mainly from two types of storms. Summer thunderstorms, which develop as a result of the flow of moist-tropical air from the Gulf of Mexico, make July and August the wettest months. Regional storms from the Pacific Ocean produce gentle widespread showers during the fall and winter months.

Wind movement in the area is relatively light. In 1895, the monthly average was about 5 mi/h at Phoenix (Davis, 1897, p. 31). U.S. Weather Bureau records for January 1948 through December 1955 show that average wind speeds do not exceed 8.3 mi/h at Phoenix (Sellers and Hill, 1974, p. 30).

Previous Investigations

An investigation of the water supplies available for irrigation in the Salt and Gila Valleys near Phoenix, Arizona, was made in 1896 by Authur P. Davis (1897). This investigation dealt mainly with surface-water supplies. W.T. Lee (1905) investigated the underground waters of the Salt River Valley; his report presents tabulations of well records, water levels, and chemical quality of ground water and includes descriptions of geology, physiography, and the economics of pumping ground water. Ground

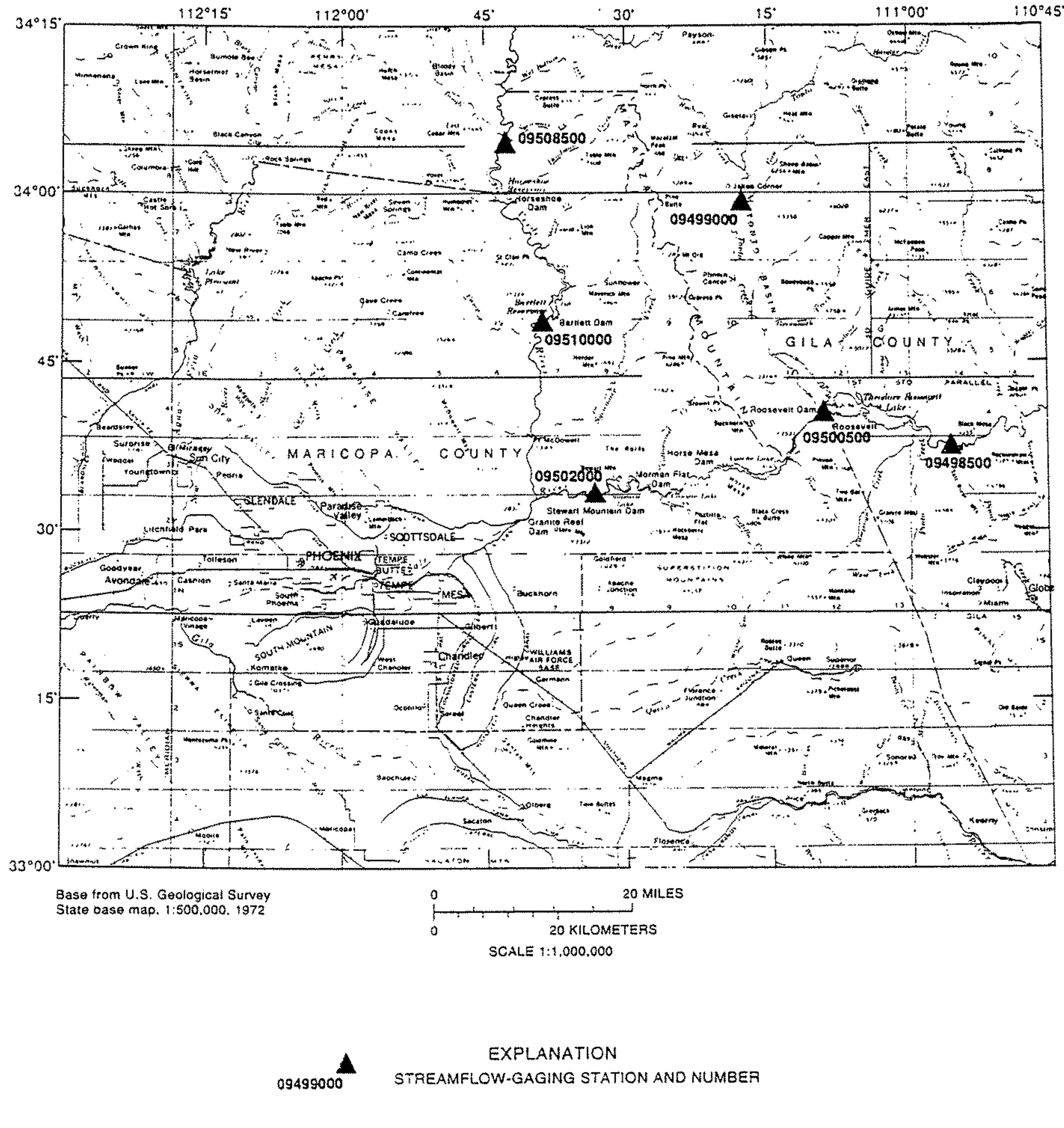


Figure 2.--Location of streamflow-gaging stations.

water of the Arizona territory was examined to determine its suitability for sanitary, irrigation, and technical uses (Skinner, 1903).

A study of Paradise Valley was made to evaluate the possibility of developing a ground-water supply for irrigation (Meinzer and Ellis, 1915). McDonald and others (1947) collected information on the availability of ground water in Paradise Valley as a possible source of municipal supply for the City of Phoenix. Arteaga and others (1968) updated knowledge of ground-water conditions in Paradise Valley. Two reports present records of wells and related ground-water data in the Queen Creek area (Babcock and Halpenny, 1942; Skibitzke and others, 1950).

An electrical-analog model of the ground-water system in central Arizona was used to determine the probable future effects of continued ground-water withdrawal (Anderson, 1968). The model was constructed by using the known hydrologic characteristics of the water-bearing rocks and the pumping history through 1964. Ross (1980) developed a digital model to evaluate the effects of a proposed well field on water levels in wells on the Salt River Indian Reservation.

Maps showing water-level altitudes for 1976 and water-level changes for 1923-76 in the eastern part of the Salt River Valley were prepared by Laney and others (1978). Maps showing ground-water conditions in the Salt River Valley as of 1983 were prepared by Reeter and Remick (1986). Geologic and hydrologic characteristics of the water-bearing units in the eastern part of the Salt River Valley were described by Laney and Hahn (1986). Description of hydrologic conditions and distribution of aquifer materials in alluvial basins (Freethey and others, 1986) are pertinent to the study area. Ground-water conditions for 1900 and 1986 and changes in ground-water conditions were described by Thomsen and Miller (1991).

HISTORY OF WATER DEVELOPMENT

Most of the Salt River Valley was occupied and irrigated by the Hohokam Indians from about 300 B.C. to A.D. 1450 (Masse, 1981). Remnants of prehistoric villages and canal systems were noted by archeologists in 1887, but by 1903, most of the surface evidence of these villages and canal systems had been obliterated by farming and construction. On the basis of the remains of extensive irrigation works, the amount of land irrigated under the prehistoric system was estimated to have been at least 250,000 acres (Hodge, 1893). Recent archeological studies of the Hohokam irrigation system have recorded more than 300 mi of main canals and 1,000 mi of smaller canals in the Salt River Valley (Masse, 1981).

Modern irrigation in the Salt River Valley was begun by John W. Swilling in 1867 (Salt River Project, 1970). The Swilling Ditch, as it was originally called, was on the north side of the river about 5 mi east of Phoenix. In 1868 the canal became known as the Salt River Valley Canal (Davis, 1897). In 1870 the Tempe Canal was constructed on the south side of the river about 7 mi upstream from the Salt River Valley Canal. Other canals constructed on the south side of the river included the San Francisco, Utah, Mesa, and Consolidated Canals built in the 1870's and the

Highland Canal built in 1889. On the north side of the river, the Grand Canal was built in 1878 and the Arizona Canal in 1883-84 (Davis, 1897).

Reliable figures on the amount of land irrigated in the late 1800's were difficult to obtain. The farmers did not keep good records, and in many cases the amount of land claimed as irrigated was that "under ditch" (land to which water might be taken). According to the Eleventh Census, the total area irrigated in Maricopa County during 1889 was 35,212 acres (Davis, 1897). Water was claimed, however, for 151,360 acres in 1889, according to records compiled under the orders of Judge Kibbey. The average water use on 60,000 acres irrigated in 1895 was 4.6 acre-ft/acre (Davis, 1897).

The need for a dependable supply of water for irrigation led to the construction of reservoirs to store excess runoff and to regulate the flow of the river. The first structure on the Salt River, Roosevelt Dam, was completed in 1911, followed by Mormon Flat Dam in 1925, Horse Mesa Dam in 1927, and Stewart Mountain Dam in 1930. On the Verde River, Bartlett Dam was completed in 1939 and Horseshoe Dam in 1946. The six reservoirs have a combined storage capacity of more than 2 million acre-ft of water, of which about 85 percent is stored on the Salt River.

Many wells were dug or drilled to provide domestic water supplies, but only small quantities of ground water were withdrawn for irrigation in the late 1800's. The use of ground water for irrigation was hampered by the scarcity and cost of suitable power for pumping (Davis, 1897). The quantities of ground water pumped remained relatively small, less than 100,000 acre-ft/yr in the entire Salt River Valley until the early 1920's. Ground-water withdrawals in the Salt River Valley increased gradually and exceeded 1 million acre-ft in 1942 and 2 million acre-ft in 1952 (U.S. Geological Survey, 1986).

GEOLOGY

The study area is in the Basin and Range physiographic province (Fenneman, 1931), which is characterized by broad alluvial valleys separated by rugged mountains. The mountains are composed mainly of granitic, volcanic, and metamorphic rocks that yield little water. The valley floors are underlain by a wide variety of sedimentary deposits that constitute the main ground-water reservoirs. Deposits consist of unconsolidated to variably consolidated sediments that are several thousand feet thick in places. The sediments include unconsolidated clay, silt, sand and gravel, caliche, gypsum, mudstone, siltstone, sandstone, conglomerate, and anhydrite. The degree of sorting and cementation and the distribution of the different materials varies areally and with depth. Interbedding and lensing are common, and lateral discontinuities caused by high-angle faults could be present in some older units (Laney and Hahn, 1986).

On the basis of geologic and hydrologic properties, the sediments have been divided into four units—red, lower, middle, and upper (Laney and Hahn, 1986). The following description of the sedimentary units is summarized from Laney and Hahn (1986). The red unit was deposited before the period of block faulting associated with the Basin and Range structural disturbance. The red unit consists of well-cemented breccia, conglomerate, sandstone, and siltstone. As a result of faulting, the red unit is exposed locally along the mountain fronts, mainly north of the Salt River along the east and west boundaries of the study area; the thickness of the unit is unknown. The lower, middle, and upper units were deposited during and after the period of block faulting. The lower unit consists of clay, silt, mudstone, and evaporite with interbedded sand, gravel, conglomerate, and basalt. The unit is at least 600 ft thick near the mountains and could be as much as 10,000 ft thick southeast of Chandler and in the center of Paradise Valley. The middle unit consists of silt, siltstone, and silty sand and gravel and ranges in thickness from less than 100 ft near the mountains to about 1,000 ft near Williams Air Force Base; the unit is about 800 ft thick in Paradise Valley. The upper unit consists of gravel, sand, and silt and underlies most of the valley floor; most of the unit is unconsolidated, but locally the deposits are strongly cemented by caliche. The upper unit is more than 300 ft thick south and southwest of Mesa and 200 ft thick in Paradise Valley.

HYDROLOGY

Hydrologic cycle is a term used to denote the circulation of water from the ocean, through the atmosphere, to the land, and back to the ocean. The movement of water over and through the land enroute back to the ocean is the main concern of this study.

Water that moves over the land surface tends to collect and become streamflow. The quantity and duration of streamflow depends, in general, on the quantity, intensity, and type of precipitation and on the nature of the material over which the water passes. As streamflow moves along natural channels, some water might evaporate and thus be lost from the local system, or a part or all of it might percolate into porous materials and become either soil moisture or ground water.

Water that percolates into the earth from either precipitation or streamflow and reaches the water table, or the zone of saturation, is called ground water. Water that is retained in the unsaturated zone above the water table is called soil moisture. Water in the subsurface might return to the land surface and become streamflow where the water table intersects the land surface. The water might move into the unsaturated zone to become soil moisture or it could be removed from the local system by evapotranspiration or by pumping.

Precipitation

Precipitation is the initial source of water, but not all the precipitation that reaches the land surface is available for man's use. Water that reaches the land surface as precipitation probably proceeds along any of three general paths. The water might evaporate soon after contact with the land surface, move across the land as surface runoff, or penetrate the earth to become either soil moisture or ground water. Recorded precipitation data indicate that the quantity of precipitation can be extremely different from year to year, and studies of past climates show long-term changes in precipitation quantities (Sellers, 1965).

Precipitation in the study area averages about 8 in./yr and occurs mainly as rain. Snow falls in the upper reaches of the rivers that affect the study area. Total precipitation in the study area averages more than 300,000 acre-ft/yr, of which 30,000 acre-ft/yr falls on the reservation. Most of the rainfall on the flatlands of the study area evaporates or is used by vegetation, and virtually none reaches the ground-water reservoir. Precipitation on the mountains tends to collect in channels and run off and can be sufficient in quantity at times to provide recharge to the ground-water system along the mountain fronts.

For 1931-72, annual precipitation averaged 7.60 in. at Scottsdale and 7.57 in. at Mesa and ranged from 3.04 to 13.84 in. at Scottsdale and 2.83 in. to 16.64 in. at Mesa (Sellers and Hill, 1974). Precipitation is less than the potential evapotranspiration in all months, but particularly so in April, May, and June.

Most long-term precipitation records in Arizona began between 1895 and 1915, at least 25 years after the period of interest for this study. The longest continuous precipitation record in Arizona is for Tucson at and near the University of Arizona. During 109 years, annual precipitation averaged 11.41 in. and ranged from 5.07 to 24.17 in.; the median value was 10.94 in. A statistical analysis of the Tucson data indicates no trend in precipitation (Thomsen and Eychaner, 1991).

Fritts and others (1979) used tree-ring data to evaluate climatic variations over a longer time period (1602-1970) and showed that average winter precipitation during 50-year intervals can vary by 20 percent over much of the United States. The percentage of agreement, however, between reconstructed and observed precipitation was greatest in the southwestern United States, including Arizona.

Each line of evidence suggests that the precipitation regime before 1870 was similar to the current regime; therefore, precipitation estimates using recent data are considered to be representative of predevelopment time. Precipitation records at Phoenix date back to 1877 but records for 7 years between 1886 and 1896 are missing. The average annual precipitation was 7.54 in. at the Phoenix post office for 1877 to 1967 and 7.26 in. at the Phoenix airport for 1938 to 1983. Annual precipitation ranged from 2.85 to 19.73 in. at the post office and 2.82 to 16.26 in. at the airport, and median values were 6.85 in. at the post office and 7.09 in. at the airport.

Streamflow

The Salt River was a perennial stream and the main source of water in the study area when the non-Indian settlers arrived (Davis, 1897). The Verde River, which joins the Salt River near the east boundary of the Salt River Indian Reservation, was also a perennial stream. Upstream from the confluence of the two rivers, each river drains an area of more than 6,000 mi^2. The Gila River, Cave Creek, and Queen Creek are related to the hydrology of the study area because of their role in recharging the ground-water system.

Records of discharge of the Salt and Verde Rivers have been kept since 1888. The early estimates of discharge were provided by the Arizona Canal Company and the Hudson Reservoir and Canal Company (Davis, 1897). Subsequently, estimates of daily or monthly discharge were compiled by the U.S. Bureau of Reclamation and the Salt River Valley Water Users' Association (U.S. Geological Survey, 1954). Early estimates of discharge were made on the Verde River near Fort McDowell and on the Salt River at two sites—one called "at McDowell," which was upstream from the confluence with the Verde River, and one called "at Arizona Dam," which was downstream from the confluence with the Verde River. Arizona Dam was about 2.5 mi upstream from the present site of Granite Reef Dam. Water-stage recorders were installed on the Verde River above Camp Creek (equivalent to present site below Bartlett Dam, 09510000) in 1925, on the Salt River below Stewart Mountain Dam (09502000) in 1930, and on the Salt River near Roosevelt (09498500) in 1935 (fig. 2). Before the installation of water-stage recorders, discharge of the Verde River was related to staff gages at several sites near the mouth of the river, and discharge of the Salt River near Roosevelt was related to staff gages 1 mi downstream from the recorder site. Records for the Salt River at Roosevelt, just upstream from the site of Roosevelt Dam, include the discharge of Tonto Creek (fig. 2). Although the discharge of the Verde River was measured or estimated at several sites over the years, the records are considered to be equivalent; hence, continuous records are available from 1888 to 1986 (table 1). The longest record of discharge for the Salt River is for the site near Roosevelt, which dates from 1913. Discharge records for the Salt River below Stewart Mountain Dam began with the 1931 water year (table 1).

The two gaging stations nearest the confluence of the Salt and Verde Rivers are on the Salt River below Stewart Mountain Dam and the Verde River below Bartlett Dam. Records for these two stations were combined to determine the flow of the Salt River through the study area, and discharge values have been adjusted for storage in reservoirs. On the basis of available records, the combined average discharge of the Salt and Verde Rivers is 1,223,000 acre-ft/yr; the median discharge is 889,000 acre-ft/yr. Records for the Verde River date back to 1888 and those for the Salt River to 1931. For the common period of record, 1931-86, the combined average discharge is 1,151,000 acre-ft/yr, the median discharge is 873,000 acre-ft/yr, and the annual discharge ranged from 282,000 to 3,832,000 acre-ft. The recorded values reflect the effect of upstream diversions and reservoir evaporation on the discharge at the confluence of the Salt and Verde Rivers.

Diversions for irrigation in the upper Verde River area average 31,000 acre-ft/yr (Owen-Joyce and Bell, 1983). Additional small diversions for irrigation in the upper Salt River basin bring the total quantity of water diverted for irrigation upstream from the reservoirs to about 40,000 acre-ft/yr. Evaporation from the reservoirs on the Salt and Verde Rivers is estimated to average 110,000 acre-ft/yr. Estimates are based on pan-evaporation data collected by the Salt River Project since 1954 at Roosevelt and Bartlett Lakes (Dallas Reigle, Hydrologist, Salt River Project, Phoenix, written commun., 1988). Diversions for powerplant operations, storage in stockponds and recreational lakes, and transbasin

Table 1.--*Streamflow data at selected streamflow-gaging stations*

Station number[1]	Station name	Drainage area, in square miles	Water years	Annual runoff: Mean: Acre-feet	Annual runoff: Mean: Inches[2]	Annual runoff: Median: Acre-feet
09500500	Salt River at Roosevelt	5,830	1888-1907 1910-13	756,000	2.44	491,000
09498500	Salt River near Roosevelt	4,306	1913-86	653,000	2.84	514,000
09502000	Salt River below Stewart Mountain Dam[3]	6,232	1931-86	730,000	2.20	498,000
09508500	Verde River below Tangle Creek	5,872	1945-86	411,000	1.40	319,000
09510000	Verde River below Bartlett Dam[3]	6,188	1888-1986	493,000	1.49	391,000
09499000	Tonto Creek above Gun Creek	675	1942-86	114,000	3.16	66,700

[1]The complete 8-digit station number for each station, such as 09498500, includes the 2-digit part number "09" plus the 6-digit downstream order number "498500."

[2]One inch of runoff is the volume equivalent to a layer of water 1 inch deep over the entire basin.

[3]Data adjusted for changes in storage in major upstream reservoirs.

diversions are considered to have a negligible effect on the average discharge of the basin.

The total reduction in the natural discharge of the Salt and Verde River basins as a result of evaporation from reservoirs and diversions for irrigation in the upper reaches cannot be accurately determined but is estimated to average 150,000 acre-ft/yr. Much of the reduction in discharge was occurring in 1931 when discharge records began on the Salt River below Stewart Mountain Dam. A trend analysis using Kendall's tau-b statistic indicated no trend in the combined discharge data for 1931-86.

Tree-ring data provide evidence of past climatic variations. Long-term-growth records of trees and a shorter term streamflow record can be used to estimate streamflow for the longer period using statistical multiple regression (Fritts, 1976). Tree-ring data were used to extend the annual- and seasonal-discharge records of the Salt and Verde Rivers back to A.D. 1580 (Smith and Stockton, 1981). The extended records were for the gaging stations on the Salt River near Roosevelt and the Verde River below Tangle Creek. The 400 years of reconstructed discharge records were divided into five 80-year periods, and the average discharge for four of the five periods was less than for the period of record for each basin. When the reconstructed discharge records for the two basins were combined, the average discharge for the five 80-year periods ranged from 83 to 99 percent of the average discharge for the period of record. The average discharge for the entire 400 years was 91 percent of the average for the period of record.

The annual discharge of the natural (predevelopment) Salt-Verde drainage basin into the study area is estimated to average 1,250,000 acre-ft. This estimate is based on the recorded data with adjustment for the results of the tree-ring study and the estimates of upstream diversions and reservoir evaporation. The median annual discharge is estimated to be 950,000 acre-ft.

The Salt River undoubtedly was a constant source of recharge to the ground-water system in the study area before the arrival of non-Indian settlers. Water-level data compiled by Lee (1905) showed that water moved from the Salt River to the aquifer in the first 10 mi downstream from Granite Reef Dam, but about 3 mi farther downstream, water moved from the aquifer back to the Salt River. Flow of the Gila River was also a source of recharge to the ground-water system in the southern part of the study area (Thomsen and Eychaner, 1991).

Queen Creek, which heads in the mountain area south of the Salt River and east of the study area, is tributary to the Gila River. The average discharge of Queen Creek was about 5,000 acre-ft/yr, and most of the water infiltrated into the alluvium near the contact with the mountain area. Flood-control structures have changed the flow pattern of Queen Creek.

Cave Creek drains the mountain area north of Paradise Valley and flows across the northwest corner of the study area where its channel is in coarse alluvium. The channel is dry most of the time but carries water occasionally in response to intense rainfall. Flow is perennial in the upper reaches of Cave Creek, but the water generally infiltrates into the alluvium several miles upstream from the study area. The average discharge of Cave Creek is estimated to be 5,000 to 10,000 acre-ft/yr.

Ground Water

Ground water occurs mainly under water-table or unconfined conditions in the sedimentary material that underlies much of the Salt River Indian Reservation and the surrounding area. The water table is that surface in an unconfined water body at which the pressure is atmospheric. The water table is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. When Lee (1905) investigated the underground waters of the Salt River Valley, water levels were from 10 to 70 ft below the land surface in the developed area. These water levels could have been higher than the predevelopment level owing to infiltration of diverted irrigation water. Seepage losses were large in the many long ditches required to carry water to scattered tracts of land, and irrigators applied water very lavishly in early spring when water was abundant (Davis, 1897, p. 43). However, water levels reportedly had declined "in the past few years," and the decline was attributed to the drought that prevailed during those years and to the increasing number of wells in use (Lee, 1905, p. 120-121). The effects of irrigation seepage and drought conditions on the ground-water levels of the early 1900's are unknown but probably are minimal. Thus, the water levels measured by Lee (1905) are considered to adequately represent predevelopment conditions. Lee (1905, p. 119) described the water table as "a comparatively regular plain, sloping in general with the grade of the river." The direction of ground-water movement in 1900 was from east to west along the flood plain of the Salt River and in the area south of the river and from north to south in Paradise Valley. The ground-water reservoir apparently was filled to capacity or nearly so and was sustained mainly by the infiltration of water from the Salt River.

Mountain ranges that border much of the area impede the movement of ground water. The rocks that form the mountains generally are not water bearing but might, where fractured, yield as much as a few tens of gallons per minute of water to wells. On the valley floor, the upper unit has excellent water-bearing characteristics and, where saturated, could yield as much as 4,500 gal/min of water to wells. During floods on the Salt River and Queen Creek, the upper unit readily accepts large volumes of recharge. In the south-central part of the area where deposits are cemented by caliche, ground water is perched in the upper unit (Laney and Hahn, 1986). The middle unit generally will yield as much as 1,000 gal/min of water to wells; however, north of Mesa, the unit yields about 4,000 gal/min of water locally to wells. The lower unit yields 50 gal/min or less of water to wells in many areas; however, the conglomerate and the sand and gravel components of the unit could yield as much as 3,500 gal/min of water to wells. The red unit yields as much as 1,000 gal/min of water to wells near Scottsdale (Laney and Hahn, 1986).

Recharge to the ground-water system occurs mainly from infiltration of streamflow. Prior to development, the Salt River was the main source of recharge. Queen Creek, Cave Creek, and the Gila River contributed small quantities of recharge on the periphery of the study area. Mountain-front runoff from the McDowell and Superstition Mountains contributed small quantities of recharge in the Paradise Valley and Queen Creek areas.

Water is discharged from the ground-water system by surface flow and underflow from the area and by evapotranspiration. Discharge of ground water in the Salt River near Tempe occurred regularly prior to development and probably averaged about 25,000 acre-ft/yr (Lee, 1905, p. 151).

Underflow and Mountain-Front Recharge

Underflow through permeable materials that underlie the surface drainages helps to recharge the ground-water system. The Salt River and

Queen Creek enter the study area from areas underlain by crystalline rocks of low permeability; hence, the underflow from these drainages probably was negligible. The Gila River and Cave Creek are underlain by alluvium and are potential sources of underflow into the study area. Underflow from the Gila River and mountain-front recharge from the Superstition Mountains are indicated by predevelopment water levels (Thomsen and Baldys, 1985; Thomsen and Miller, 1991). The quantity of underflow was about 6,000 acre-ft/yr on the basis of hydraulic-conductivity data and estimates of the cross-sectional area. Underflow through Paradise Valley was principally from Cave Creek and was calculated to be 6,700 acre-ft/yr (McDonald and others, 1947, p. 11). Freethey and Anderson (1986) estimated the predevelopment underflow from Cave Creek and the mountain-front recharge from the McDowell Mountains to be 4,000 acre-ft/yr, and this value was used in the ground-water budget. Total underflow into the area was estimated to be 10,000 acre-ft/yr.

Underflow southwestward from the area is indicated by predevelopment water levels (Thomsen and Baldys, 1985; Thomsen and Miller, 1991). The quantity of underflow could have been as much as 7,000 acre-ft/yr on the basis of transmissivity data and estimates of the cross-sectional area. Underflow along the Salt River between Tempe Butte and South Mountain was estimated to be 1,000 acre-ft/yr. Total underflow from the area probably was about 8,000 acre-ft/yr.

Hydraulic Characteristics of the Ground-Water Reservoir

The hydraulic characteristics of the ground-water reservoir are the physical properties that control the ability of the material to store and transmit water. These properties depend mainly on the size of openings or interstices and their shape, arrangement, and interconnection. The hydraulic characteristics commonly used to describe ground-water reservoirs are storage coefficient and transmissivity, which provide a measure of the quantity of water stored in the reservoir and the rate at which the reservoir will transmit water. The movement of ground water through a section of aquifer can be expressed by the equation:

$$Q = TIW, \qquad (1)$$

where

Q = flow, in cubic feet per day;
T = transmissivity, in feet squared per day;
I = hydraulic gradient (dimensionless); and
W = width of section, in feet.

Transmissivity is a function of the hydraulic conductivity and saturated thickness of the reservoir and can be expressed by the equation:

$$T = KM, \qquad (2)$$

where

K = hydraulic conductivity, in feet per day, and
M = saturated thickness, in feet.

Hydraulic conductivity is the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow (Lohman and others, 1972). Hydraulic conductivity is expressed in units of length per unit time, such as feet per day.

Transmissivity is the rate at which water at the existing kinematic viscosity is transmitted through a unit width of aquifer under a unit hydraulic gradient. Transmissivity is expressed in consistent units of volume (L^3) per unit time (T) per unit width (L), which reduces to L^2T^{-1}. In the English system, transmissivity is expressed in cubic feet per day per foot, which reduces to feet squared per day.

The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (Lohman and others, 1972). In an unconfined water body, it is virtually equal to the "specific yield," which is the ratio of the volume of water that saturated material will yield by gravity drainage to the volume of the material drained. The storage coefficient is expressed as volume (L^3) per unit area (L^2) per unit length (L) and is, therefore, dimensionless. Specific storage is the volume of water released from or taken into storage per unit volume of the porous medium per unit change in head (Lohman and others, 1972).

Quantitative data on the hydraulic characteristics of ground-water reservoirs are obtained from field data on water levels, water-level fluctuations, and natural or artificial discharges (Ferris and others, 1962; Bentall, 1963). Aquifer-test data indicate that transmissivity values in the study area range from about 2,500 to 50,000 ft^2/d and values as great as 75,000 ft^2/d have been estimated for some local areas (Laney and Hahn, 1986). Most of the aquifer tests were made after the upper part of the aquifer, which in many areas is the most transmissive, had been at least partly dewatered; hence, the transmissivity values are less than they would have been when the aquifer was full. The greatest values of transmissivity occur south of the Salt River in the Mesa area (Anderson, 1968; Laney and Hahn, 1986). In general, transmissivity values range from 20,000 to 40,000 ft^2/d north of the Salt River and decrease northward into Paradise Valley. Stratification in alluvial material causes transmissivity values to be much larger parallel to the bedding plane than perpendicular to the bedding plane.

The average storage coefficients for sedimentary deposits in central Arizona range from 15 to 20 percent (Anderson, 1968). In simulating the effects of a proposed well field on the ground-water system in the Salt River Indian Reservation, Ross (1980) used a storage coefficient of 0.12.

The hydraulic gradient averaged about 0.001 and ranged from 0.0006 to 0.004 prior to ground-water withdrawals by the non-Indian settlers. At the present time (1986), hydraulic gradients range from about 0.002 to 0.03 in most of the area.

Evapotranspiration

Evapotranspiration is defined as "water withdrawn from a land area by *evaporation* from water surfaces and moist soil and plant *transpiration*" (Langbein and Iseri, 1960). Evaporation is commonly measured by noting the change in water level in an open pan during a given time period. Such measurements do not accurately reflect evaporation from natural water bodies because of difference in water temperature, vapor pressure, and water-surface roughness. The rate of evaporation from a small pan usually far exceeds that from a large reservoir or lake. The ratio of lake to pan evaporation is referred to as the pan coefficient. Annual evaporation from a U.S. Weather Bureau Class A pan at Mesa during 1963-73 averaged 106.31 in. (Sellers and Hill, 1974). The pan coefficient is about 0.67, and the average annual lake evaporation is about 70 to 75 in. (U.S. Department of Commerce, 1968). Annual lake evaporation, in feet, multiplied by an area of water surface, in acres, would give the volume of water evaporated, in acre-feet per year. Plants obtain water from precipitation and soil moisture, and deep-rooted plants called phreatophytes obtain much of their water from the capillary fringe and the saturated zone. The rate of transpiration by phreatophytes depends on the availability of water and on the species, cover density and size, and stage of maturity of the plants. The quantity of water withdrawn from the ground-water reservoir by phreatophytes depends on the depth to ground water. The use of water by phreatophytes is greatest when ground water is shallow and decreases as depth to water increases (fig. 3). The relation between water use and depth to water is not well defined for all phreatophyte species but is fairly well defined for mesquite (Anderson, 1976).

The most common species of phreatophytes indigenous to southern Arizona are cottonwood, willow, baccharis (seepwillow), and mesquite (Gatewood and others, 1950). These species probably were the main woodland types of vegetation along the Salt River near the Salt River Indian Reservation prior to the arrival of non-Indian settlers. The area of potential phreatophytic growth was 18,500 acres as determined from topographic maps published in the early 1900's and aerial photographs taken in 1936. Probably only about half the area contained phreatophytes. According to early photographs and descriptions (Davis, 1897; Lee, 1905; Salt River Project, 1970), most of the flood plain and low terraces along the Salt River were covered with grass and were scattered with phreatophytes that were light in density.

An investigation of the consumptive use of water by phreatophytes was made in 1963-71 to determine evapotranspiration before and after clearing phreatophytes on 15 mi of the Gila River flood plain (Culler and others, 1982). Results of the study showed that the annual evapotranspiration averaged 3.7 ft and ranged from 4.7 ft for dense stands of phreatophytes to 2.1 ft for areas of no phreatophytes. Vegetation consisted mainly of saltcedar and mesquite with scattered cottonwood, seepwillow, seepweed, and arrowweed. Depth to ground water on the flood plain ranged from 5 ft near the river to 20 ft near the outer boundaries of the flood plain. Removal of the phreatophytes resulted in a reduction in evapotranspiration that averaged 1.6 ft/yr and ranged from 1.2 to 2.2 ft/yr owing to the differences in the density of phreatophytes. Evapotranspiration after the removal of phreatophytes consisted of

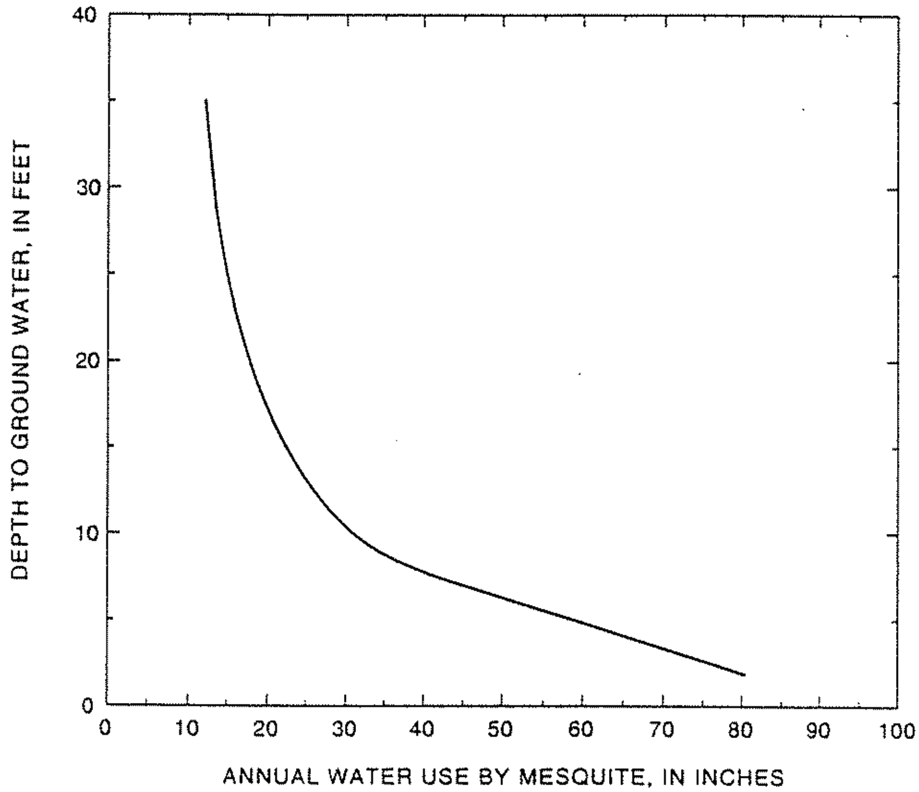


Figure 3.—Relation between depth to ground water and annual water use by mesquite (From Anderson, 1976, fig. 10, p. 46).

evaporation from bare ground and transpiration from annual vegetation. Because phreatophytes obtain their water supply primarily from ground water, the reduction in evapotranspiration that resulted from removal of the phreatophytes is considered to represent a measure of ground water withdrawal by phreatophytes. Precipitation and soil moisture provide a significant part of the evapotranspiration during the period of high potential evapotranspiration (Culler and others, 1982).

Ground-water withdrawal by phreatophytes was estimated to average 15,000 acre-ft/yr on the basis of an evapotranspiration rate of 1.6 ft/yr and the assumption that phreatophytic growth covered half the potential growth area. Because phreatophytes were scattered and their distribution unknown, the evapotranspiration rate was halved and applied to the entire area of potential phreatophytic growth for modeling purposes.

Ground-Water Budget

A water budget that accounts for all inflows and outflows was prepared for the ground-water reservoir underlying the study area. Because aquifers were in equilibrium prior to development by non-Indian settlers, the average long-term change in ground-water storage prior to 1870 was considered to be zero. Hence, the sum of all inflows must have equaled the sum of all outflows.

The average annual water budget for the ground-water reservoir under predevelopment conditions is expressed by the equation:

$$G_i + Q_r = G_o + Q_d + ET_g, \quad (3)$$

where

G_i = subsurface inflow,
Q_r = recharge to the aquifer from the Salt River,
G_o = subsurface outflow,
Q_d = discharge to the Salt River from the aquifer, and
ET_g = evapotranspiration from the ground-water reservoir.

All components were evaluated independently except Q_r, which was computed as a residual. Average values were as follows:

G_i = 10,000 acre-ft/yr,
Q_r = 38,000 acre-ft/yr,
G_o = 8,000 acre-ft/yr,
Q_d = 25,000 acre-ft/yr, and
ET_g = 15,000 acre-ft/yr.

The net flux from the Salt River to the aquifer, Q_n, is expressed by the equation:

$$Q_n = Q_r - Q_d. \quad (4)$$

Using the above values, Q_n is 13,000 acre-ft/yr.

SIMULATION OF GROUND-WATER FLOW

The modular three-dimensional, finite-difference ground-water flow model of the U.S. Geological Survey (McDonald and Harbaugh, 1991) was used in the simulation of the predevelopment ground-water flow regime. A two-dimensional application of the model was used because regional flow in the upper and middle lithologic units was predominantly horizontal. The aquifer was simulated as a steady-state flow system because all available data suggest that annual ground-water inflows and outflows were about equal (Anderson, 1968; Thomsen and Baldys, 1985). The model was calibrated mainly to the earliest available well data and was constructed to reflect steady-state ground-water flow conditions that existed before settlement of the East Salt River Valley.

The model solves the following partial-differential equation for three-dimensional flow in a saturated medium (McDonald and Harbaugh, 1988):

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right) - W = S_s\frac{\partial h}{\partial t}, \quad (5)$$

where

x, y, z = cartesian coordinates, aligned along the major axes of the hydraulic-conductivity tensor [L],
K_{xx}, K_{yy}, K_{zz} = principal components of the hydraulic-conductivity tensor [LT^{-1}],
h = hydraulic head [L],
W = volumetric flux per unit volume of sources and (or) sinks of water [T^{-1}],
S_s = specific storage of aquifer material [L^{-1}], and
t = time [T].

A two-dimensional model simulates no vertical flows except for those embodied in the term, W; therefore, head is invariant with respect to altitude, and the vertical-flow term drops out of the equation. Because a steady-state condition implies that inflows and outflows to the aquifer are equal, heads throughout the aquifer also are steady over time. The two-dimensional steady-state flow equation, therefore, is expressed as

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right) - W = 0. \quad (6)$$

The required input data for a two-dimensional steady-state model are the grid and cell dimensions, boundary conditions, and parameter values relating to the hydraulic conductivity, and various components of the term W. For this study, the term W includes the processes of evapotranspiration, riverbed infiltration, and mountain-front recharge. For unconfined aquifers, such as is present in East Salt River Valley, the model allows the user to specify either transmissivity values or hydraulic conductivities and layer thicknesses.

Model Construction

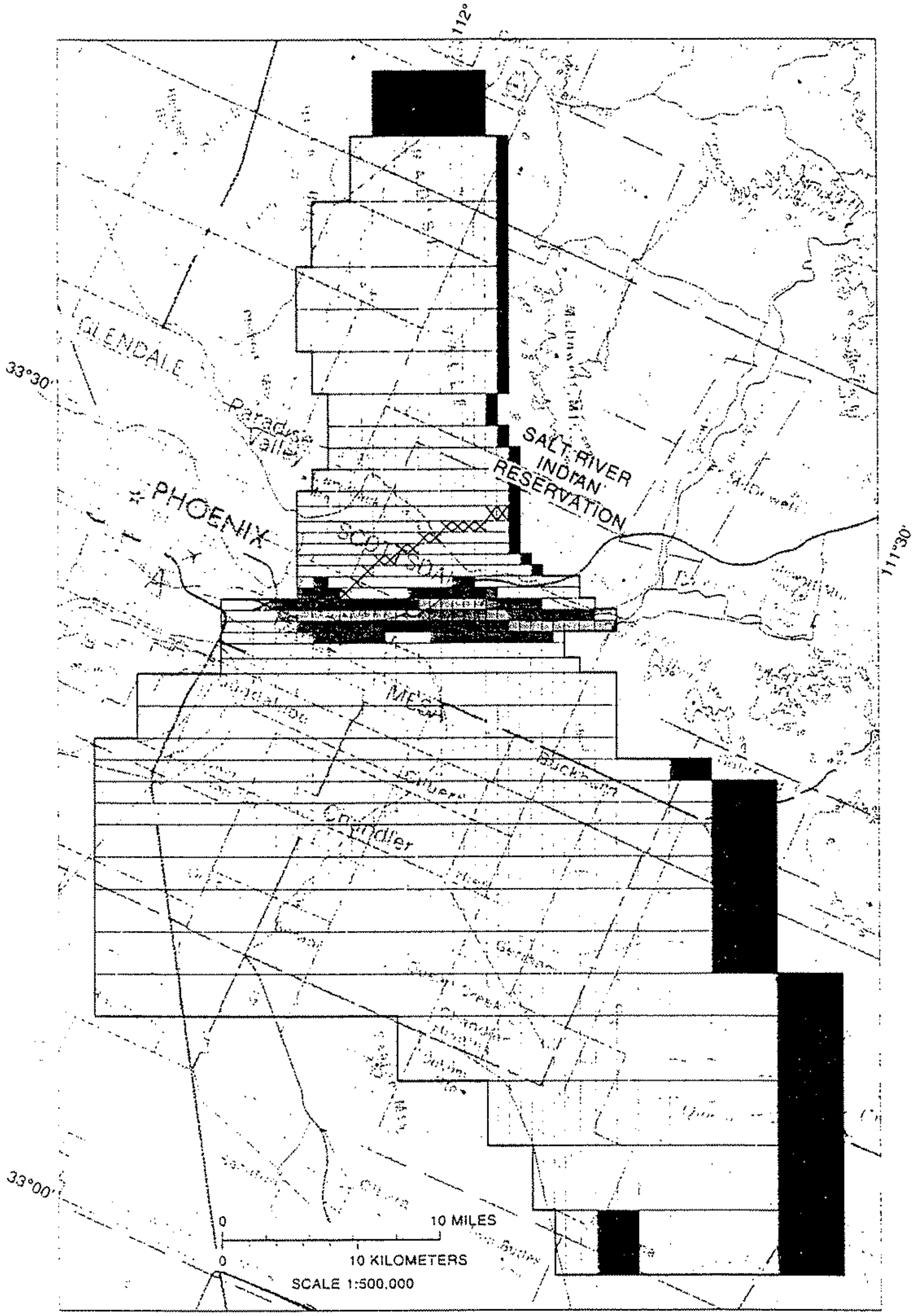
The finite-difference technique used by the ground-water flow model requires the subdivision of the active ground-water flow region into a grid of rectangular cells, which can be identically sized or variably sized. The aquifer was modeled with a grid dimension of 44 rows by 39 columns (fig. 4). The cells were variable in size. The grid was designed to place the smallest cells along the channel of the Salt River and the largest cells along the model boundaries. The grid was oriented 24.7° west of true north so that the cells would be in close alignment with the path of the Salt River because the ground-water budget indicated that the river was the dominant source and sink for subsurface waters under predevelopment conditions. The solution of the steady-state heads at each cell was obtained using the strongly implicit solution procedure of the model with a head-closure criterion of 0.01 ft.

Model boundaries were based on previously mapped boundaries between alluvial deposits and crystalline rocks except in the Gila River area where an artificial boundary was established for modeling convenience. The simulation used specified-flux, specified-head, and head-dependent boundaries. Areas of mountain-front recharge were simulated as specified-flux boundaries. Subsurface outflow at Tempe Butte and the Gila River was simulated with specified-head boundaries. The head altitudes were selected from measurements at nearby wells and from the predevelopment water-level contours. The Salt River was treated as a head-dependent flux boundary; values of head and vertical flux at each river node were computed as a function of the specified stage of the river and the head in the aquifer.

An underflow of 3,300 acre-ft/yr from Cave Creek was distributed evenly over all specified-flux nodes in the northernmost row of the model, and 700 acre-ft/yr of mountain-front recharge from the McDowell Mountains was distributed evenly along the mountain range. An underflow of 500 acre-ft/yr from the Gila River was applied to two nodes in the southernmost row of the model, and mountain-front recharge of 5,200 acre-ft/yr from the Superstition Mountains was distributed along the mountain range.

Perennial streamflow from the Salt River watershed was simulated as flow in the present (1986) channel of the river. A total of 28 cells were specified as river reaches. The river stages in the upper 10 reaches were set to altitudes that were 2 ft above the average channel-floor altitudes in each cell. River stages in the lower 18 reaches were set equal to water-table altitudes suggested by regional-predevelopment contours (Thomsen and Baldys, 1985). Riverbed altitudes were determined from recent (1973-82) topographic maps and differ by as much as 15 ft in places from altitudes determined from topographic maps published in the early 1900's (fig. 5). The differences might result in part from mapping variations but probably result mainly from channel changes.

Although the flood plain of the Salt River was more than one model-cell wide in much of the valley, only a single cell within appropriate grid columns was selected because mean annual widths of channel flow probably were no greater than a few hundred feet (Hodge, 1877). Riverbed conductance was estimated initially from channel geometry and a vertical-hydraulic conductivity of 5 ft/d was assumed. Riverbed conductance is the product of vertical hydraulic conductivity and area of riverbed sediments in a model cell, divided by the thickness of the riverbed sediments. For simulation purposes, the riverbed thickness for each reach was set arbitrarily at 100 ft except at the edges of the valley where simulated thicknesses ranged from 50 to 90 ft.



Base from U.S. Geological Survey
State base map, 1:500,000, 1972

EXPLANATION

SPECIFIED-HEAD CELL

SPECIFIED-FLUX CELL

EVAPOTRANSPIRATION CELL

RIVER AND EVAPOTRANSPIRATION CELL

STREAM-LINE CELL IN CALIBRATED MODEL—Studied in the sensitivity analysis

BOUNDARY OF MODEL

Figure 4.—Finite-difference grid and boundary conditions used in ground-water flow model.

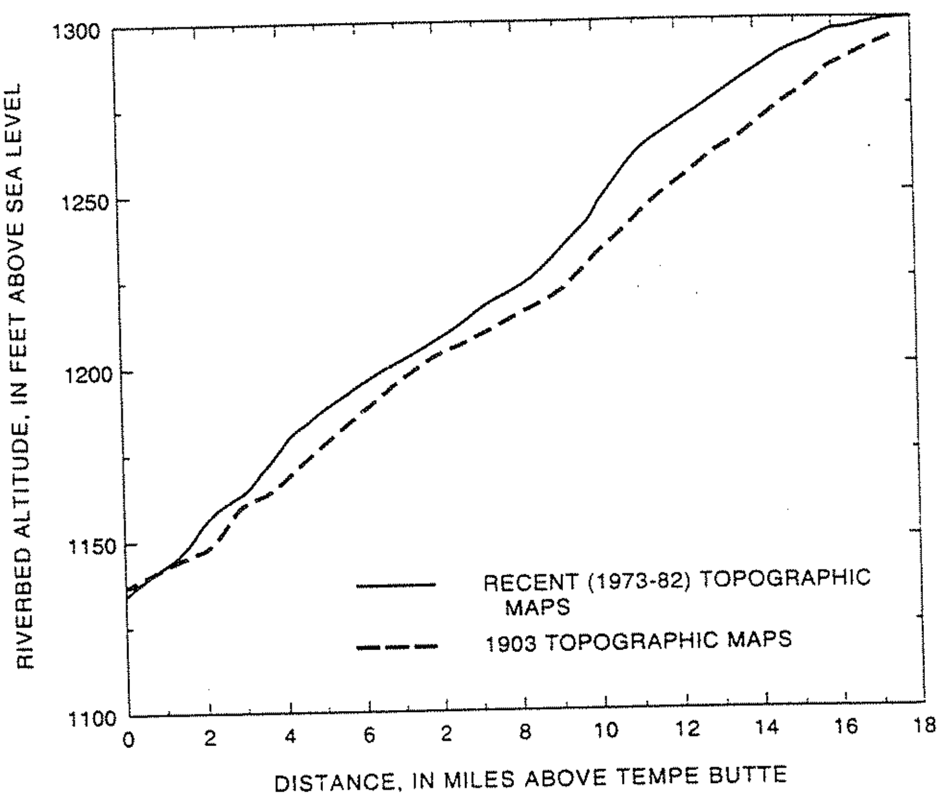


Figure 5.—Recent (1973-82) and 1903 profiles of the Salt River bed.

Evapotranspiration cells were restricted mainly to the flood plain of the Salt River (fig. 4). River cells also were simulated as evapotranspiration cells because of the growth of phreatophytes in the river channel. The evapotranspiration surface, defined as the aquifer-head altitude above which maximum evapotranspiration occurs, was set equal to the altitude of the land surface at most evapotranspiration cells. Within river cells, this surface was set 5 ft above the channel-floor altitude to account for the perennial nature of the river, as well as the topographic relief between the channel floor and banks. The simulated evapotranspiration extinction depth, defined as the depth below which phreatophytes are unable to withdraw ground water, was 30 ft.

Simulated transmissivities were selected to reflect the dominant role of the upper unit in the two-dimensional predevelopment ground-water flow system. Estimates of transmissivity for the upper unit were derived from Anderson (1968) and from Laney and Hahn (1986), and the unit was simulated as an isotropic medium. Initial approximations of transmissivity in Paradise Valley were derived mainly from upper-unit contour maps of thickness and percent sand and gravel (Laney and Hahn, 1986). Transmissivities that ranged from 2,000 to 75,000 ft^2/d and transmissivity-distribution patterns suggested by Anderson (1968) and Laney and Hahn (1986) were used as a guide for changes in transmissivity during the calibration process.

Calibration

The principal goal of the calibration process was to match simulated-head contours with heads measured at 121 wells while maintaining the various ground-water flow components within reasonable limits of their independent estimates. The calibration was followed by a sensitivity analysis in which variations in model parameters were examined for their relative effects on head configuration and magnitudes of the flow components. The sensitivity analysis was vital in assessing the credibility of the calibrated model because the two-dimensional nature of the model prevented evaluation of how well it would reproduce historical patterns of pumping over the past 50 years.

Many ground-water models are calibrated in a manner that lends more credence to independent estimates of the transmissivity distribution and the ground-water flow budget than to the estimated-head distribution. In this study, the well data provided more information about the flow system than did the transmissivity and budget estimates because only depths to water were directly measured before much of the upper unit was dewatered. Because the transmissivity distribution and the flow components were estimates, rather than measured values, they were considered less reliable than the measured water levels.

Initial estimates of riverbed conductance were based on channel geometries and an assumed vertical hydraulic conductivity of 5 ft/d. These estimates, however, produced an unrealistic distribution of gaining and losing reaches of the Salt River. A reduction of all riverbed conductances by two orders of magnitude produced more reasonable distributions of fluxes with little change in the total volume of flow exchanged between the river and the aquifer. This change reflected adjustments of the estimates of channel geometry and vertical hydraulic conductivity that were used in the original computations of riverbed conductance. Riverbed conductance was reduced because vertical fluxes in the river are proportional to the difference between river and aquifer heads, and that difference was much smaller under predevelopment conditions than under present (1986) conditions.

Simulation Results

Simulated transmissivities within the Salt River Indian Reservation ranged from 2,000 ft^2/d along the margins of the aquifer to 40,000 ft^2/d near the river (fig. 6). The same range of transmissivities was simulated throughout the study area. Simulated transmissivities were intermediate in magnitude between those given by Anderson (1968) and Laney and Hahn (1986) and exhibited similar spatial trends. The simulation displayed a high-transmissivity zone from central Paradise Valley southwestward toward the Gila River and a low-permeability zone near the town of Queen Creek. Simulated values of evapotranspiration along the Salt River flood plain were in close agreement with initial estimates of evapotranspiration.

Simulated water-level contours generally compared well with the independent estimates of Thomsen and Baldys (1985) and contours derived

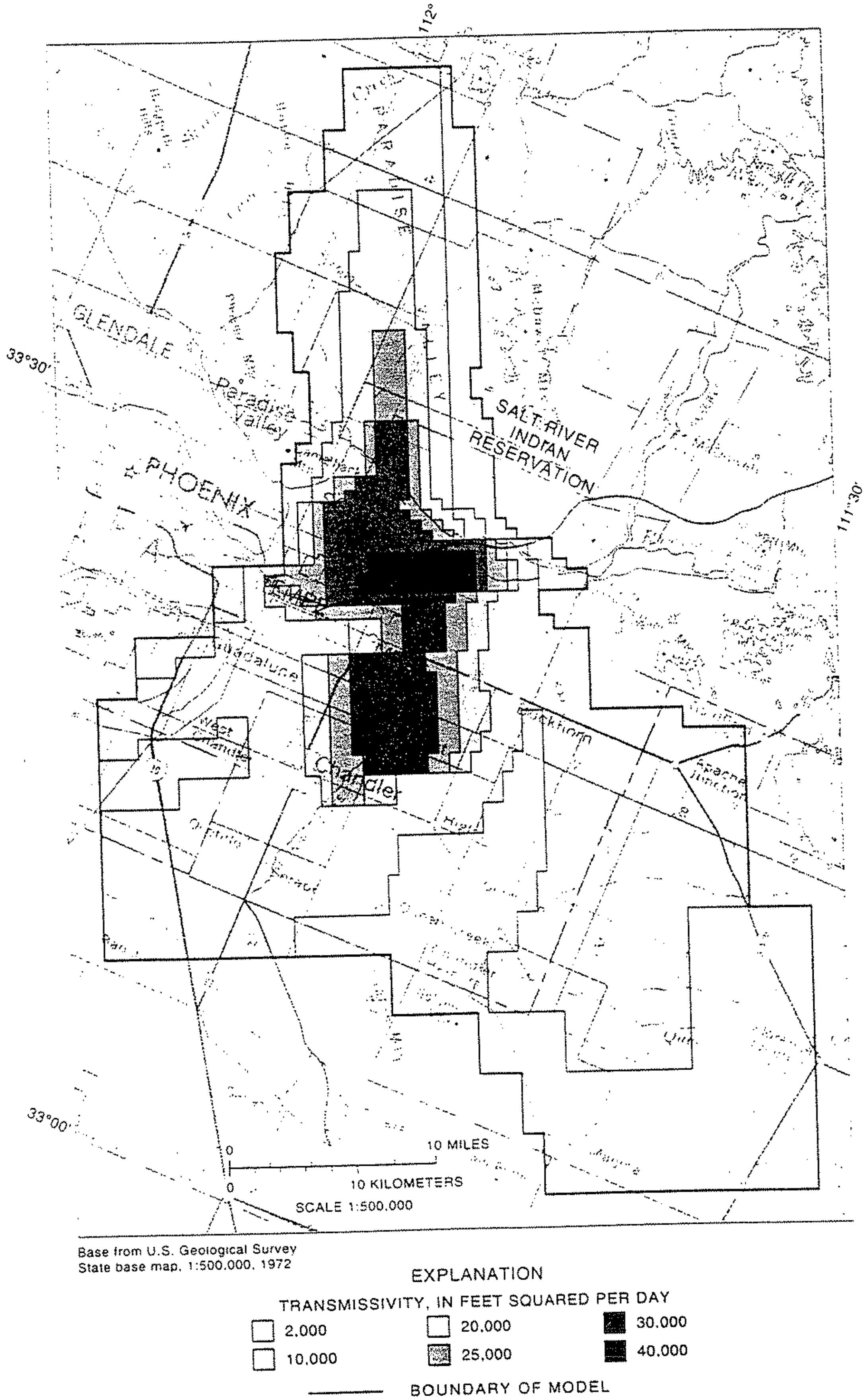


Figure 6.--Simulated transmissivity distribution.

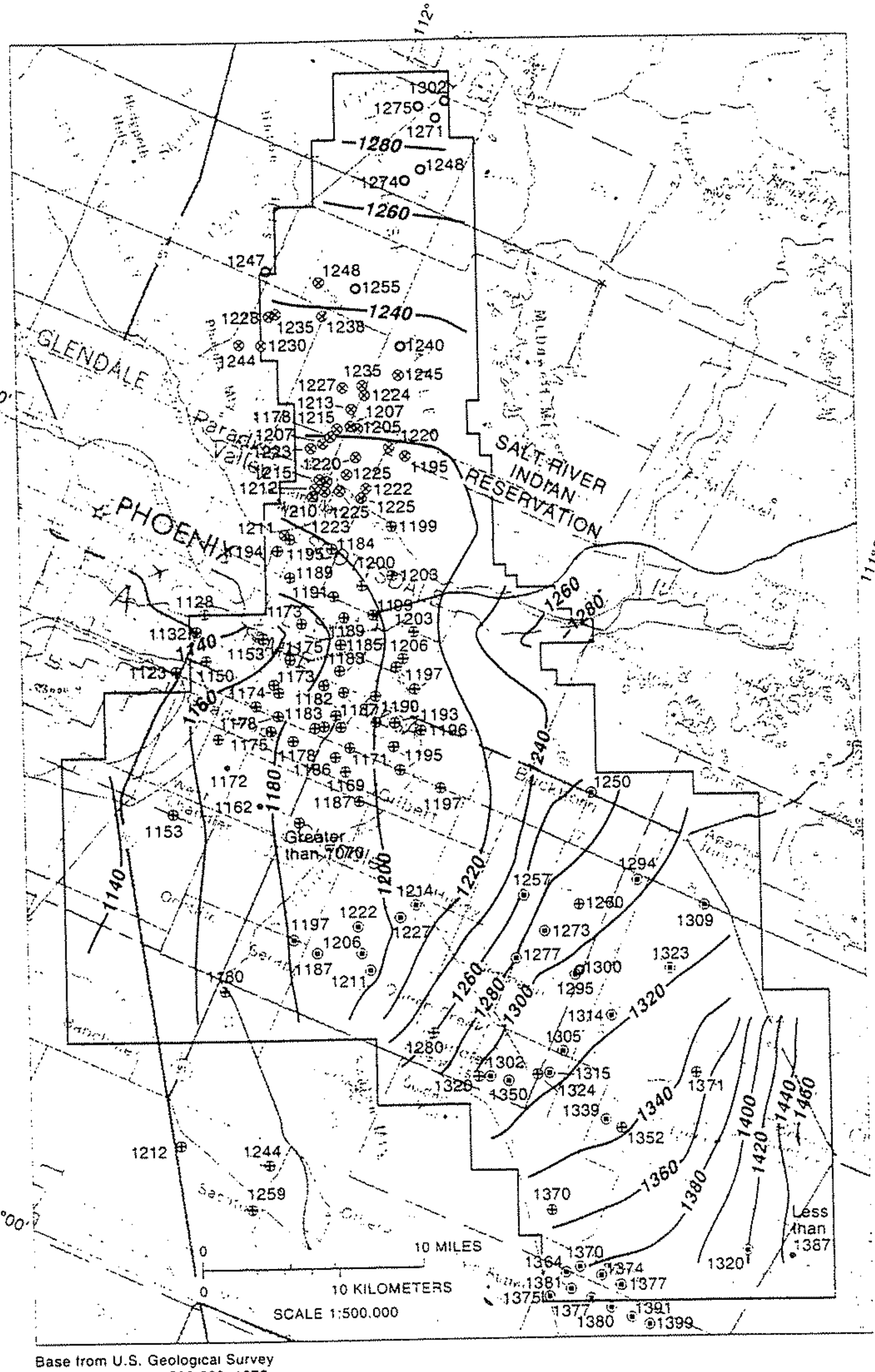
from water-level measurements shown by Meinzer and Ellis (1915). Contours indicate that the Salt River was a predominantly losing stream in the east half of the study area and a predominantly gaining stream in the west half of the area (fig. 7). This result agrees with maps and descriptions given by Lee (1905). Heads computed at river cells generally were a few tenths of a foot within the specified river stages. Similar heads and stages of the river cells and the shapes of the contours crossing the river indicate that the river was the dominant hydrologic feature of the valley.

The shapes of the 1,220-foot and 1,240-foot contours south of the Salt River indicated that some of the predevelopment riverbed recharge flowed southwestward toward the Gila River and the rest followed the general path of the river. The ground-water divide was poorly defined. Mountain-front recharge from the Superstition Mountains and underflow from the Gila River in the southeast corner of the study area flowed westward and then southwestward toward the Gila River in the southwest corner of the study area.

Simulated water-level contours within the Salt River Indian Reservation ranged from 1,160 ft to 1,260 ft along the Salt River (fig. 7). The simulated flow north of the reservation and along its west boundary was derived from underflow from Cave Creek and mountain-front recharge. The shapes of the contours reflect the assumption that mountain-front recharge from the McDowell Mountains was a minor source of ground water to the reservation.

Differences between simulated and measured water levels (herein called residuals) were generally less than ±20 ft. Residuals ranged from 0 to 96 ft, but only 4 of the 121 values were greater than ±30 ft. The average-absolute value of the residuals was 10 ft, and the standard deviation was 15 ft. The root-mean-square average of the residuals also was 15 ft. The residual population appeared normally distributed as a group, but slight spatial trends were evident. A zone of negative residuals immediately downgradient from a zone of positive residuals in the Tempe-Mesa area indicates that the water table in this area in 1903 could have been flatter than the predevelopment water table because of the combined effects of drought and recharge from irrigation. A zone of negative residuals immediately north of the Arizona Canal suggests that McDonald and others (1947) were correct in their assumption that the water levels measured by Meinzer and Ellis (1915) in this area were influenced by leakage from the canal. The distribution of head residuals suggests that any temporal trends inherent in the water-level data used were minimal in comparison to the spatial trends.

The simulated predevelopment ground-water inflow to the Salt River Indian Reservation was 26,700 acre-ft/yr; 19,700 acre-ft/yr occurred as infiltration of Salt River flows, and 7,000 acre-ft/yr occurred as underflow from Cave Creek and mountain-front recharge (table 2). About 51 percent of ground-water discharge from the reservation occurred as subsurface outflow along the south and west boundaries of the reservation, and evapotranspiration and discharge to the bed of the Salt River constituted 30 and 19 percent of the discharge, respectively. The net flux of 14,700 acre-ft/yr from the river to the aquifer was slightly greater than the subsurface outflow from the reservation.



Base from U.S. Geological Survey
State base map, 1:500,000, 1972

EXPLANATION

WELL—Number, 1172, indicates altitude of the water level in feet above sea level. Sources of water-level data:

1172	Davis (1897)	1314⊙	Babcock and Halpenny (1942)
1191⊕	Lee (1905)	1271 ○	McDonald and others (1947)
⊗1225	Meinzer and Ellis (1915)		

—1320— SIMULATED WATER-LEVEL CONTOUR—Shows altitude of the water level as estimated by the model, in feet above sea level. Contour interval 20 feet

——— BOUNDARY OF MODEL

Figure 7.—Simulated predevelopment water levels and measured water levels.

Table 2.--*Estimated and simulated values of ground-water flow components*

[Flow is in acre-feet per year]

Flow component	Estimated flow in the modeled area[1]	Simulated flow in the modeled area[1]	Simulated flow in the Salt River Indian Reservation
INFLOW			
Recharge from Salt River	38,000	19,700	19,700
Mountain-front recharge and subsurface inflow	10,000	10,700	[2]7,000
Total aquifer recharge	48,000	30,400	26,700
OUTFLOW			
Discharge to Salt River	25,000	9,800	5,000
Evapotranspiration	15,000	13,300	8,100
Subsurface outflow			
At Tempe Butte	1,000	800	------
At Gila River	7,000	6,500	------
Total	8,000	7,300	13,600
Total aquifer discharge	48,000	30,400	26,700
NET FLUX FROM SALT RIVER[3]	13,000	9,900	14,700

[1]The modeled area includes the Salt River Indian Reservation.
[2]Subsurface inflow to the reservation from Cave Creek is 6,700 acre-feet and mountain-front recharge within the reservation is 300 acre-feet per year.
[3]Recharge from the Salt River minus discharge to the Salt River equals net flux.

The simulated predevelopment ground-water flow budget indicated that the Salt River was the dominant source of recharge to the regional aquifer, and evapotranspiration was the dominant sink. The net flux from the river was 9,900 acre-ft/yr. The simulated and estimated magnitudes of evapotranspiration were nearly identical, but the simulated discharge to the Salt River was much less than was estimated. The large difference between the simulated and estimated values of the discharge to the Salt River suggests that the estimated value was corrupted by irrigation return flow resulting from canal leakage and irrigation techniques. Most simulated regional ground-water flow components were less than initial estimates. The difference between estimated and simulated values ranged from about 10 percent for evapotranspiration to about 60 percent for discharge to the Salt River.

Sensitivity Analysis

The sensitivity analysis, which is the principal means of assessing the credibility of the calibrated model, was designed to illustrate the changes in head profiles and flow components that result from variations of parameter values. The analysis was done by performing a series of simulations in which all parameters were held constant except the one being analyzed, and that parameter was varied over a broad range of values that were considered reasonable. Transmissivity, mountain-front recharge, riverbed conductance, evapotranspiration-extinction depths, and evapotranspiration rates were all varied independently. Simulated heads within the Salt River Indian Reservation were evaluated in each sensitivity simulation by constructing head profiles along a stream line through the middle of the reservation extending from the base of the McDowell Mountains westward and southwestward toward the Salt River (fig. 4). This profile represented the head distribution along a stream line in the calibrated model but not necessarily along a stream line in the sensitivity runs. The sensitivity of heads along the profile may not be indicative of sensitivity everywhere in the model. The average-absolute and root-mean-square values of head residuals of each simulation were compared in order to assess the sensitivity of heads throughout the valley (table 3).

Sensitivity of Heads

Heads along the stream line were sensitive to all parameters except the two evapotranspiration parameters. Head changes were negatively correlated to changes in transmissivity along the east 7 mi of the profile, insensitive along a 3-mile reach above the river, and positively correlated to transmissivity changes at Tempe Butte (fig. 8). Heads generally were insensitive to riverbed-conductance values greater than the calibrated values indicating that the river was acting nearly as a constant-head boundary because of the high riverbed-conductance values. Lower conductances flattened the head gradient noticeably (fig. 9). Changes in head were positively correlated to changes in simulated boundary flux; the degree of sensitivity decreased steadily downgradient toward Tempe Butte where heads in the lower 4 mi of the profile were insensitive to boundary-flux changes (fig. 10).

Head-residual statistics followed the same general sensitivity trends as the head profile; however, decreases in riverbed conductance had little influence on the residuals (table 3) in comparison with the noticeable influence on the slope of the profile (fig. 9). The head-residual statistics were insensitive to variations in most parameters because the residual values were distributed throughout the entire study area; whereas, the sensitivity of the head profile resulted from its representation of a single stream line.

Table 3.--*Sensitivity of head-residual statistics to model parameters*

Multiplier of calibrated value	Percent change in average-absolute head	Percent change in root-mean-square value
	Transmissivity	
0.50	387	416
.75	104	111
1.00	0	0
1.25	31	18
1.50	73	63
2.00	137	133
	Evapotranspiration extinction depth	
0.33	0	0
.67	0	0
1.00	0	0
1.33	0	0
1.67	0	0
	Evapotranspiration rate	
0.20	0	0
.50	0	0
1.00	0	0
1.50	0	0
2.00	0	0
	Riverbed conductance	
0.01	-5	-3
.10	-1	0
1.00	0	0
10.00	0	0
100.00	0	0
	Mountain-front recharge	
0.50	138	133
.75	46	33
.90	7	-1
1.00	0	0
1.10	19	22
1.25	72	77
1.50	174	185
2.00	391	418

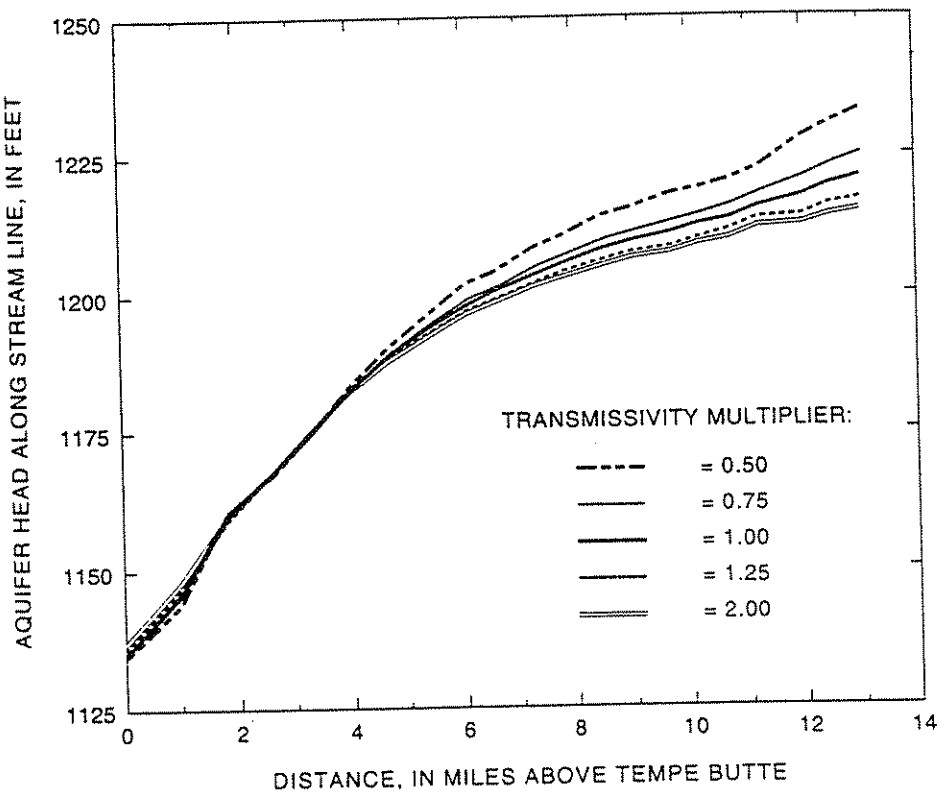


Figure 8.—Sensitivity of stream-line profile to changes in transmissivity values.

Sensitivity of Flow Components

Flow components generally were sensitive to changes in model parameters (fig. 11). Changes in transmissivity produced the greatest changes in the ground-water budget, whereas changes in riverbed conductance produced the least.

The net flux from the Salt River to the aquifer was insensitive to changes in riverbed conductance but highly sensitive to changes in boundary fluxes and evapotranspiration parameters (extinction depth and ground-water withdrawal rate). The net flux was negatively correlated to changes in boundary fluxes and positively correlated to changes in evapotranspiration parameters. Variations in transmissivity produced variations in the net river flux that appeared as equivalent changes in subsurface outflow. Evapotranspiration was completely unresponsive to changes in transmissivity. Changes in net river flux produced by variations in evapotranspiration parameters caused equivalent changes in the evapotranspiration component. Subsurface outflow was completely insensitive to changes in net river flux induced by variations in evapotranspiration parameters. Changes in riverbed conductance had little effect on net river flux, subsurface outflow, and evapotranspiration. Variations in mountain-front recharge (boundary flux) had a negative correlation to net river flux and had only a slight positive correlation to subsurface outflow and evapotranspiration.

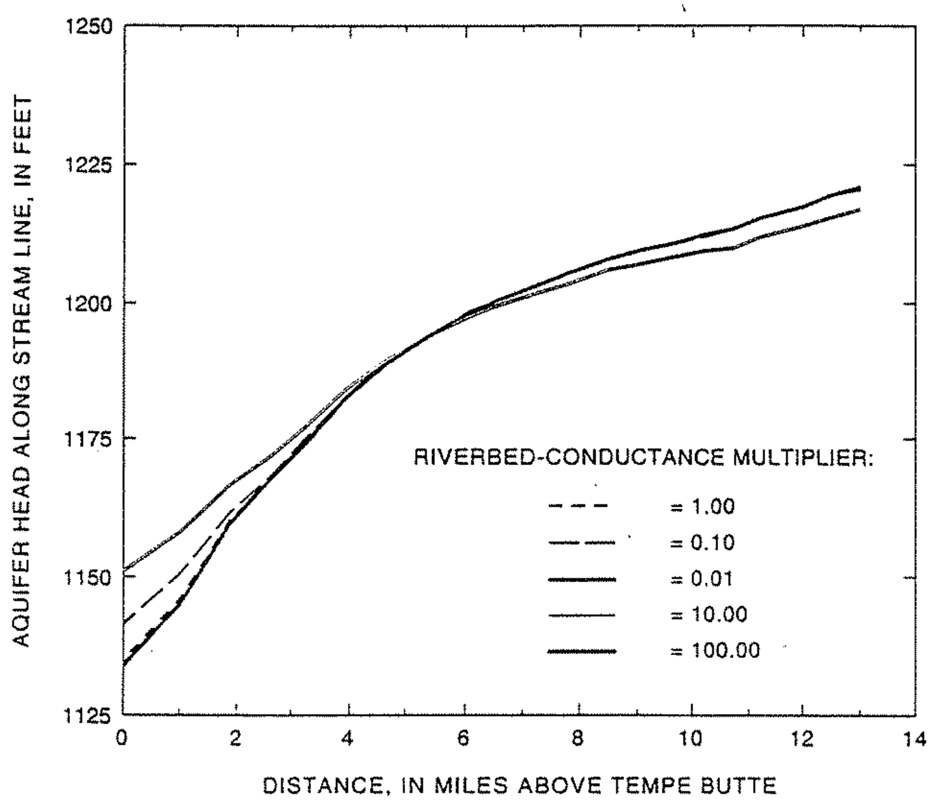


Figure 9.—Sensitivity of stream-line profile to changes in riverbed conductance.

Total recharge from and discharge to the river exhibited strong positive correlations to transmissivity changes. These fluxes, however, were sensitive to decreases and insensitive to increases in riverbed conductances. Increases in evapotranspiration rates and extinction depths reduced the discharge to the river and increased the recharge from the river and the net-river flux.

The flow-component sensitivity results are compatible with the head-sensitivity results and suggest that the simulated predevelopment scenario was reasonable and that the emphasis placed on the well data during the calibration process was appropriate. Net river flux and evapotranspiration along the flood plain had little influence on regional-head configurations outside the flood plain, as suggested by the insensitivity of the head profile and head residuals to most variations in evapotranspiration parameters and riverbed conductance. Head configurations were most sensitive to changes in boundary fluxes and regional variations in transmissivity.

SUMMARY

The Salt River Indian Reservation is in an area of broad desert plains separated by rugged mountains and is transected by the Salt River. Ground water occurs mainly under unconfined conditions in unconsolidated to

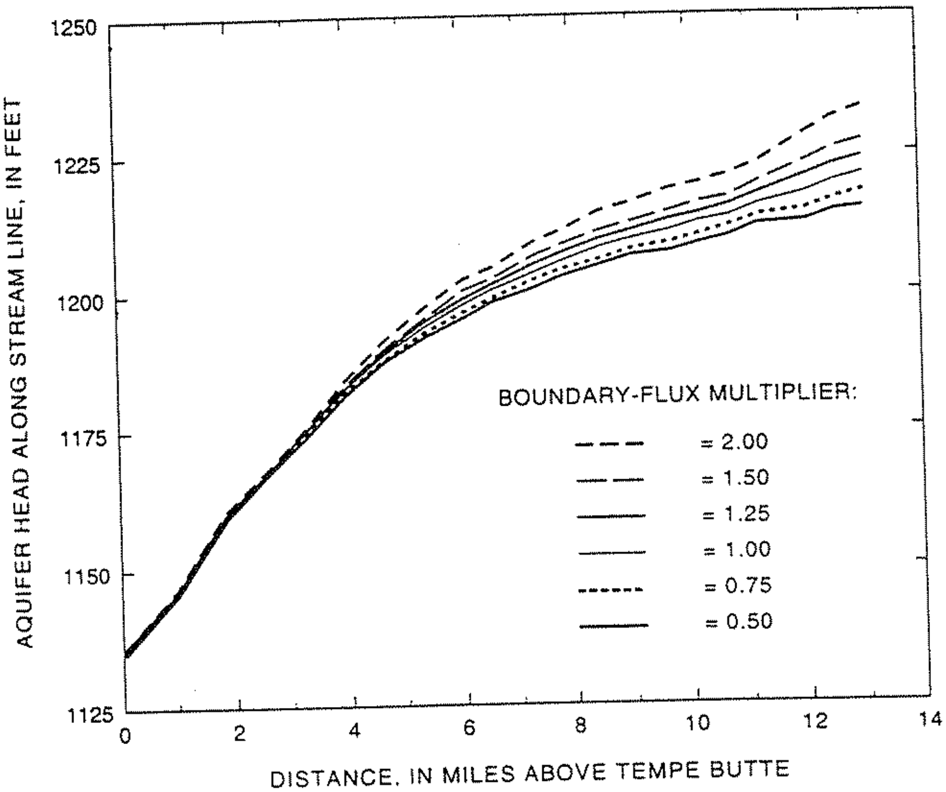


Figure 10.--Sensitivity of stream-line profile to changes in boundary-flux values.

variably consolidated sedimentary material that underlies the desert plains. Hydrologic conditions that existed in and near the Salt River Indian Reservation prior to development by non-Indian settlers were investigated. Prior to the 1860's, when modern irrigation began in the Salt River Valley, flow was perennial in the Salt River. The median annual flow at Granite Reef Dam was estimated to be 950,000 acre-ft, and the average annual flow was estimated to be 1,250,000 acre-ft. Ground water was 10 to 70 ft below the land surface in areas developed before 1900. Infiltration from the Salt River maintained water levels at shallow depths, and ground water was discharged into the Salt River near Tempe.

Simulation of the predevelopment ground-water flow indicates that average recharge to the aquifer by infiltration from the Salt River was 19,700 acre-ft/yr. Mountain-front recharge and subsurface inflow was 10,700 acre-ft/yr. Discharge from the aquifer to the Salt River was 9,800 acre-ft/yr, subsurface outflow was 7,300 acre-ft/yr, and evapotranspiration from ground water was 13,300 acre-ft/yr.

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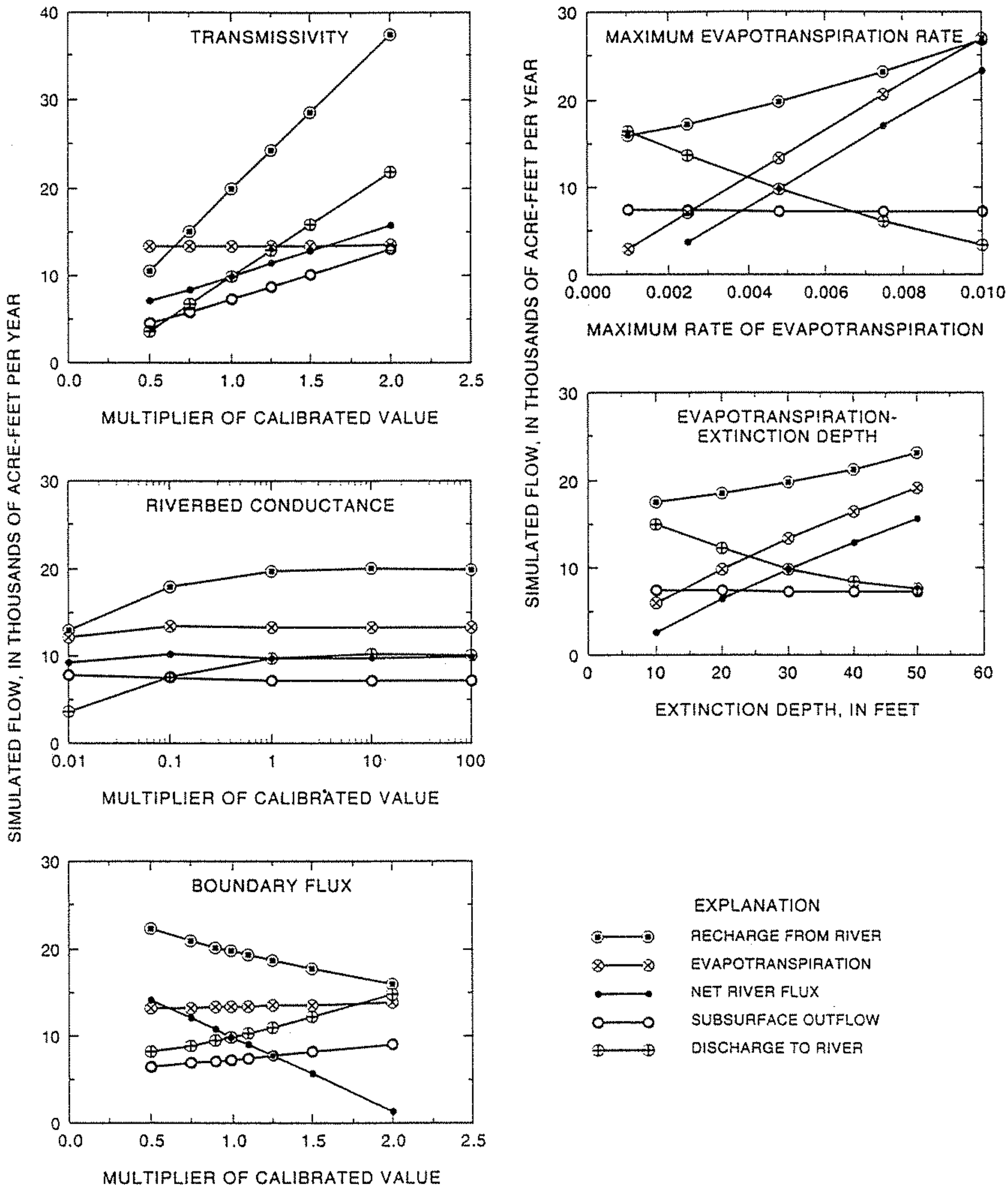

Figure 11.—Model sensitivity to changes in transmissivity, riverbed conductance, boundary-flux values, evapotranspiration rate, and evapotranspiration-extinction depth.

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EXHIBIT 183

Monthly and yearly diversion, in acre-feet, for city of Phoenix from Verde River, at McDowell, Ariz.

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1922	-	-	-	-	450	540	590	650	730	820	740	650	-
1923	590	490	490	490	480	580	630	700	780	880	790	690	7,590
1924	640	525	535	535	520	620	680	755	845	950	850	745	8,200
1925	570	485	565	565	550	660	720	390	330	800	900	790	7,320
1926	430	580	600	600	580	700	760	670	850	1,070	940	750	8,530
1927	780	640	650	650	630	690	780	920	1,030	1,160	1,020	900	9,850
1928	870	720	730	730	700	850	880	1,030	1,120	1,300	1,160	1,020	11,110
1929	960	910	890	855	686	1,080	1,120	1,170	1,230	1,320	1,380	1,380	12,980
1930	1,200	997	1,080	874	996	1,090	1,060	1,160	1,200	1,340	1,290	1,170	13,460
1931	1,070	1,020	1,050	1,080	1,030	921	1,110	1,060	1,270	1,530	1,310	1,170	13,620
1932	1,290	866	891	1,060	940	1,110	1,200	1,310	1,440	1,550	1,490	1,290	14,440
1933	810	761	726	663	601	931	1,050	1,230	1,560	1,720	1,580	1,200	12,830
1934	1,050	793	693	819	828	1,190	1,370	1,630	1,650	1,870	1,510	1,450	14,850
1935	1,260	888	770	736	668	901	1,270	1,410	1,720	1,740	1,270	1,270	13,900
1936	1,070	794	779	824	637	879	994	1,210	1,410	1,420	1,290	1,160	12,470
1937	986	835	723	660	711	941	1,190	1,410	1,590	1,760	1,760	1,260	13,830
1938	1,170	893	800	812	833	1,050	1,360	1,530	1,800	1,940	1,830	1,670	15,690
1939	1,310	1,020	845	804	791	1,200	1,410	1,750	2,020	2,160	1,905	1,260	16,470
1940	1,290	893	1,060	1,100	1,070	1,540	1,660	2,050	2,200	2,370	2,340	1,750	19,320
1941	1,320	1,130	892	979	1,060	1,170	1,300	1,740	2,100	2,270	2,150	1,690	17,800
1942	1,220	1,070	914	978	1,090	1,420	1,470	2,010	2,440	2,500	1,940	1,470	18,520
1943	1,520	1,140	1,060	1,030	1,140	1,470	1,740	2,150	1,780	1,540	1,680	1,550	17,810
1944	1,180	1,040	1,110	1,150	1,140	1,390	1,610	2,050	2,310	2,440	2,440	2,130	19,990
1945	1,580	1,160	927	963	1,250	1,530	1,850	2,260	2,190	2,320	2,050	1,990	20,060
1946	1,530	1,200	1,180	1,180	1,140	1,790	1,780	1,920	2,080	2,220	1,830	1,880	19,730
1947	1,380	1,170	1,430	1,390	1,610	2,020	2,220	1,710	1,940	2,360	1,940	1,800	20,980
1948	1,990	1,520	1,500	1,580	1,510	1,800	2,340	2,600	2,430	2,580	2,530	2,530	24,930
1949	2,190	1,850	1,720	1,540	1,580	2,040	2,220	2,420	2,200	3,440	3,510	3,060	27,760
1950	2,240	1,840	1,740	1,560	1,730	2,350	2,620	3,470	4,550	4,620	4,760	3,600	35,080

787. Salt River at Arizona Dam, Ariz. 1/

Location.--Lat 33°32'00", long. 111°40'20", in NE¼ sec. 7, T. 2 N., R. 7 E., unsurveyed, at the former Arizona Dam (2½ miles upstream from Granite Reef Dam), 1¼ miles downstream from Verde River and 7 miles south of McDowell.

Drainage area.--12,900 sq mi, approximately.

Determination of discharge.--Depth of water on crest of Arizona Dam determined, and dam rated as a weir. Coefficients for use in weir formula determined by discharge measurements, made mostly by float-area method.

Extremes.--1888-91, 1895: Maximum discharge, 300,000 cfs (formerly published as maximum daily) Feb. 24, 1891, computed from weir formula for Arizona Dam; minimum daily recorded, 262 cfs July 16, 1895.

Remarks.--Small diversions for irrigation above station. No storage above station during period of these records.

Cooperation.--Records furnished by Arizona Canal Company.

Monthly and yearly mean discharge, in second-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1888	-	-	-	-	-	-	-	-	-	-	350	350	-
1889	331	842	6,698	5,947	2,605	8,745	3,975	1,039	470	495	417	521	2,688
1890	440	576	5,686	4,982	10,100	6,421	1,840	914	511	524	3,885	2,339	3,148
1891	2,768	4,717	6,259	3,416	39,200	-	-	-	-	-	-	-	-
1895	-	-	-	10,090	3,133	5,532	2,594	966	479	350	947	503	-
1896	2,095	1,839	1,279	-	-	-	-	-	-	-	-	0	-

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1888	-	-	-	-	-	-	-	-	-	-	21,520	20,820	-
1889	20,360	50,100	411,900	365,700	144,600	537,700	236,500	63,890	27,960	30,440	25,640	31,000	1,946,000
1890	27,060	34,270	349,600	306,400	560,700	394,800	109,500	56,210	30,400	32,230	238,900	139,200	2,279,000
1891	170,200	280,700	384,900	210,100	2177,000	-	-	-	-	-	-	-	-
1895	-	-	-	620,600	174,000	340,200	154,300	59,380	28,510	21,540	58,200	29,930	-
1896	128,800	109,400	78,670	-	-	-	-	-	-	-	-	-	-

1/ Published as "below Verde River", 1895.

Yearly discharge, in second-feet, of Salt River at Arizona Dam, Ariz.

Year	W.S.P. no.	Water year ending Sept. 30					Calendar year	
		Momentary maximum		Minimum day	Mean	Runoff in acre-feet	Mean	Runoff in acre-feet
		Discharge	Date					
1888	(a)	-	-	-	-	-	-	-
1889	(a)	-	-	300	2,688	1,946,000	2,589	1,847,000
1890	(a)	-	-	319	3,148	2,279,000	3,735	2,704,000
1891	(b)	c300,000	Feb. 24, 1891	-	-	-	-	-
1895	(d)	-	-	-	-	-	2,491	1,804,000

a 11th Ann. Rept., Pt. 2.
b 12th Ann. Rept., Pt. 2.
c Formerly published as maximum daily discharge.
d Bull. 140.

788. Diversions from Salt River at Granite Reef Dam, Ariz.

Location.--Granite Reef Dam, lat 33°31', long. 111°42', in sec. 13, T. 2 N., R. 6 E., 2½ miles downstream from former Arizona Dam, 3 3/4 miles downstream from Verde River, and 8½ miles south of McDowell.

Determination of discharge.--Water-stage recorders near the heads of Arizona and South Canals which divert at Granite Reef Dam. In early years, staff gages at about the same sites. Discharge computed on basis of gage heights and current-meter measurements except during period 1930-36 when measurements were made at submerged weirs by means of the Clausen-Pierce hydraulic-weir rule. Water returned to river through canal waste ways below gaging stations computed on basis of records for rated gates or weirs in the wasteways.

Average discharge.--37 years (1913-50), 1,314 cfs.

Remarks.--Records given herewith are those of discharge at the two canal gaging stations less flow returned from the canals to the river by wasteways between the stations and irrigated lands, and represent the flow diverted from Salt River for irrigation of lands in the Salt River Valley. Flow at Granite Reef Dam has been regulated since before 1913 by Reservoir system on Salt River at and below Roosevelt Dam and in later years also by Reservoir system on Verde River at and below Horseshoe Dam (see records for both reservoir systems elsewhere in this report).

Cooperation.--Records furnished by Salt River Valley Water Users' Association.

Monthly and yearly diversions, in thousands of acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1913	-	-	-	22.68	47.11	60.79	100.5	108.5	107.4	111.4	100.8	95.08	-
1914	60.88	35.43	29.10	41.74	51.37	73.99	87.02	98.06	71.50	74.19	95.09	93.23	811.6
1915	47.05	38.69	27.57	15.25	31.25	90.92	101.2	122.3	120.2	129.1	117.3	113.8	954.6
1916	94.93	67.93	42.40	39.63	59.13	98.94	118.2	140.7	140.5	145.4	119.4	89.16	1,156
1917	86.43	70.63	43.45	15.91	39.82	107.9	96.87	124.4	150.4	144.3	116.9	136.3	1,133
1918	114.0	76.54	57.54	40.29	48.46	82.86	143.7	151.1	148.6	134.1	128.4	142.3	1,268
1919	87.60	48.05	23.91	23.37	34.60	94.65	119.4	129.0	135.7	106.4	125.4	101.7	1,030
1920	48.95	31.16	14.43	24.58	33.05	75.18	118.8	112.1	133.1	151.8	147.9	130.9	1,022
1921	43.26	28.85	28.62	42.78	67.27	113.5	97.49	105.2	111.0	126.4	88.78	114.4	967.6
1922	59.76	40.32	31.76	27.96	51.50	82.37	114.1	125.6	122.6	136.1	132.6	129.2	1,054
1923	68.59	44.89	27.32	51.44	53.74	102.4	118.7	124.2	118.3	115.4	122.5	124.4	1,072
1924	58.20	14.29	24.50	39.47	59.70	77.62	132.1	132.0	154.6	173.6	188.3	156.8	1,211
1925	62.63	39.64	36.60	31.27	47.79	86.12	96.83	87.53	87.09	105.1	81.65	107.3	869.6
1926	44.62	34.75	30.44	22.89	32.41	72.32	54.93	81.64	104.6	111.9	94.87	123.4	806.8
1927	54.43	49.55	22.57	37.37	66.26	121.1	84.25	93.60	95.89	116.3	100.5	116.4	958.2
1928	73.73	52.23	37.87	37.04	66.22	105.4	94.21	104.9	130.6	146.7	115.6	138.4	1,103
1929	50.41	36.99	23.35	25.51	37.13	100.8	91.81	89.10	93.86	90.03	80.46	129.6	849.0
1930	54.30	37.72	18.93	20.58	31.87	85.34	57.59	59.19	89.00	82.51	77.81	128.0	742.8
1931	49.35	49.59	24.86	18.43	47.46	64.30	62.64	77.70	87.48	99.49	74.24	104.6	760.1
1932	73.05	53.00	43.84	33.09	61.36	136.1	91.30	109.5	111.7	109.6	104.7	145.7	1,073
1933	61.16	62.12	31.42	30.80	33.75	81.31	72.13	84.26	99.61	114.2	95.66	120.5	886.9
1934	87.33	58.26	29.38	49.02	42.37	76.20	84.24	74.90	78.31	95.23	68.51	116.8	860.6
1935	68.56	40.63	22.27	51.51	69.83	84.63	91.58	86.06	109.0	120.9	88.29	115.6	948.9
1936	80.05	52.67	39.62	40.07	39.56	94.91	109.6	107.5	123.4	119.7	102.8	131.9	1,042
1937	73.73	57.82	34.81	27.33	79.35	102.7	127.2	130.3	122.9	159.9	170.3	149.8	1,236
1938	78.15	48.02	29.26	27.00	36.30	96.51	105.5	106.1	121.5	128.9	121.2	134.6	1,033
1939	72.59	49.34	30.42	19.15	30.26	75.81	84.57	81.00	84.83	91.81	80.04	57.13	757.0
1940	63.29	43.28	43.09	22.70	30.30	82.31	73.49	64.39	67.88	70.91	47.88	48.93	658.4
1941	35.82	31.74	17.70	26.11	59.61	42.65	103.2	150.5	154.2	142.6	148.2	159.8	1,072
1942	78.42	58.69	36.31	25.56	65.69	93.94	100.9	119.6	136.8	133.0	114.7	115.1	1,079
1943	77.66	53.54	52.31	23.58	46.10	80.55	105.0	117.0	119.9	115.6	64.34	113.5	969.1
1944	87.95	64.81	34.66	28.94	32.06	66.26	114.0	97.29	122.0	111.3	103.3	131.5	994.1
1945	91.96	37.07	54.10	18.36	42.92	69.75	98.33	108.7	116.3	100.1	88.82	144.1	970.5
1946	86.73	71.25	51.80	14.95	55.20	99.53	91.32	95.44	102.3	75.79	74.90	88.20	907.4
1947	73.19	38.28	66.35	35.13	47.50	72.88	72.27	55.83	65.27	57.98	55.08	74.93	714.7
1948	53.19	29.98	43.57	20.03	27.59	64.10	92.92	66.57	71.93	67.03	69.32	86.16	692.4
1949	50.88	35.57	30.39	7.31	27.19	96.36	91.61	76.88	87.10	102.4	94.98	104.6	805.3
1950	54.69	35.43	26.80	20.13	31.49	74.33	93.18	64.01	89.07	82.23	93.75	85.38	750.5

Monthly and yearly runoff, in acre-feet, of Salt River below Stewart Mountain Dam, Ariz.

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1930	-	-	-	-	-	10,790	25,300	48,900	83,520	64,660	44,590	113,000	-
1931	36,090	20,680	2,930	4,350	3,670	25,030	45,770	63,230	81,950	89,360	26,360	82,420	481,800
1932	60,880	18,590	2,590	3,910	21,140	1,860	45,460	97,410	104,200	96,520	90,300	142,000	684,900
1933	42,410	49,960	12,630	5,790	13,220	37,720	54,710	63,240	93,480	104,600	87,010	106,700	671,300
1934	74,570	46,810	13,690	33,720	28,490	63,200	71,020	69,230	74,320	89,640	43,530	105,600	713,800
1935	58,810	24,300	3,280	589	1,220	1,990	40,700	74,710	105,400	116,800	56,510	87,670	572,000
1936	66,200	38,450	23,040	24,620	1,820	38,350	70,690	99,610	122,300	114,700	80,740	115,400	795,900
1937	60,990	39,820	18,060	1,480	5,540	1,240	47,990	120,100	122,700	154,300	168,300	145,900	886,400
1938	71,150	38,740	13,430	11,710	16,440	18,110	93,890	99,230	120,500	123,100	105,800	125,800	837,900
1939	64,200	38,130	7,560	2,030	12,750	29,100	65,650	77,180	87,570	94,630	68,550	11,640	559,000
1940	41,820	29,380	22,950	4,440	1,210	45,340	55,650	58,740	67,200	68,800	37,040	33,550	466,100
1941	4,760	7,320	732	664	490	545	145,100	351,500	104,700	100,600	107,400	95,320	915,100
1942	68,320	45,850	29,030	24,840	58,950	51,120	54,560	83,980	92,290	105,900	108,500	113,600	836,900
1943	75,370	45,150	44,840	4,260	25,080	26,520	56,630	82,140	121,200	114,600	62,010	89,860	747,700
1944	72,350	53,650	32,480	12,820	18,760	14,870	17,470	62,040	74,070	84,400	66,950	103,100	613,000
1945	80,770	36,070	31,930	2,120	22,390	19,640	36,670	68,580	77,690	85,100	68,480	107,600	637,000
1946	75,530	64,380	39,840	2,420	42,300	87,500	58,870	81,000	99,790	73,240	73,800	67,900	766,600
1947	70,630	31,230	40,700	24,390	26,590	43,330	54,220	46,070	60,480	55,960	52,390	59,020	565,000
1948	34,570	18,100	20,830	9,880	22,640	27,470	40,070	55,780	63,180	64,080	63,320	68,690	488,600
1949	38,720	28,760	21,650	664	722	597	567	625	49,400	73,930	65,970	52,580	334,200
1950	33,050	34,000	13,660	1,080	2,340	45,340	66,290	61,640	74,180	67,140	69,950	69,250	537,900

Note.--Records for water years 1930-34 not previously published.

Yearly discharge, in second-feet

Year	W.S.P. no.	Water year ending Sept. 30					Calendar year	
		Momentary maximum		Minimum day	Mean	Runoff in acre-feet	Mean	Runoff in acre-feet
		Discharge	Date					
1930	(a)	-	-	-	-	-	-	-
1931	(a)	-	-	20	666	481,800	696	504,200
1932	(a)	-	-	18	943	684,900	975	707,840
1933	(a)	-	-	15	928	671,300	969	701,370
1934	(a)	-	-	15	986	713,800	919	665,120
1935	789	2,660	Sept.13, 1935	3	790	572,000	847	613,300
1936	809	2,900	July 15, 1936	18	1,096	795,900	1,084	787,200
1937	829	3,450	Sept.16, 1937	16	1,224	886,400	1,231	890,900
1938	859	3,000	Sept.14, 1938	7	1,157	837,900	1,139	824,500
1939	879	3,170	Apr. 19, 1939	6	772	559,000	750	543,200
1940	899	1,730	Mar. 27, 1940	7	642	466,100	530	384,800
1941	929	b11,700	May 7, 1941	7	1,264	915,100	1,444	1,046,000
1942	959	2,860	Sept.10, 1942	10	1,156	836,900	1,187	859,100
1943	979	2,380	June 10, 1943	3	1,033	747,700	1,023	740,800
1944	1009	2,520	Sept.15, 1944	8	844	613,000	831	603,200
1945	1039	2,780	Sept.20, 1945	5	880	637,000	923	668,000
1946	1059	2,570	Aug. 30, 1946	6	1,059	766,600	1,007	729,400
1947	1089	1,830	Nov. 1, 1946	19	780	565,000	685	496,000
1948	1119	1,900	June 14, 1948	7	673	488,600	695	504,200
1949	1149	1,630	Sept. 8, 1949	8	462	334,200	450	325,800
1950	1159	2,000	July 8, 1950	14	743	537,900	-	-

a Files of Salt River Valley Water Users' Association.
b Mostly spill from reservoir system which was entirely filled.
Note.--Records for water years 1930-34 not previously published.

772. Salt River at McDowell, Ariz. 1/

Location.--Lat 33°33', long. 111°39', in NE¼ sec. 5, T. 2 N., R. 7 E., unsurveyed, 1.7 miles or less upstream from Verde River and 6¾ miles south of McDowell (also called Ft. McDowell).

Drainage area.--6,280 sq mi, approximately.

Gage.--Staff gages, presumably for entire period of record. Little is known about the gages in use in 1895-96 and 1907-10 except that they were within the reach from Verde River to a point 1.7 miles upstream, the same as were all other gages. Datums of gages are as follows: Jan. 1, 1901, to Apr. 2, 1903, 1,323.59 ft; May 19, 1903, to Apr. 14, 1905, 1,336.27 ft; Apr. 15 to Sept. 1, 1905, 1,330.62 ft; Sept. 2, 1905, to 1907 and perhaps later, 1,326.62 ft; all datums are referred to mean sea level, Geological Survey datum at the time.

Average discharge.--9 years (1897-99, 1903-10), 1,562 cfs.

Extremes.--1895-1910: Maximum daily discharge, 138,000 cfs Nov. 27, 1905 (gage height, 21.2 ft, datum then in use), from rating curve extended above 60,000 cfs; minimum daily, 38 cfs July 14, 1904.

Remarks.--Diversions for irrigation above station. No storage above station until construction of Roosevelt Dam caused some regulation in November 1908 and perhaps some small effect earlier; full-scale storage at Roosevelt Dam began in the first half of 1910.

Cooperation.--Records for 1895-96 furnished by Hudson Reservoir and Canal Company and those for 1907-1910 furnished by Bureau of Reclamation.

1/ Published as "above mouth of Verde River", 1895-96, and as "at McDowell, near Lehi," 1903.

Monthly and yearly mean discharge, in second-feet, of Salt River at McDowell, Ariz.

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1895	-	-	-	6,056	1,445	1,829	1,860	708	325	204	584	329	-
1896	1,624	1,376	888	470	476	1,185	959	446	224	639	-	-	-
1897	-	-	-	-	-	-	-	1,172	386	176	431	716	-
1898	548	287	284	360	618	724	822	471	255	434	405	360	466
1899	165	213	315	379	406	505	585	324	219	472	706	316	384
1900	269	213	-	-	-	-	-	-	-	-	-	-	-
1901	-	-	-	582	2,422	1,634	-	-	284	152	369	192	-
1902	143	189	182	176	198	197	-	-	-	-	-	-	-
1903	-	-	-	189	304	350	-	-	262	141	365	312	-
1904	231	196	197	185	170	164	132	117	63.7	418	1,697	513	342
1905	269	176	192	2,250	10,170	14,680	13,700	5,253	1,547	568	591	930	4,146
1906	444	9,954	2,047	1,664	1,769	8,009	5,103	1,641	645	508	896	379	2,749
1907	303	377	4,819	3,782	3,207	4,644	2,489	883	570	421	1,120	1,180	1,982
1908	1,182	979	554	411	3,978	3,898	1,673	957	456	827	2,190	1,147	1,513
1909	391	375	3,832	1,203	3,622	3,055	3,945	544	681	468	1,220	2,510	1,805
1910	485	1,127	341	1,767	635	1,256	1,077	515	145	164	309	224	671
1911	181	309	288	-	-	-	-	-	-	-	-	-	-

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1895	-	-	-	372,400	80,250	112,400	110,700	43,540	19,350	12,590	35,910	19,580	-
1896	99,880	81,900	54,620	28,910	27,350	72,880	57,050	27,450	13,300	39,320	-	-	-
1897	-	-	-	-	-	-	-	72,090	22,880	10,820	26,530	42,620	-
1898	35,900	17,070	17,460	22,150	34,300	44,530	48,890	28,950	15,190	26,680	24,920	21,440	337,500
1899	10,140	12,680	19,370	23,280	22,550	31,050	34,810	19,900	13,040	29,040	43,430	18,780	278,100
1900	16,510	12,650	-	-	-	-	-	-	-	-	-	-	-
1901	-	-	-	35,800	134,500	100,500	-	-	16,970	9,350	22,710	11,420	-
1902	8,820	11,220	11,180	10,810	11,020	12,130	-	-	-	-	-	-	-
1903	-	-	-	11,620	16,880	21,520	-	-	15,600	8,650	22,470	18,590	-
1904	14,210	11,670	12,120	11,390	9,770	10,080	7,830	7,190	3,790	25,700	104,300	30,510	248,600
1905	16,570	10,460	11,810	138,400	564,600	902,600	815,300	323,000	92,050	34,940	36,350	55,350	3,001,000
1906	27,280	592,300	125,900	102,300	98,230	492,400	303,700	100,900	38,360	31,210	55,110	22,570	1,990,000
1907	18,630	22,440	296,300	232,500	178,100	285,600	148,100	54,290	33,910	25,870	68,880	70,220	1,435,000
1908	72,680	58,260	34,050	25,270	228,800	239,700	99,530	58,850	27,120	50,860	134,700	68,260	1,098,000
1909	24,060	22,310	235,600	73,980	201,200	187,800	234,700	33,420	40,540	28,800	75,020	149,300	1,307,000
1910	29,840	67,050	20,950	108,600	35,240	77,220	64,100	31,690	8,640	10,080	19,000	13,350	485,800
1911	11,100	18,360	17,680	-	-	-	-	-	-	-	-	-	-

Yearly discharge, in second-feet

Year	W.S.P. no.	Water year ending Sept. 30					Calendar year	
		Momentary maximum		Minimum day	Mean	Runoff in acre-feet	Mean	Runoff in acre-feet
		Discharge	Date					
1895	(a)	-	-	-	-	-	1,441	1,043,000
1896	(a)	-	-	-	-	-	-	-
1897	(b)	-	-	-	-	-	-	-
1898	(c)	-	-	137	466	337,500	427	309,200
1899	(d)	-	-	155	384	278,100	-	-
1901	75	-	-	-	-	-	-	-
1902	85	-	-	-	-	-	-	-
1903	100	-	-	-	-	-	-	-
1904	133	-	-	38	342	248,600	344	249,400
1905	175	-	-	154	4,146	3,001,000	5,122	3,708,000
1906	211	-	-	275	2,749	1,990,000	2,185	1,582,000
1907	249	-	-	276	1,982	1,435,000	1,744	1,262,000
1908	249	-	-	214	1,513	1,098,000	1,674	1,215,000
1909	269	-	-	50	1,805	1,307,000	1,578	1,143,000
1910	289	-	-	-	671	485,800	573	415,100

a 18th Ann. Rept., Pt. 4.
b 19th Ann. Rept., Pt. 4.
c 20th Ann. Rept., Pt. 4.
d 21st Ann. Rept., Pt. 4.

773. Granite Creek near Prescott, Ariz.

Location.--Lat 34°34', long. 112°27', in SW¼ sec. 26, T. 14 N., R. 2 W., unsurveyed, at bridge on U. S. Highway 89, 2 miles north of Prescott, 3 miles upstream from dam forming Watson Lake, and 4½ miles upstream from Willow Creek.

Drainage area.--39 sq mi.

Gage.--Water-stage recorder. Datum of gage is 5,207.3 ft above mean sea level (Arizona Highway Department bench mark).

Average discharge.--14 years (1932-34, 1935-47), 5.88 cfs.

Extremes.--1932-47: Maximum discharge, 2,900 cfs Feb. 7, 1937 (gage height, 9.20 ft), from rating curve extended above 1,400 cfs; no flow at times each year.

Remarks.--Diversion for municipal supply of city of Prescott from tributaries and from underground infiltration gallery immediately upstream from station.

Cooperation.--Records for period July 1941 to February 1945 furnished by Bureau of Reclamation.

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EXHIBIT 184

A STUDY OF THE
WATER SUPPLY OF THE SALT RIVER PROJECT
ARIZONA
SHOWING THE NEED OF STORAGE ON THE
VERDE RIVER
AND
THE EFFECT OF AN OVER-DEVELOPED
VERDE DISTRICT

by

T. A. HAYDEN, Hydraulic Engineer

Phoenix, Arizona August 26, 1933

EXHIBIT 185

Air Base Wing, Air Force Logistics Command, 1986).

27. Bill of Sale, April 30, 1938, and Agreement, May 20, 1938, between Grand Canyon Scenic Tours and G & G Airlines Company Ltd.; Walter Douglas, Jr., to H. F. Bryant, January 22, 1946, all in Walter Douglas, Jr., Collection.

28. Walter Douglas, Jr., to Byron Harvey, Jr., August 17, 1949, ibid.

29. Palen Hudgin and Henry Hudgin interview with the author, Tucson, August 23, 1993; Bill of Sale, July 15, 1953, between G & G Air Lines Company Ltd. and Alfred A. Hudgin, Walter Douglas, Jr., Collection.

30. The collision, involving United Airlines and TWA, occurred on June 30, 1956. Note that the new Grand Canyon *Airlines* was unrelated to its similarly named precessor, Grand Canyon *Air Lines*.

31. James Vercellino telephone interview with the author, Phoenix, February 10, 1993; Contract, FAAP Project #9-02-027-C402, Peter Kiewit Sons Co., RAD, GCNP; *Arizona Republic*, July 18, 1965.

32. *Arizona Daily Sun* (Flagstaff), May 10, 1965; *Arizona Republic*, June 9, 1963.

33. John R. Seibold interviews with the author, various dates, 1980–1993.

34. A. E. DeMaray, "High Seas of the Parks: Shall Airplanes be Given a Place in the National Parks?" *American Forests* (August 1929), pp. 517–18; *Williams News*, January 8, August 7, 1947; Public Law 93–620, Section 8, January 3, 1975, 88 Stat. 2091, 16 USC. 174. On December 2, 1968, outgoing superintendent Howard B. Stricklin issued guidelines for tour aircraft operations in Grand Canyon National Park. Robert R. Lovegren, Stricklin's successor, revised the guidelines, which were reissued on April 21, 1969. During the summer of 1969, the National Park Service realized that flight guidelines required FAA approval and solicited the comments of tour operators. Robert R. Lovegren to Richard Rowlands, October 9, 1969, Corporate Archives, 1969, Tri-State Operators, Grand Canyon Airlines, Inc., Grand Canyon, Arizona.

35. Public Law 100–91, Section 3, August 18, 1987, 101 Stat. 674, amending 16 USC Section 1a-1 (National Parks System General Authorities Act).

36. Grand Canyon National Park Visitor Statistics, November 30, 1993, Fee Management and Statistics Office, GCNP.

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DR. A. J. CHANDLER
Practitioner in Land Fraud

by
Earl Zarbin

IN 1912 DR. A. J. CHANDLER founded the town named for him in the Salt River Valley south of Mesa. The townsite was part of more than 18,000 acres he amassed in one of Arizona's most successful land frauds. The scheme, which had its origins in the late 1880s, a year or two after the new Arizona Live Stock Sanitary Board hired Chandler as the territory's veterinary surgeon, was not disclosed publicly until April of 1912, some six months after Chandler's Mesa Improvement Company began selling the land in 10- to 160-acre parcels. Lot sales began in Chandler in May of 1912. By then it was too late for the previous owner, the United States government, to recover it's property or to prosecute Chandler and the dozens of people he had recruited to help him.[1]

Born and educated in Canada, Alexander John Chandler graduated from the Montreal Veterinary College and moved to Detroit, Michigan, in 1882. There he practiced his profession, while he also worked for the D. W. Ferry Seed Company. Arriving in Arizona in August of 1887, twenty-eight-year-old Chandler spent a month at the territorial capital in Prescott, before moving his office to Phoenix. Soon, he bought two ranches south of the Salt River, one watered by the Mesa Canal and the other via the Tempe Canal.[2]

Chandler quickly absorbed valuable lessons about irrigating with Salt River water. First of all, the flow fluctuated broadly

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from too little to too much. Even when the flow was adequate, canals sometimes failed to carry water to the land they were intended to irrigate. Finally, Chandler observed that the flow diminished as it traveled downriver, a portion of it sinking into the sandy wastes. Chandler particularly noticed that the Mesa Canal "had a very inferior head," which set him to thinking about ways to improve it.

He also considered ways to unite canal companies operating south of the Salt River and to use the conserved water on unentered public land. "I thought, taking the whole thing together combined, it was a good enterprise," he said. But he learned, too, "that everybody that had touched [an] irrigation enterprise was a financial wreck; never seemed to be any money in it; seemed to be some cause for it, and I took it up with some of the (local) authorities."[3]

One of the local "authorities" was Daniel H. Wallace, a Phoenix lawyer and former receiver in the U.S. Land Office in Tucson. According to Chandler, Wallace "suggested that there had been a recent law passed [by Congress] which permitted canal companies, or people interested in irrigation enterprises, to mortgage the (government) lands for the improvements, and therefore the man who would put his money into an irrigation enterprise would be protected thereby."[4]

Congress never passed such a law, and Chandler admitted that he never attempted to confirm its existence. Nevertheless, he used the fictitious statute as the basis for the scheme he cooked up "to get good substantial citizens, good citizens," to apply for government parcels under the Desert Land Act of March 3, 1877, and then sign contracts mortgaging the acreage to him.[5]

Chandler may also have discussed his ideas with W. J. (William John) Murphy who, in 1883, received a contract to build the Arizona Canal north of Phoenix. By the time Chandler arrived on the scene, Murphy was president of the Arizona Canal Company and reportedly had acquired thousands of acres in the Salt River Valley. Evidently, he employed some of the same strategems that Chandler later used.[6]

For instance, immediately after Congress passed legislation in February of 1885 to restore to the public domain odd numbered sections of land that had been granted as a subsidy to the Texas Pacific Railroad Company in 1871, Laura Murphy wrote to her husband for guidance in obtaining some of the released acreage. "The odd sections I suppose will be thrown open to settlers soon," she speculated. "Are there any you want entered on Desert [Land] Act and *what names can you use* [emphasis added]? Don't you think it best to enter Sec. 29 on Desert Act as soon as the odd sections are declared open for settlers?" Laura went on to describe actions Murphy's relatives, friends, and employees were taking in order to prevent other settlers or speculators from claiming the land.[7]

The Desert Land Act required every person making an entry to file with the U.S. Land Office "a declaration under oath" that he or she would reclaim a maximum of 640 acres "by conducting water upon the same, within the period of three years thereafter." The water was to come from a "bona fide prior appropriation," which meant it could not be diverted from other ground to reclaim the new parcel. At any time within the three years allotted for bringing water to the land, the claimant could, "upon making satisfactory proof . . . of the reclamation," apply for a patent. Reclamation simply meant running water over the land once; the entrant did not have to grow a crop on any portion of the acreage. Proof consisted of "two or more credible witnesses" swearing under oath that the land was desert and could not be farmed without irrigation. The entrant then completed an affidavit attesting that no one else had any interest, such as a mortgage, in the land.[8]

Following Murphy's example, Chandler needed three things for his scheme to succeed: financing, people willing to make dummy entries under the Desert Land Act and mortgage the unpatented government land to Chandler, and a one-time source of water.

For money, Chandler turned to his former Detroit employer, Dexter Ferry, and Ferry's secretary-treasurer, Charles C. Bowen. Both men were millionaires, and their cash financed, among other things, construction of the Consolidated Canal to carry water to Chandler's desert acreage.[9]

As businessmen, Ferry and Bowen wanted to know how Chandler proposed to protect their investments and how they

Alexander J. Chandler, c. 1890. Chandler Historical Society (CHS).

were going to make money. Chandler explained that each dummy claimant would enter 640 acres, for which he or she would get title to 40 acres, free and clear, and a water right. The dummy would mortgage to Chandler the remaining 600 acres at $25 per acre. The $15,000 total for each 600 acres, if paid, would compensate Chandler, Ferry, and Bowen for their investment and work. If the dummies defaulted on their mortgages, the land would reimburse the partners. Because Chandler anticipated developing a water supply that would increase the value of the land, he expected the mortgages to be paid. As it turned out, the water supply never materialized, and not one of Chandler's four dozen or so dummies, almost half of them women, paid off their mortgage. Moreover, not one of the mortgages was ever filed with the Maricopa County recorder.[10]

Besides the promise of forty free acres and a water right, Chandler also offered to pay all expenses of the dummy entries. This included the 25-cent-per-acre entry fee to the U.S. Land Office, the additional $1-per-acre payment when final proof was made, and construction of irrigation ditches. Evidently, Chandler sweetened the deal by promising to buy the forty-acre parcel of

any dummy entrant who wished to sell. It was a tempting proposition. In addition to former Chandler employees, everyday gardeners, carpenters, farmers, and housewives took the doctor up on his proposition. Apparently, entire families joined in. Seven people named Barnett—John, Hattie, George S., Charles W., Samuel T., Helen M., and William—participated in the land fraud.[11]

Chandler's real challenge was getting water to the land. Of course, he had a plan.

First, he proposed to join together the south side canals and run all the water through an improved and enlarged Mesa Canal. By creating a unified distribution system, he expected to save water that otherwise would have been lost in the sandy river bed as it flowed downstream to the dam and on to the head of the next canal. Chandler also planned to build a hydropower plant for generating electricity to pump additional water out of the river.

Consequently, in January of 1891, Chandler took over management of the Mesa Canal. Besides reconditioning the existing canal, he constructed two new branches running east and west. The eastern extension (originally called the Ferry Canal) would turn south to carry water to the dummy tracts. Renamed the Consolidated Canal after Chandler, Ferry, and Bowen incorporated the Consolidated Canal Company in March of 1892, it ran nineteen miles to the northern boundary of the Gila River Indian Reservation. The western branch, known as the Cross Cut Power Canal, linked the Mesa Canal with the Tempe Canal two miles away. Chandler constructed his hydropower plant at a point along the Cross Cut Canal where the water dropped over a forty-two-foot bluff. When the power plant went into operation in 1897, part of the electricity was used to pump groundwater to a small portion of Chandler's land. It was not enough to irrigate what became the Chandler Ranch.[12]

The Consolidated Canal (sometimes called the Mesa Consolidated Canal) was completed in April of 1893. That same month, Chandler, who had been unable to obtain water for the dummy land entries, talked some Mesa Canal water users into allowing their water to remain in the Consolidated Canal for that purpose. The *Arizona Republican* reported that the Mesa Canal Company secretary objected that the water would be used "not to save the suffering crops but to give desert claimants a chance to prove up their claims." He might have objected even more strongly had he known that the claims were mortgaged to Chandler.[13]

Chandler also took water from a branch of the Mesa Canal that served farmers associated with the Utah Canal Enlargement and Extension Company and with the Eureka Canal. Seven of the men sued, charging that their crops had been ruined because Chandler had violated his contract to provide them with water. Instead, he turned it "down on the desert to prove up desert entries."[14]

Soon after Chander had run water on the claims, the dummy entrants began applying to make "final proof" with the U.S. Land Office. Newspaper announcements identified the person making the claim and the land on which he or she was filing, along with the names of "witnesses to prove the complete irrigation and reclamation" of the ground. Some names appear repeatedly on the list of witnesses for twelve sections of land in Township 2 South, Range 5 East, published in the *Mesa Free Press* of March 29, 1894. For instance, Charles W. Barnett and Hyrum S. Peterson were two of the four witnesses for ten of the dummy entries. Moreover, nine of the claimants, excluding Barnett and Peterson, served as witnesses for one another. No wonder historian Sylvia Lee Bender-Lamb concluded that the repetition of witnesses "further corroborate[s] the complicity involved in these transactions."[15]

On August 3, 1890, Congress muddied the waters when it passed a law that limited to 320 the number of acres a person could obtain; the following March 3 it appended an identical amendment to the Desert Land Act. In another effort to end abuses, the Desert Land Act now required that claimants cultivate at least one-eighth of the land entered (forty acres on a 320-acre entry); spend at least $1 per acre per year for three years on permanent improvements; and file a map of the land, including the source of irrigation water.[16]

At best, it was a minor inconvenience for Chandler, who had acquired more than half his dummy entries before Congress passed the revised legislation. Because of the amended law, he now had to recruit two dummies (instead of one) to file on an

Alexander J. Chandler at Chandler townsite office, 1911. CHS.

entire section. At the same time, he reduced the offer of free-and clear land to twenty acres on every 320-acre entry. He also arranged for farming forty acres, paid the added costs of making permanent improvements, and provided the map. Thereafter, virtually all of Chandler's dummy entries occurred in Township 1 South, Range 5 East.[17]

In May and June of 1901, Chandler acquired the last 320 acre parcels that made up his ranch. He had plenty of land but, of the 28,760 acres served by the Consolidated Canal, less than 5 percent—1,320 acres—was in cultivation by October of 1901.[18]

To obtain water and give value to his land, Chandler busily promoted schemes to build storage reservoirs for the Salt River Valley. Congress solved the problem when it approved, and President Theodore Roosevelt signed, the National Reclamation Act of June 17, 1902. The act provided federal assistance for construction of irrigation works, including water storage dams. In February of 1903, Chandler and other land owners incorporated the Salt River Valley Water Users' Association to entice the federal government, through the newly created U.S. Reclamation Service, to build Roosevelt Dam on the Salt River, about sixty five miles northeast of Phoenix.[19]

Although the Chandler Ranch fell within the boundaries of the Water Users' Association, Chandler decided not to enroll his land, because the reclamation act limited to 160 acres the amount of ground for which any one owner could get water. Instead, in 1904 he organized the Mesa Improvement Company to manage and develop his land. Three years later, Chandler agreed to sell the Consolidated Canal, which he had allowed to deteriorate, to the Reclamation Service. The service needed it to properly serve south-side land owners. Louis C. Hill, supervising engineer for the Roosevelt Dam and associated works, set a price of $187,000—$63,000 below the original cost, less depreciation. Chandler also agreed to subdivide and sell his ranch in tracts of 160 acres or less, thereby making the land eligible for water that it otherwise would not have received.[20]

Chandler's fraudulent scheme became public in 1912. In April, a three-member congressional subcommittee overseeing Interior Department expenditures arrived in Phoenix to investigate matters on the Pima and Maricopa Indian reservations. Finding that the Indians' interests had "been most outrageously intermingled with the affairs of the Reclamation Service," the investigators turned their attention to unsorting "the appropriations and uses of waters of the Salt and Gila Rivers." Against this backdrop, Chandler was called on to descibe how he had accumulated the land that made up the Chandler Ranch and to explain his sale of the Consolidated Canal to the Reclamation Service.[21]

Perhaps the most damaging part of Chandler's testimony, given over two days, dealt with the contract that he required each of his dummy entrants to sign. In part, it read:

"Know all men, That [name], party of the first part, *in consideration of fifteen thousand dollars in hand paid by A. J. Chandler* [emphasis added], . . . party of the second part, the receipt whereof is hereby acknowledged, does hereby grant, bargain, sell, and convey to the said party of the second part, . . . the following real estate, [description of the survey location of the 600 acres], . . . together with all the privileges and appurtenances to the same belonging."

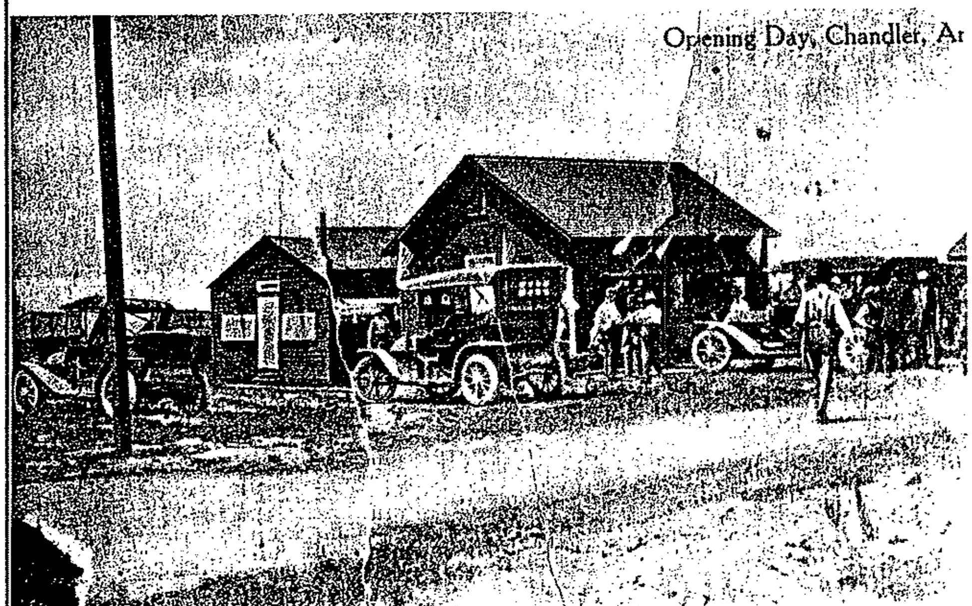
In return, the entrant "hereby covenants that he is well and truly seized of a good and perfect title to the premises above conveyed in the law, in fee simple, and has good, right, and lawful authority to convey the same, and that the title so conveyed is

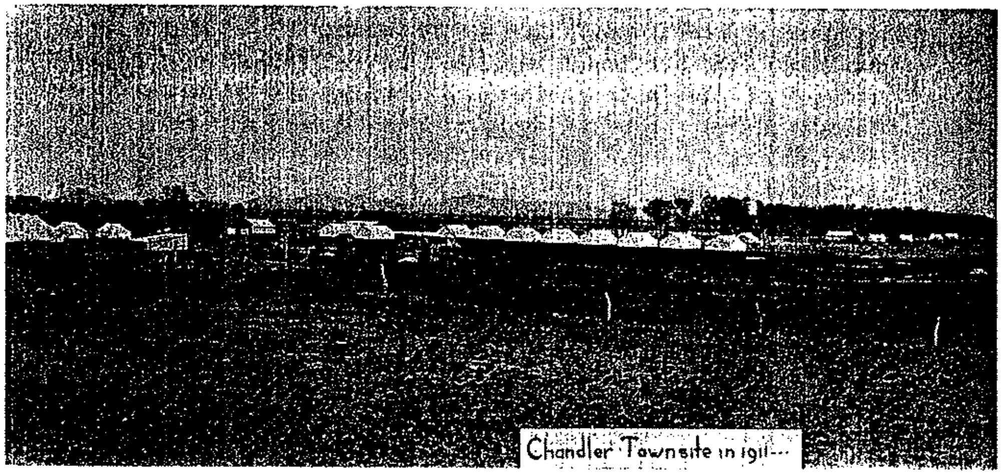
clear, free, and unencumbered." But, of course, beyond the fact that the entrant had no right to mortgage government land, there was another catch. "These presents are upon the express condition," the agreement stipulated, "that if . . . [name], . . . shall pay or cause to be paid to . . . [Chandler], . . . the just and full sum of fifteen thousand dollars loaned to the party of the first part by the party of the second part, at or before the execution of this mortgage, . . . then these presents shall be null and void."[22]

Subcommittee chairman Walter L. Hensley of Missouri questioned Chandler about the contract, noting that none of the dummies had received any money. Chandler justified this by saying that he had made improvements on their claims and had "furnished water rights."

Hensley quickly got to the heart of the matter. "They [the dummies] had no use for water rights in the moon, in the open atmosphere, or mountain tops; the only place in the world they had any use for water was on the land and every bit of the money that you had spent improving the land, the water furnished, etc.,

Opening Day at Chandler, 1911. AZ & SW CP MCL 25865.C47. McLaughlin Collection, Arizona State University (MC-ASU).





Panorama of Chandler townsite, c. 1911. CP MCL 25864.C47, MC-ASU.

went onto this land you held a mortgage on," he asserted.

"Yes," Chandler responded. "They held the water right and they had the improvements."

Again, Hensley pushed. "And you hadn't furnished them a dollar outside of that?"

"And all these improvements," Chandler insisted.

"You hadn't furnished personally one single cent; all you did was to improve that land," Hensley repeated.

"Furnished water rights," Chandler answered.[23]

Both Hensley and Congressman Oscar Callaway of Texas noted that the dummies were responsible for paying off the contract before it was executed. Hensley thought this explained why none of the dummies had discharged their mortgages. Chandler, however, maintained that the notes were not paid simply because he had been unable to develop a water supply for the land. Although he blamed lawsuits for the inability to get water, it was a subterfuge. The Salt River's entire normal flow already had been appropriated for use on other land.[24]

Nevertheless, Chandler persisted. If the water supply had been forthcoming, he argued, the value of the entries would have

exceeded $25 an acre, and the dummies would have paid off their mortgages. But this argument, too, was specious. At a time when $100 per month was good wages, there was little likelihood that carpenters, gardeners, housewives, and others whom Chandler had drawn into his scheme, could have accumulated, in the three years allotted for watering the land, $15,000 to pay off their mortgages.

Chandler adamantly rejected suggestions that he had done anything wrong, claiming that he merely had followed the advice of his attorney, Daniel Wallace, and was unaware of details. Even though he readily acknowledged recruiting dummies, he denied that he ever intended to accumulate large landholdings; he merely had offered irresistable deals to "good citizens" in exchange for the use of their names and signatures. Chandler conveniently ignored that he had illegally diverted water in order to meet the requirement of the Desert Land Act. By August of 1895, he had amassed more than 10,000 acres, and he continued the scheme for six more years. Years after the lawsuits he complained of had ended, little of Chandler's land was watered on a permanent basis.[25]

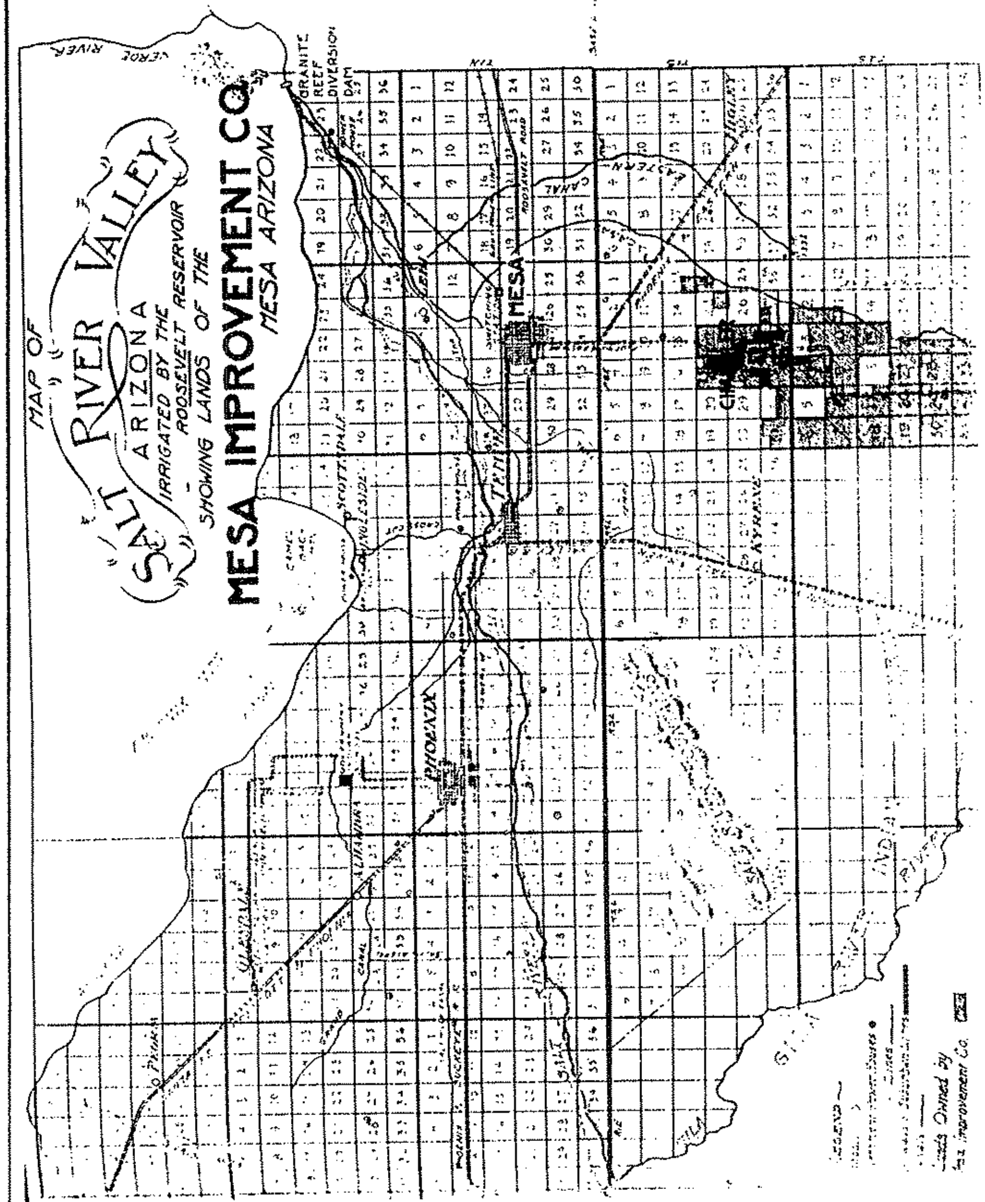
Chandler's disingenuousness failed to impress Justice Department attorney M. C. Burch, who proposed that the doctor "restore to the Government that which was illegally procured from it." While protesting that he did "not want to have anything that was illegally obtained," Chandler added, "but I would have to be convinced." Evidently, the government failed to convince Chandler that he had done anything wrong; he never returned any of the land to the public domain.[26]

In its report on February 11, 1913, the congressional subcommittee stated flatly that, by his own testimony, Chandler had admitted to defrauding the government "by the 'dummy entry' plan, the 'dummies' filing under the desert-land act, making and filing false affidavits as to their respective interests, and executing formal conveyances to Chandler after receiving patents." Had they probed deeper, the investigators would have discovered that many of the land transfers to Chandler had taken place *before* the dummies received their patents.[27]

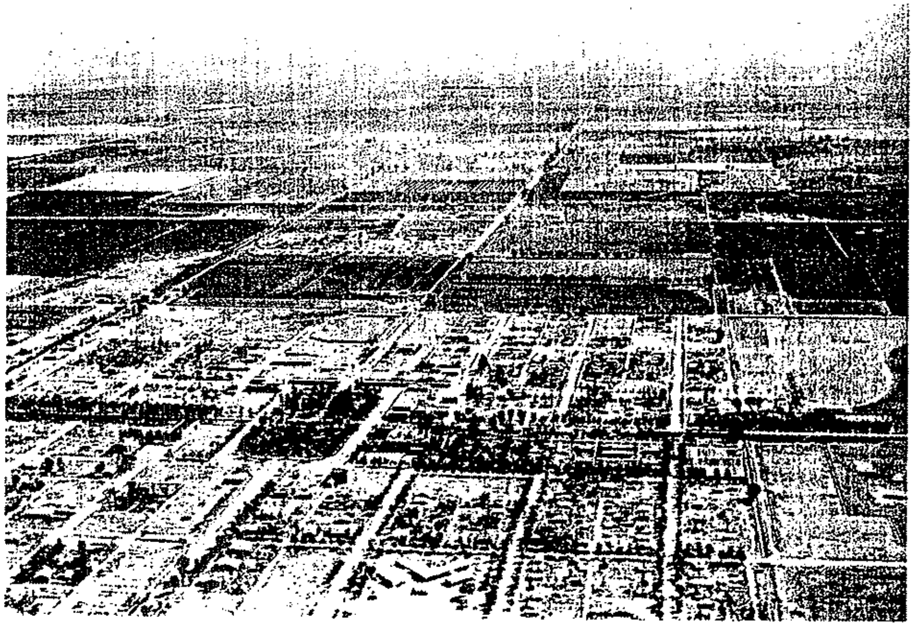
Upset by Chandler's duplicity in the land scheme, the congressmen also accused him of putting together another "dummy" program to get water for the Chandler Ranch. "The reclamation act limits the amount of water which any one user may purchase to that sufficient for 160 acres," the subcommittee report explained, "but by giving a deed to a 'dummy' and having that dummy in turn execute a mortgage to Chandler for the full selling price or more, the law is evaded, and one individual thus receives sufficient water to irrigate many thousands of acres." Apparently, the congressmen overreacted. There was no evidence that Chandler used dummies to buy the ranch land he was selling.[28]

The subcommittee was back on solid ground when it condemned the Reclamation Service purchase of the Consolidated Canal from Chandler. The congressmen charged that, once Chandler had secured title to the land watered by the canal, he allowed the ditch to run down. The Reclamation Service found "from 4 to 5 feet of sand and numerous trees and other obstructions in the ditch. One bank had been washed away for a distance of nearly a mile and a half near the intake, and it was hardly possible to travel along the banks." Chief engineer Hill had negotiated the $187,000 sale price, based upon the cost he and Chandler estimated for digging "a similar ditch." It cost the government an additional $100,000 to repair the canal. Ironically, in Reclamation Service hands, the Chandler Canal helped reclaim "the very lands of which the Government had been defrauded." "In short," the subcommittee concluded, "the 'dummy' system by which Chandler fraudulently acquired title to lands now irrigated by the Government, is again in process to get the water."[29]

Three of the subcommittee's six recommendations were directed at eliminating the kind of fraud that Chandler had perpetrated. First of all, the congressmen urged higher assessments on "raw, speculative lands of the Chandler ranch and similar tracts" and use of the proceeds to pay for the construction of Roosevelt Dam. They went on to suggest that the Reclamation Service extend the Consolidated Canal to the Gila River Indian Reservation and reject delivery of water to large tract owners who refused to sell their land "at prices approximating those at which Government lands are sold to settlers." None of the subcommittee's recommendations were put into effect.[30]



Courtesy of the Salt River Project Research Archives, Phoenix.



Aerial view of Chandler, c. 1920. AZ & SW CP MCL 99177.C47, ASU.

Chandler's reputation seems not to have suffered as a result of the 1912 hearings or publication of the subcommittee report. He built the San Marcos Hotel in Chandler, was elected the town's first mayor after its incorporation in 1920, and otherwise enjoyed a long career as a rancher, developer, and businessman. He died at age ninety-one, on May 8, 1950, at his home next to the San Marcos.[31]

Today, the Chandler Ranch makes up most of Chandler, all of Sun Lakes, and a small part of Gilbert. Land that Chandler bought for "about $3 per acre" in the 1890s, and which he sold "for prices ranging from $90 to $150," now is priced at $30,000 or more for a residential acre. Commercial property commands up to $150,000 an acre. A. J. Chandler's scheme succeeded far beyond anything he could have imagined.[32]

NOTES

1. *Report in the Matter of the Investigation of the Salt and Gila Rivers—Reservations and Reclamation Service*, 62 Congress, 3 Session (Washington, D.C.: Government Printing Office, 1913), pp. 3, 272 (hereafter cited as *Investigation Report*); Robert Conway Stevens, *A History of Chandler, Arizona*, University of Arizona Social Science Bulletin no. 25 (October 1954), pp. 14, 26.

2. Stevens, *History of Chandler*, pp. 14–15; *Investigation Report*, pp. 239–40.

3. *Investigation Report*, pp. 141, 240.

4. Ibid., p. 141.

5. Ibid., pp. 241, 245.

6. In his testimony before a congressional subcommittee on April 26, 1912, Murphy admitted that he had induced settlers to file on public land in the Salt River Valley and then mortgage the property to him. Ibid., p. 318.

7. Laura Murphy to W. J. Murphy, February 23, 1885, quoted in Merwin L. Murphy "William John Murphy and the Building of the Arizona Canal," pp. 63–64, unpublished manuscript (1974), copy in author's files; *Phoenix Herald*, May 13, October 29, 1883 February 7, 1884, February 20, 1885; *Arizona Gazette* (Phoenix), February 21, 1885.

Evidently, Laura Murphy was soliciting names of people who would serve as dummy entrymen so that she and her husband could acquire more public land than federal law allowed. The Murphys had already made entries under the Desert Land Act. Murphy, "William John Murphy," p. 64, provides a brief list of relatives and a friend who apparently entered land on behalf of the Murphys. It includes Nannie C. Fulwiler ("a niece of W. J. and wife of Laura's brother, Will D. Fulwiler"); W. J.'s brothers Samuel A. and Thomas Murphy; Laura's father, John Fulwiler; and John B. Nellager ("a close friend of W. J. from Chicago"). A list prepared by son Ralph Murphy in ibid., p. 67, shows that "probably about 1900" W. J. still owned almost ten square miles (6,240 acres), including sections that Thomas Murphy and John Nellegar had originally entered.

Geoffrey P. Mawn, "Phoenix, Arizona: Central City of the Southwest, 1870–1920" (Ph.D. dissertation, Arizona State University, 1979), p. 94, notes that in 1885 a Phoenix newspaper reported that the Arizona Canal Company controlled more than thirty sections (19,000 acres). Since the land was not privately owned in 1885, the statement suggests that dummy entrymen and others made entries on behalf of the canal company. By "controlled," the newspaper may also have been referring to land entered by, or on behalf of, individual stockholders. Mawn writes that "company backers and speculators utilizing dummy entrymen filed extensive claims" when odd sections were opened for entry. Ibid., p. 93.

The Valley Bank of Phoenix, successor to the First National Bank of Phoenix, was another large owner of Arizona Canal land. W. J. Murphy and cashier William Christy organized the First National Bank to support construction of the Arizona Canal. The bank's national charter, issued in September of 1883, listed Samuel Murphy as president and chief financial backer and authorized $100,000 in capital. The Valley Bank was created on April 12, 1884, to avoid a federal audit of the First National. Ibid., pp. 86–90.

8. "An act to provide for the sale of desert lands in certain States and Territories," March 3, 1877, U.S. Statutes at Large, XIX, p. 377; *Investigation Report*, p. 247.

9. *Investigation Report*, pp. 244–45; *Phoenix Herald*, July 18, 1890.

10. *Investigation Report*, pp. 244–46, 248–50, 266.

11. Ibid., pp. 245–46, 269–70; Records for Township 2 South, Range 5 East, Gila and Salt River Base Line and Meridian, Arizona, U.S. Bureau of Land Management (BLM), Phoenix.

12. *Investigation Report*, pp. 244–45, 292; *Phoenix Herald*, January 25, 1897; Sylvia Lee Bender-Lamb, "Chandler, Arizona: Landscape as a Product of Land Speculation" (M.A. thesis, Arizona State University, 1988), p. 55; "A. J. Chandler," in *The Taming of the Salt*, 2nd

edition (Phoenix: Salt River Project, 1979), pp. 53–56. BLM records in Phoenix show that almost all the acreage that Chandler amassed was in Townships 1 and 2 South, Range 5 East, west of the Consolidated Canal. Today, these townships are bounded by Gilbert Road on the east, Price Road on the west, Baseline Road on the north, and Hunt Highway on the south. A small portion—at least a square mile and perhaps more—was in Township 1 South, Range 4 East, west of Price Road.

13. *Phoenix Herald*, April 8, 1893; *Arizona Republican* (Phoenix), April 23, 1893.

14. *A. J. Peters vs. the Consolidated Canal Company*, Case 1763, Third Judicial District, Maricopa County (1893), in Salt River Project Archives [SRPA], Tempe.

15. Bender-Lamb, "Chandler, Arizona," p. 34.

16. *Phoenix Herald*, September 2, 1890; "An act to repeal timber-culture laws, and for other purposes," March 3, 1891, U.S. Statutes at Large, pp. 1095–97.

17. *Investigation Report*, pp. 246, 266; Records for Township 1 South, Range 5 East, BLM. Before then most entries were in T2S, R5E. A transaction with Reuben D. and Elmira Rosenberger provides an example of how Chandler operated under the amended law. On January 30, 1899, Reuben received a patent for the west one-half, and Elmira for the east one-half, of Section 33, T1S, R5E. On August 29, Chandler paid $1 for the east one-half and $1 for all but forty acres of the west one-half of the Rosenbergers' section. On January 30, 1907, Chandler paid $500 for the remaining forty acres, which were by then included in the water district served by Roosevelt Dam.

18. Stevens, *History of Chandler*, Appendix I, p. 99; *Arizona Republican*, May 3, 1902.

19. *Arizona Republican*, June 19, 1902; Salt River Valley Water Users' Association (SRVWUA), Articles of Incorporation, in U.S. Reclamation Service, "Salt River Project, Arizona, Final History to 1916," vol. 1, article 2, p. 19, unpublished manuscript (April 1, 1916), SRPA.

20. Stevens, *History of Chandler*, p. 23, Appendix I, pp. 98–99; *Investigation Report*, p. 285; National Reclamation Act, section 5, reprinted in ibid., pp. 324–26; SRVWUA, Articles of Incorporation, article 4, section 3.

21. *Investigation Report*, pp. 239–308.

22. Ibid., pp. 267–68, 279.

23. Ibid., p. 280.

24. Ibid., pp. 250, 279–80. Most of the lawsuits involved the Tempe Canal Company, whose shareowners resisted Chandler's efforts to supply water through the Cross Cut Power Canal. The two sides did not reach an agreement until 1900. *Frank B. Austin et al. vs. A. J. Chandler et al.*, Case 1578; and *Consolidated Canal Company vs. Tempe Canal Company*, Case 2567, both in Third Judicial District, Maricopa County. See also Earl Zarbin, "Settling the Priority of Water Rights," in *Salt River Project: Four Steps Forward, 1902–1910* (Phoenix: Salt River Project, 1986), pp. 89–120.

25. *Investigation Report*, pp. 241, 247; *Arizona Gazette*, January 16, 1894.

26. *Investigation Report*, p. 308.

27. Ibid., p. 4; Bender-Lamb, "Chandler, Arizona," Appendix B, p. 141.

28. *Investigation Report*, p. 13.

29. Ibid., p. 13.

30. Ibid., p. 25.

31. "A. J. Chandler," in *Taming of the Salt*, pp. 53–56.

32. *Investigation Report*, p. 14. Land values were supplied by Mike Foley of Realty Executives, Chandler, August 30, 1993.

BOOK REVIEWS

HISTORIA DE LA NUEVA MEXICO, 1610/GASPAR PEREZ DE VILLAGRA: A Critical and Annotated Spanish/English Edition. Translated and edited by Miguel Encinias, Alfred Rodríguez, and Joseph P. Sánchez. Albuquerque: University of New Mexico Press, 1992. Maps, notes, biblio., index, 367 pages. ISBN 0-8263-1392-2, $35.00 (hard-cover).

This is a publication of which the editors and the University of New Mexico Press can be proud. It is the first volume in a new series entitled "Pasó Por Aquí," planned to celebrate New Mexico's literary heritage. The choice of Villagrá's epic poem not only calls attention to New Mexico's first published history but also intends to install his work as "one of the central literary documents of the Americas."

Prior to the publication of this volume, scholars used the English translation of Gilberto Espinosa, published in 1933 and reprinted in 1962 and 1967. In addition to the thirty-four cantos, Espinosa's translation included a detailed forward by the Southwest Museum's F. W. Hodge and twenty-one translated documents detailing Villagrá's relationship with Don Juan de Oñate and his punishment by the Mexican *audiencia* for having murdered two Spanish deserters without trial or confession. The volume is indexed, but it is sparsely annotated and lacks a number of improvements to be found in the 1992 edition.

Editors of the new *Historia* have included an ample introduction, explaining what is known about Villagrá and why his work should be seen as legitimate history. This section is followed by a "Historical Overview" that places the Oñate expedition of 1598 in historical context. Translation of the cantos is based on the work of Fayette S. Curtis, who completed a draft of the entire poem prior to his death in 1927. The editors believe that Curtis was working from a 1900 Mexican reprint of the *Historia*.

In addition to the attractive presentation of this large (8.5 by 11 inches) book, it offers side-by-side Spanish and English versions of the cantos. Appendices reveal locations where the Curtis translation was changed as well as an extensive glossary of old Spanish words and phrases with more modern Spanish meanings. Notes and index are

EXHIBIT 186

The Magnificent Experiment

Building the Salt River Reclamation Project 1890-1917

KAREN L. SMITH

1986

The University of Arizona Press
TUCSON

1908. Judge Edward Kent handed down his decision in the *Hurley v. Abbott* case, known as the Kent Decree, on March 1, 1910. In what was to become the most important water-rights case in the Salt River Valley, Kent not only determined each acre's prior right to use the normal flow of Salt River, but also classified the land in the valley according to date of cultivation.[14]

Kent's method for classifying lands was simple. Those lands with old water rights, which had been continuously cultivated, were termed "Class A"; owners of these lands would have the first opportunity to become members of the Salt River Project. Kent placed those lands with some right to flood water, which had been cultivated prior to (but not after) 1903, next in line for inclusion within the project; these lands were termed "Class B." Those lands which had no right to the water and which had never been cultivated were termed "Class C"; these lands would be considered for inclusion last. Judge Kent's arrangement of the valley lands into three classes did not automatically give the Class A and B lands a project reservoir right, but, according to the Judge, it did allow them preference.[15]

THE BOARD OF SURVEY

The Kent Decree provided a framework for selecting project lands, but it did not completely settle the membership dispute. In August 1913 Assistant Secretary of Interior A. A. Jones wrote the Association that recent Reclamation Service maps showing the irrigable area of the valley as determined by the Kent Decree revealed a larger acreage than could be served water from the storage reservoir. "It is therefore necessary," noted Jones, "to somewhat arbitrarily select certain lands which will be watered and reject others."[16] Jones suggested creation of a small committee or board to review the situation and mark on the maps which lands would be included. The following principles, he suggested, should guide the board:

(1) Lands selected should be in as compact a body as possible;
(2) Preference should be given to lands of highest productivity;
(3) In the case of the small landowners, the man living upon his land and cultivating it should be given first consideration.[17]

The Association's Board of Governors agreed with Assistant Secretary Jones's suggestion in principle, and offered its own idea on how to compose the board: the Board of Governors should select one representative, the Reclamation Service another, and the third member, acting as chairman, would be a mutual selection from outside the state. Secretary of Interior Franklin Lane agreed to this proposal.

The Board selected Frank Parker, former secretary of the Association, as its representative.[18]

Although the chairman of the board was to be impartial in all matters pertaining to the project (hence the requirement that he be from another state), John Orme suggested to both Frederick Newell and Secretary of Interior Lane that Frank Hanna fill this position.[19] Hanna, previously the Reclamation Service's project engineer at Yuma and chairman of the 1913 Reclamation Service Inquiry Board investigating the administration of the Salt River Project, was now manager on the Boise, Idaho, project. While he fit the requirement of being a nonresident, the Association's solicitation somewhat thwarted the spirit of the provision. Lane, however, agreed to Orme's request and appointed Hanna as chairman of the Salt River Project Board of Survey.[20]

The Reclamation Service originally intended to appoint J. F. Sprague, an engineer on Salt River, as its representative to the Board. Further discussions with Charles Fitch, project manager at Phoenix, persuaded Arthur Davis and Frederick Newell to select William Farish instead.[21] What Fitch said is not known, but it is likely that the project manager was concerned that the representative be acceptable to the Association. Since the majority of the Board of Governors at that time was composed of "prior righters," whose main concern was limiting the acreage to a low figure, the selection of Farish, who supported the position of that group, was likely to be well regarded.[22]

Farish was indeed acceptable to the Board of Governors. "This appointment will meet with the hearty endorsement of the Board of Governors," Orme wrote Arthur Davis in late October 1913. The Board had considered "unofficially" asking the Service to appoint Farish, but "felt they would not be justified in formally naming any more members than they had done."[23] Although the water users technically had only one representative on the Board of Survey, in reality they approved of all three members. Secretary Lane's new spirit of cooperation between the water users and the Reclamation Service was evident at last.

Louis Hill, former project manager at Salt River and now supervising engineer of the Service's southern division, and Frederick Newell expressed some concern, however, over the Survey Board's bias in favor of prior righters. Hill strongly recommended to Newell that the first meeting of the Board of Survey be postponed until after the rainy season; otherwise, with the reservoir low, the landowners with old water rights might pressure the Survey Board into excluding from irrigation more acreage than necessary. "I hardly think that you could get the prior righters today to use good judgement in studying the question," Hill wrote Newell; "they only realize that the amount has been depleted [in the reservoir] and do not seem to have any idea that this will ever be replenished."[24] While Newell seemed to agree with Hill on the matter of postponing the meeting of the Survey Board, the Reclamation Service acknowledged a scheduling conflict; Hanna was already on his way to Phoenix. The Board of Survey would meet at the end of November 1913, as planned, and Hill would have to send all his material on the valley's water supply to Phoenix by then.[25]

The Board of Survey held daily meetings from November 18 through December 9, 1913. Although it prepared a preliminary report on its findings, Hanna believed the inquiry to be incomplete. He believed the Board needed more information regarding the cultivated and occupied lands, the size of the individual holdings, and their water rights classification before a final delimiting of the project took place. The chairman of the Survey Board recommended adjourning until this information became available.[26] At the same time, several legal questions bothered Hanna, and he thought the Board needed to anwer them before selecting or rejecting any lands. Fundamentally, they all focused on the legal and moral strength of the Kent Decree as the basis for choosing lands entitled to participate in the project.[27]

The Reclamation Commission, which consisted of Frederick Newell and Arthur Davis as the engineers, I. D. O'Donnell as superintendent of irrigation, Will R. King as chief counsel, and W. A. Ryan as comptroller (the last three were Secretary Lane's appointees), reviewed Hanna's report and questions, and formulated new selection guidelines to submit to the water users for comments. The Survey Board had initially favored limiting the total acreage to 170,000; the Reclamation Commission raised the limit to 175,000 acres.[28]

The most controversial of all the Commission's recommendations, however, was its response to Hanna's questions regarding whether it was appropriate for the Reclamation Service to implement the Kent Decree. The Reclamation Commission created new guidelines, using Judge Kent's land classification system, a notion of fair play, and the cultivation criterion of the Association's Articles of Incorporation.[29] Basically, the Commission wanted to limit landowners of cultivated Class A and B lands to project membership for 160 acres. In this way the Reclamation Commissioners hoped to defuse a potentially volatile situation by spreading the membership lands among many landowners holding various classes of land. They hoped this course would prevent landowners holding lands for speculative purposes from becoming project members before those who

were genuine farmers. Under no conditions would the Commission accept any uncultivated and unsubscribed land into the storage project.[30] Coincidentally, these new principles for selection were most favorable to the landowners who held lands with prior rights.

Delimiting the project was destined to be unpopular with some, but the Board of Survey and the Reclamation Commission were optimistic about their actions. While they eliminated from the project lands not fitting the government requirements, they also recommended that the Association develop new sources of supply. By building Horseshoe Dam on the Verde River and by constructing pumping plants, eventually there would be enough water to serve all the subscribed land in the valley.[31]

The Board of Survey published these guidelines for selecting lands under the Salt River Project on January 15, 1914, and distributed copies to landowners in the valley. Public meetings to discuss the limitation plan with I. D. O'Donnell and Arthur Davis of the Reclamation Commission as well as with the Board of Survey and officers of the Association were set for March 13 and 14, 1914. The only significant change that the Board of Survey made in the Reclamation Commission's recommendations was to increase the total estimated project acreage to about 180,000 acres including townsite and school lands; of the 211,000 acres of irrigable land subscribed to the Association and within the Board of Survey boundaries at that time, 31,000 would have to be excluded. The excluded lands included those not fitting the Reclamation Commission's guidelines, those not cultivated within the previous three years, and state school lands.[32]

Fewer landowners in the valley turned out for the meetings than either John Orme or Arthur Davis expected; they interpreted this lack of response to mean that there was little dissatisfaction with the arrangements of the Board of Survey. It was predictable that those holding uncultivated lands—largely for speculative purposes—would be unhappy with the preferences outlined by the Board, and a few, like Ralph Murphy, complained that the project should be held open until an adequate water supply was developed for all the lands. But in the main, valley landowners were satisfied that the best job possible had been done, given the nature of the task.[33]

It was the beginning of an era of collaboration between the water users and the Reclamation Service. No one expressed this new feeling better than Arthur P. Davis:

> There has been too much disregard of the water users; we do not mean of their material interests, but of their personal interest in the project. They have been asked to take too much for granted

and to trust blindly to the scientific skill and technical knowledge of the members of the service.

> Many things have been done which they have not understood, though they have been done right. And some things have been done wrong which might have been avoided if the water users had been taken into the confidence of the reclamation officials. If a man is having a house built, though he may know nothing of architecture and little of construction, he has certain ideas, for reasons which the architect may not appreciate, he would like to have incorporated into the structure.[34]

Both Davis and I. D. O'Donnell of the Reclamation Commission enjoyed the water users' hearty welcomes, and farmers particularly appreciated O'Donnell's visit, as he provided them with advice on better farming and securing larger markets for their crops.[35]

If there was one person responsible for the changed relationship between the Reclamation Service and the Salt River Valley Water Users' Association, which had deteriorated in the last years of Newell's tenure as director, it was Secretary of Interior Franklin Lane. Lane was an ambitious man, determined to put his own imprint on the department. Two themes underlay Lane's conservation philosophy: greater development and greater democracy. While not fundamentally different from the beliefs of Walter Fisher or Gifford Pinchot, whom he continued to consult on matters of concern to them, Lane's ideas regarding the public domain were tested not by the rational, scientific method, but by their political acceptance in the West. For this reason, as well as for his personality, which was described as "magnetic," President Wilson's first Secretary of Interior was very popular with westerners in all walks of life and especially with the water users on the federal projects.[36] He "shaped the affairs of the reclamation service so as to give the fullest hearing to the expression of the wishes and desires of . . . the water users."[37] Work had been undertaken and policies decided upon without consultation between the officers of the government and those of the Association before Lane came to office; now, "by direct orders of the Secretary," the administrative bodies of the water-users' associations reviewed all of these matters.[38]

The local leadership of the Salt River Valley Water Users' Association delighted in the turn of events, as did most of the landowners under the project. Even C. B. Wood, the former candidate for president of the water users on the Landowners' Protective Association ticket, approved the Board of Survey report and the new cooperative efforts of the Service.[39] The Board of Governors enthusiastically endorsed the government recommendations to construct a storage reservoir on the Verde River and to install pumping plants to increase

the developed water supply, and agreed to put them to an immediate vote by the water users.[40]

The Secretary of Interior reviewed the final report of the Board of Survey, which essentially followed the same form as the preliminary one except for small modifications of the boundary line, in August 1914, and approved it on November 14, 1914.[41] From this date to the early 1920s, those owners of uncultivated land within the reservoir district boundaries that were not included in the project petitioned the Association and the Secretary of Interior for admittance. When the reservoir was full, the owners of these lands rented water for irrigation of their crops, but this supply was only temporary water; rental contracts were subject to renewal or cancellation each year. Owners of fragmentary Class A lands—small, odd-shaped parcels adjacent to member lands, but not included in the final report because of their erroneous classification as uncultivated lands—were successful in having a second Board of Survey include them permanently within the project in 1916.[42]

In addition to the fragmentary Class A lands, there were about 23,000 acres of land that were not included within the project, although they were located within the reservoir district boundaries. The owners of these so-called "dry lands" also appealed to the Association and the Secretary of Interior for admittance to the project, but were not accepted until an additional water supply was developed in the early 1920s.[43]

Fixing 180,000 acres as the amount of land to be served reservoir water on a continuing basis finally resolved the conflict over membership priorities that had been raised in 1903 by Dwight Heard and the minority report. Although it had been a bitter issue between those with old water rights and new landowners in the early years of the Association, by 1914 it ceased to have the same emotional appeal. This change was due in large part to Secretary Lane's board of review procedure. By bringing the water users into the decision-making process through representation on the board and through public hearings, the landowners directly participated in the delimiting of the project. The final decision, of course, was the Secretary's, but in this instance, Lane successfully eliminated the water users' complaints of Reclamation Service tyranny.

THE BOARD OF COST REVIEW

In the same spirit of cooperation which imbued the proceedings of the Board of Survey, Secretary of Interior Lane decided to review the costs of constructing the projects; this process would satisfy the

EXHIBIT 187

U.S. Ex. # 2102
Adm. 1/9/58
p. 14,622

EXECUTIVE MANSION, January 10, 1879

It is hereby ordered that all the public lands embraced within the following boundaries lying within the Territory of Arizona, viz, commencing at the mouth of the Salt River, running thence up the Gila River to the south line of township No. 2 south, Gila and Salt River base-line; thence east with said line to the southeast corner of township No. 2 south, range 6 east; thence north with said line to a point 2 miles south of the Salt River; thence following the course of said stream in an easterly direction, and 2 miles south of the same, to the west line of the White Mountain Reservation; thence north with the line of said reservation, or the extension of the same, to a point 2 miles north of said river; thence in a westerly direction, following the course of said river, and 2 miles north of the same, to the east line of range 6 east; thence north with said line to the northeast corner of township 2 north, range 6 east; thence west with the north line of said township to the Gila and Salt River meridian line; thence south with the said line to the Gila River, and thence by the said river to the place of beginning, be, and the same are hereby, withdrawn from sale and set apart for the use of the Pima and Maricopa Indians, in addition to their present reservation in said Territory.

R. B. HAYES

(I Kappler 806)

Pre-Trial Item 611, 620, 640

 U. S. Ex # 2103
Adm. 1/9/58
p. 14,622

Pre-trial
Item #612

I Kappler
807

EXECUTIVE MANSION, *June 14, 1879.*

In lieu of an Executive order dated January 10, 1879, setting apart certain lands in the Territory of Arizona as a reservation for the Pima and Maricopa Indians, which order is hereby canceled, it is hereby ordered that there be withdrawn from sale and settlement, and set apart for the use of said Pima and Maricopa Indians, as an addition to the reservation set apart for said Indians by act of Congress approved February 28, 1859 (11 Stat., 401), the several tracts of country in said Territory of Arizona lying within the following boundaries, viz:

Beginning at the point where the range line between ranges 4 and 5 east crosses the Salt River; thence up and along the middle of said river to a point where the easterly line of Camp McDowell Military Reservation, if prolonged south, would strike said river; thence northerly to the southeast corner of Camp McDowell Reservation; thence west along the southern boundary line of said Camp McDowell Reservation to the southwest corner thereof; thence up and along the west boundary line of said reservation until it intersects the north boundary of the southern tier of sections in township 3 north, range 6 east; thence west along the north boundary of the southern tier of sections in townships 3 north, ranges 5 and 6 east, to the northwest corner of section 31, township 3 north, range 5 east; thence south along the range line between ranges 4 and 5 east to the place of beginning.

Also all the land in said Territory bounded and described as follows, viz:

Beginning at the northwest corner of the old Gila Reservation; thence by a direct line running northwesterly until it strikes Salt River 4 miles east from the intersection of said river with the Gila River; thence down and along the middle of said Salt River to the mouth of the Gila River; thence up and along the middle of said Gila River to its intersection with the northwesterly boundary line of the old Gila Reservation; thence northwesterly along said last-described boundary line to the place of beginning.

It is hereby ordered that so much of townships 1 and 2 north, ranges 5 and 6 east, lying south of the Salt River, as are now occupied and improved by said Indians, be temporarily withdrawn from sale and settlement until such time as they may severally dispose of and receive payment for the improvements made by them on said lands.

R. B. HAYES.

EXHIBIT 188

COPY

AGREEMENT
BETWEEN THE UNITED STATES AND THE SALT RIVER VALLEY WATER USERS' ASSOCIATION
VERDE RIVER STORAGE WORKS

This Agreement made this 3rd day of June, 1935, pursuant to the authority granted to the Secretary of the Interior in the Act of Congress approved May 18, 1916 (39 Stat. 123-130) and acts amendatory thereof and supplementary thereto, by and between the United States of America, acting in this behalf by Harold L. Ickes, Secretary of the Interior, party of the first part, hereafter for brevity called the United States, and the Salt River Valley Water Users' Association, a corporation organized and existing under and by virtue of the laws of the State of Arizona, having its principal place of business at Phoenix, party of the second part, hereafter for brevity called the "Association", and their successors and assigns.

WITNESSETH:

That whereas, the Indians of the Salt River Reservation were awarded by the so-called Kent Decree of March 1, 1910, 700 miners' inches of water from the Salt River for the irrigation of 2,333 acres, all in township 2 north, range 5 east, S.R.B. and M., Arizona, and 335 miners' inches for the irrigation of 1,115 acres, all in sections 35 and 36, township 2 north, range 5 east, S.R.B. and M., Arizona; and

WHEREAS, by Act of Congress of May 18, 1916 (39 Stat. 123-130) the Secretary of the Interior was authorized and directed to provide for water rights in perpetuity for the irrigation of 631 Salt River Indian allotments of 10 acres each, water from works constructed under the provisions of the Reclamation Act and acts amendatory thereof or supplementary thereto; and

WHEREAS, arrangements have not heretofore been perfected for carrying out the provisions of the Act of May 18, 1916 in respect to said 6,310 acres of the Salt River Reservation; and

WHEREAS, the Association now has pending an application with the Public Works Administriation for the allotment of approximately $4,000,000 to construct a dam and appurtenant works on the Verde River at the Bartlett site, approximately 25 miles above the junction of the Salt and Verde Rivers, which will create a reservoir of approximately 200,000 acre feet capacity; and

WHEREAS, the proposed works are to be constructed under the Reclamation Act of 1902 (32 Stat. 388) as amended, and the cost of such works is to be repaid to the United States under the original contract between the United States and Salt River Valley Water Users' Association, or under such amended contract as the United States may deem proper; and

WHEREAS, the reservoir created by the proposed dam is to be operated for temporary storage of that part of the flood waters of the Verde River which can not be diverted for use at the time on lands having established rights to the flow of the Verde River; and

WHEREAS, the quantity of water authorized by the so-called Kent Decree is not sufficient for the irrigation requirements of the Indians of the Salt River Reservation; and

WHEREAS, the most feasible means that now may be utilized by the Secretary of the Interior to provide surface water for the Indians of the Salt River Reservation for the irrigation of an additional area of 6,310 acres, the area dealt with in the Act of May 18, 1916, supra, is by participating in the construction of the proposed regulating reservoir on the Verde River; and

WHEREAS, the United States, for and on behalf of the Salt River Indians, is desirous of participating in the construction of this proposed Verde River regulating works and bearing a share of the cost of such construction to the extent of the interest therein acquired for these Indians.

NOW THEREFORE, in order to provide an additional surface water supply for the irrigation of an area of 6,310 acres of land exclusive of the present irrigated lands of the Salt River Indians on their reservation now provided with a water supply under the so-called Kent Decree, the parties hereto covenant and agree as follows:

ARTICLE 1
COST OF CONSTRUCTION AND INTEREST IN CONSTRUCTED WORKS

The cost of constructing the dam and appurtenant works necessary to create a reservoir of approximately 200,000 acre feet capacity shall be apportioned on the basis of 20 per cent to the United States, for and on behalf of the Salt River Indians, and 80 per cent to the Association. Neither party shall assume any obligation in excess of his respective share of the total cost. The United States, for and on behalf of the Indians of the Salt River Reservation, shall have a one-fifth interest in the constructed works after their completion.

ARTICLE 2
COST OF MAINTENANCE

The cost of ordinary routine maintenance of the proposed storage works shall be borne by the Association, and the Association agrees to maintain the said storage works without cost to the United States or the Indians in a manner equal to the best engineering standards and to protect them from all damage and accident that reasonably can be foreseen. If either party deems it necessary to make any repairs, replacements, or betterments other than those hereinabove provided for, the United States and the Association shall agree on the extent and cost of such repairs, replacements, or betterments, and the United States and the Association shall participate in the cost of such repairs, replacements, or betterments in the same ratio as in the original cost of construction, provided such repairs, replacements, or betterments were not made necessary through the negligence of the Association, in which event the Association agrees to prosecute diligently the necessary work without cost to the United States or the Indians. It is mutually agreed, should differences arise between the United States and the Association over what constitutes "ordinary routine maintenance" and such differences can not be composed by the local representatives of the respective parties, the matter shall be submitted to the Secretary of the Interior for his decision and the parties agree in all cases to abide by the decision made by him.

ARTICLE 3
COST OF OPERATION

The cost of operation of the proposed storage works on the Verde River and the Cost of operation and maintenance of all works below the reservoir necessary to convey the Indian water to the specified points of diversion on the Indian Reservation shall be borne by the Association.

ARTICLE 4
OPERATION OF STORAGE WORKS

The works to be constructed on Verde River for temporary storage shall be operated and maintained by the Association. The Association may at any time store any part or all of Flow of Verde River in the reservoir, and may at any time release any quantity of water from the reservoir or it may permit the river to flow through the reservoir without regulation; provided, that the controlled or controllable release of water from the reservoir shall not exceed the amount which will be diverted for use without undue waste on lands now having rights to the natural flow of Verde River; and provided further that, when available, the controlled release of water from the reservoir shall not be less than one-half of the amount which could be diverted for use without undue waste on lands now having rights to the natural flow of Verde River.

ARTICLE 5

DEFINITION OF DEVELOPED WATER

The bottom five per cent (5%) of effective capacity in the reservoir shall be reserved to the Association for regulation of the flow of

Verde River which the Association could otherwise divert. All increases in the amount of water stored inthe reservoir, whenever the total amount in storage exceeds said five per cent (5%) shall be deemed to be water developed by storage, herein termed "develope" water. Said increases shall be measured by a suitable water stage recorder.

ARTICLE 6
APPORTIONMENT OF DEVELOPED WATER

The Salt River Indian Reservation shall be allotted one-fifth of all "developed" water, as defined herein, and it may accumulate such water developed from time to time up to a maximum of 60,000 acre feet, and the Association shall deliver this water on demand through its Arizona Canal at not to exceed two points on that canal within the Salt River Indian Reservation and all water delivered hereunder shall be deemed to have been a draft on the quantity of "developed" water previously accruing to the Salt River Reservation provided that the Association may divert to its own use any part or all of the developed water accruing to the Reservation and substitute therefor an equal amount of other surface water. The quantity of "developed" water to be furnished under this agreement shall be in addition to the so-called Kent Decree water rights of the Camp McDowell and Salt River Indians on their respective reservations, and nothing herein shall be construed as in any way limiting or affecting these decreed Indian water rights nor the carriage or delivery thereof. It is mutually agreed, however, that nothing herein shall in any way be construed as preventing the said Secretary from distributing and using the "developed" water on any of the lands of the Indians of the Salt River Reservation so as to afford the greatest benefit to the said Indians.

ARTICLE 7
DELIVERY OF WATER

Deliveries hereunder by the Association to the Reservation exclusive of that water delivered under the so-called Kent Decree shall be limited to 20,000 acre feet in each calendar year and the variations in rate of delivery shall be subject to reasonable notice and shall reasonably conform to variations in use of water on lands served by the Association. The United States shall have the right to construct such outlet works in the Arizona Canal, including a submerged weir across said canal at either or both points of delivery, as are necessary to divert water by gravity to all of that land in the Reservation below the Arizona Canal which reasonably can be served without unduly interfering with the operation and maintenance of said canal. The cost of such diversion structures and any other works necessary to divert Indian water from the Arizona Canal shall be met by the United States.

ARTICLE 8
EXCHANGE WATER

Any annual payments due to the Association for electrical energy delivered to the Salt River Reservation for pumping of surface or underground waters of other purposes or for any other lawful obligations due to the Association that have been incurred lawfully by or on behalf of the Indians of the Salt River Reservation shall be made by first applying to such obligations the value of undelivered Salt River Indian Reservation water as is hereunder required to be furnished by the Association. Exchange water is defined for the prupose of this agreement to be the difference between 20,000 acre feet of developed water, or such smaller quantity of developed water as may be requested by the United States for any particular year in writing prior to April 1 thereof or such smaller quantity as it may become entitled to in any such calendar year under this agreement, and the quantity of developed water actually delivered hereunder during that year. Such exchange water shall be deemed a draft upon developed water for the use and account of the Association; and in return therefor the Association shall credit the United States on behalf of the Indians of the Salt River Reservation, as of December 31 of said year with the value thereof computed at the rate of fifty cents (50¢) per acre foot of such exchange water, such credit, however, to be applied solely upon the present or future indebtedness owing from the United States on behalf of said Indians to the Association. At the end of each calendar year all accumulated credits for exchange water remaining after liquidating the indebtedness accruing to the Association from the United States on behalf of said Indians shall be reduced twenty (20) per cent before being carried forward to the next calendar year.

ARTICLE 9
INSPECTION OF WORKS AND RECORDS BY THE UNITED STATES

It is mutually understood and agreed that the Secretary of the Interior through the Commissioner of Indian Affairs or his duly authorized agent shall be recognized by the Association in all matters pertaining to the construction, operation, and maintenance of the storage works and the delivery of water herein provided for, and that the books and records of the Association with respect thereto shall be available at all times for inspection by said representative. After the completion the storage works may be inspected from time to time under the direction of the Secretary of the Interior when he shall deem it necessary to ascertain if the provisions of this agreement are being carried out and observed by the Association in the care, operation and maintenance of said works.

ARTICLE 10
TERM OF CONTRACT

This contract shall become effective upon execution by the proper officials of the Association and upon execution by the Secretary of the Interior, and is made contingent upon the construction of the proposed works as hereinabove specified.

ARTICLE 11
CONTRACT CONTINGENT ON APPROPRIATION

Where the operations of this contract extend beyond the current fiscal year, the contract is made contingent upon Congress making the necessary appropriations for expenditures hereunder after such current year shall have expired. In case such appropriation as may be necessary to carry out this contract is not made, the Association hereby releases the United States from all liability due to the failure of Congress to made such appropriation.

ARTICLE 12

The conditions and obligations of this contract shall be binding upon, and its benefits insure to the successors in interest of the Association and assigns of the United States.

ARTICLE 13
"MEMBER OF CONGRESS" CLAUSE

No Member of or Delegate to Congress,or Resident Commissioner shall be admitted to any share or part of this contract or to any benefit that may arise hereform, but this restriction shall not be construced to extend to this contract if made with a corportation or company for its general benefit.

ARTICLE 14
COVENANT AGAINST CONTINGENT FEES.

The Association warrants that it has not employed any person to solicit or secure this contract upon any agreement for a commission, percentage, brokerage, or contingent fee. Breach of this warranty shall give the United States the right to terminate the contract, or in its discretion, to deduct from the contract price or consideration the amount of such commission, percentage, brokerage, or contingent fees. This warranty shall not apply to commissions payable by contractors upon contracts or sales secured or made through bona fide established commercial or selling agencies maintained by the Association for the purpose of securing business.

IN WITNESS WHEREOF the parties hereto have caused these presents to be executed this 3rd day of June 1935.

THE UNITED STATES OF AMERICA

BY /sgd/ Oscar L. Chapman
Assistant Secretary of the Interior

SALT RIVER VALLEY WATER USERS' ASSN.

BY /sgd/ Lin B. Orme
President

BY /sgd/ F. C. Henshaw
Secretary

Attest:

Approved as to form: May 25, 1935

/sgd/ Oscar L. Chapman
Assistant Secretary of the Interior

RESOLUTION

RESOLVED that the proposed agreement between the United States of America and Salt River Valley Water Users' Association, providing for participation of said parties in the building and operation of the proposed Verde Dam, be approved and the President and Secretary be, and they hereby are authorized and instructed to execute same.

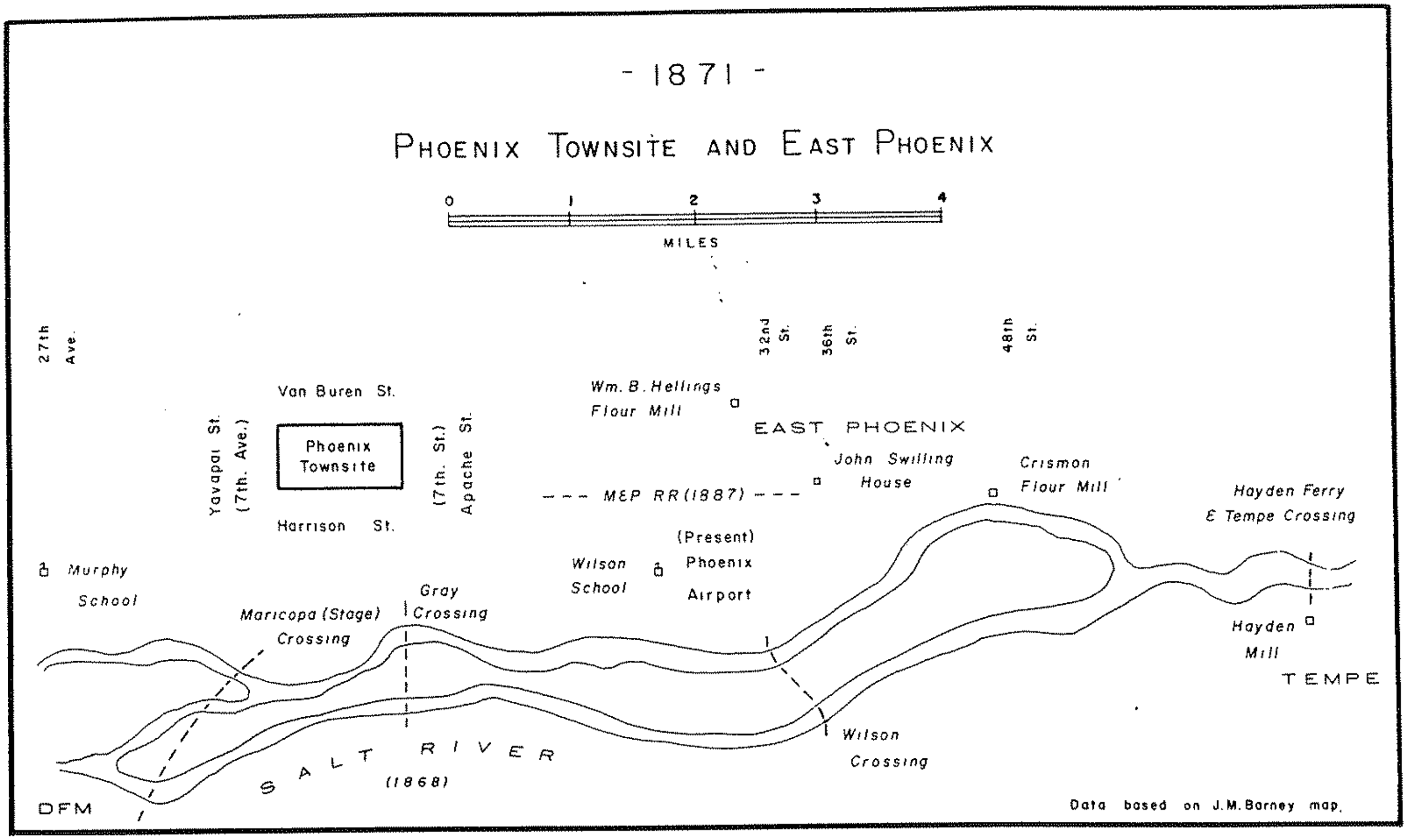
CERTIFICATE

I, F. C. Henshaw, Secretary of the Salt River Valley Water Users' Association, hereby certify that the above and foregoing is a true, correct and complete copy of a resolution unanimously adopted by the Board of Governors of said Association at a regular meeting thereof, duly and regularly held on the 3rd day of June, 1935.

WITNESS my hand and seal of the Salt River Valley Water Users' Association, this 3rd day of June 1935.

/sgd/ F. C. Henshaw
Secretary

EXHIBIT 189



ancient Indian village, he is said to have correctly predicted that a new and great city would arise from the ruins. Another version is that Jack Swilling scanned a Webster's dictionary and found the appropriate name there. (Swilling became the first postmaster on June 15, 1869.)

In Washington in April 1870, Richard C. McCormick told a Senate committee that Phoenix was three years old and that a number of Texas families had moved to the new settlement, which at this time was located northeast of the present municipal airport. Queried about local agriculture, McCormick spoke of the *acequia* (irrigation canal), said that wheat and corn were the principal crops, and that production of fruit (grapes and peaches) was confined to the Tucson area. He also added that Arizona had more timber than most people supposed.

Because the settlers were not satisfied with the location, a committee was formed in the fall of 1870 and after considerable discussion, selected a new site for the town three miles west of the original settlement. The Salt River Valley Town Association was formed to lay out a new city and when the first auction was held just before Christmas, 61 lots were sold. Judge William J. Berry, an early Prescott resident, bought the first lot for $104. As a corner lot it commanded a higher price than the adjoining lot, which brought only $40, but for a lot on the opposite corner, William A. Hancock paid $70. Hancock (1831-1902) was born in Massachusetts, went to California and then came to Arizona while in military service. He was a surveyor, then Maricopa County sheriff and later a lawyer. Hancock completed the new townsite survey shortly after the lots had been sold and another sale was held in January. By today's landmarks, the townsite boundaries would be Harrison, Seventh Street, Van Buren, and Seventh Avenue.

As a result of publicizing of the townsite, the population of Phoenix doubled within two months. Surrounding the city were more farms than the year before, with barley and wheat being the predominant crops. Some acreage was devoted to corn, sweet potatoes and beans and

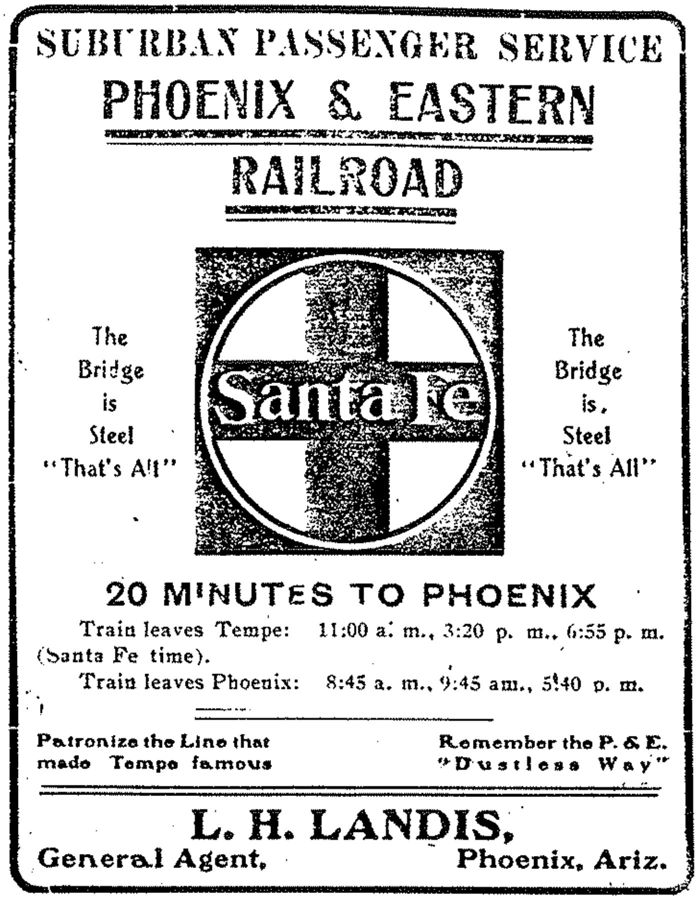
EXHIBIT 190

depth of three feet. The Salt River, having receded from the flood stage in January, returned to flood levels. A man's body was observed floating down the Salt River, and the Gila River was as high as ever known. For a while, when the SFP&P was in trouble at the New River bridge, Phoenix was cut off from the outside world.

The Ph&E was about to undergo its long period of frustrating difficulties with the Salt River. For some months previously, the newcomer had offered three scheduled trains daily between Phoenix and Tempe. Its advertising message sported the final assurance that "The Bridge is Steel, 'That's All'."

Shortly after seven in the evening of March 20, 1905, a man working near the Hayden Mill in Tempe heard a crash which came from the direction of the Salt River. Running to the river's edge, in the dim twilight he could see that the north span of the steel bridge was gone. Not being certain of the time, he assumed that the last local train to Phoenix had gone down with the bridge and was beneath the whirling waters of the Salt River.

Dashing into Tempe to secure help, he aroused a number of people who came to assist if they could, but with the fate of the remaining portion of the bridge uncertain, no one dared to venture on the structure. However, an *Arizona Republican* reporter and another man walked out on the



There was no doubt of the corporate parent in this advertisement which appeared regularly in the *Tempe News* in the spring of 1904. Twice the reader's attention was drawn to the steel bridge, in contrast to the wood structure of the parallel M&P. In less than a year, this steel bridge succumbed to flood waters while the rival's crossing survived. *(Arizona State Library)*

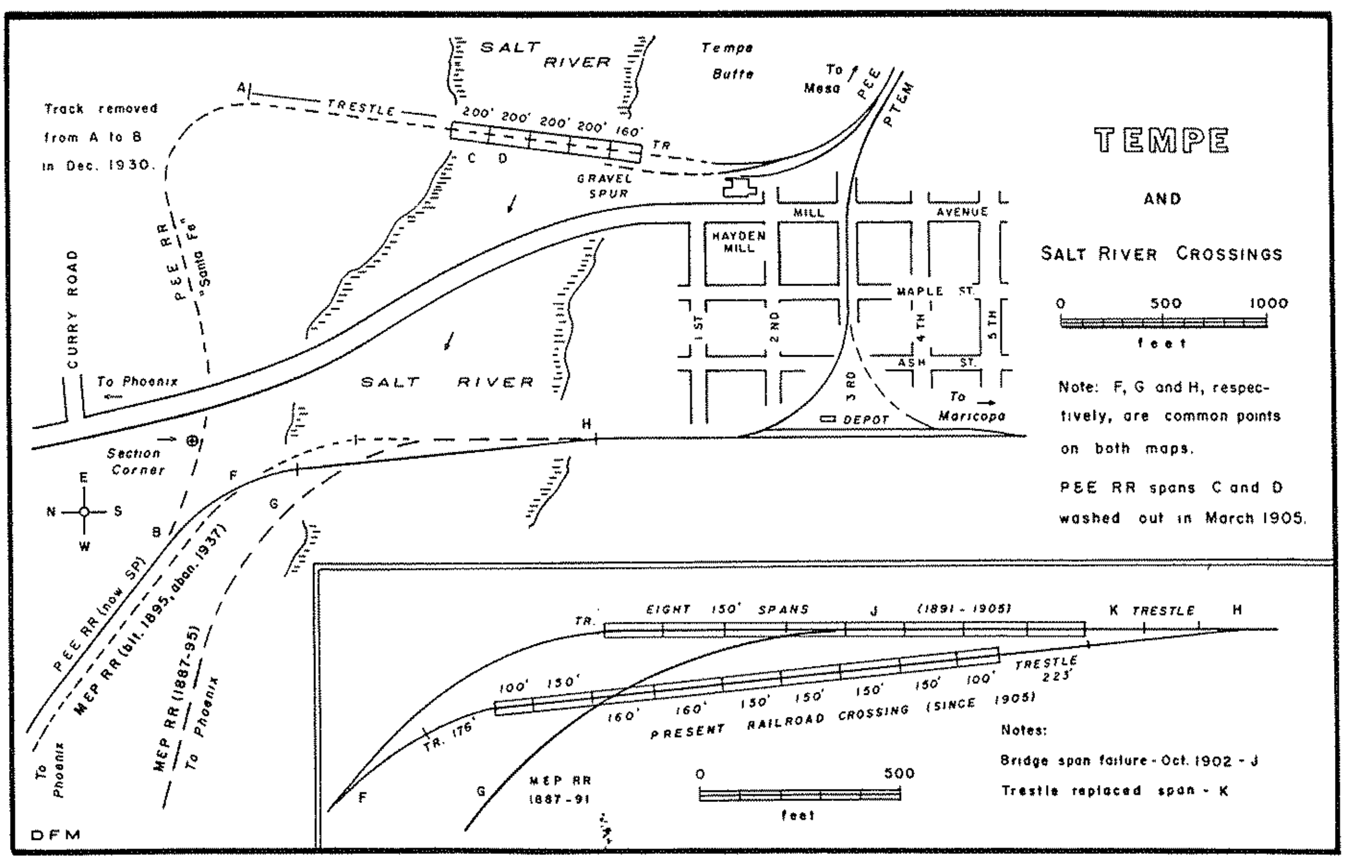


EXHIBIT 191

Ash Avenue Bridge
(Tempe Bridge, Old
Tempe Bridge, and
Salt River Bridge)
Spanning Salt River
at foot of Ash Avenue
Tempe,
Maricopa County,
Arizona

HAER No. AZ-29

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

1991

Historic American Engineering Record
National Park Service
Western Region
Department of Interior
San Francisco, California 94102

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

Ash Avenue Bridge
(Tempe Bridge, Old Tempe Bridge,
and Salt River Bridge)
Spanning Salt River at foot of Ash Avenue
Tempe,
Maricopa County,
Arizona

HAER No. AZ-29

AZ-29-1 Photocopy of photograph (original print located at Tempe Historical Museum, Tempe, Arizona)
Photographer unknown, circa 1870s - 1880s.
FORD ACROSS SALT RIVER AT SITE OF ASH AVENUE BRIDGE. VIEW LOOKING SOUTHEAST TOWARD TEMPE BUTTE.

AZ-29-2 Photocopy of photograph (original print located at Tempe Historical Museum, Tempe, Arizona)
Photographer unknown, circa 1900.
HAYDEN'S FERRY WITH RAILROAD BRIDGE IN BACKGROUND.

AZ-29-3 Photocopy of hand-colored post card (original post card located at Arizona Historical Foundation, Tempe, Arizona)
Photographer unknown, circa 1905.
MARICOPA AND PHOENIX RAILROAD BRIDGE IN THE BACKGROUND; PHOENIX AND EASTERN RAILROAD BRIDGE IN FOREGROUND. VIEW FROM TEMPE BUTTE TOWARD THE NORTHWEST. THE ASH AVENUE BRIDGE WOULD BE BUILT ABOUT MID-WAY BETWEEN THE RAILROAD BRIDGES IN 1911-1913.

AZ-29-4 Photocopy of photograph (original print located at Arizona Historical Foundation, Tempe, Arizona)
Photographer unknown, August 1913.
VIEW OF ASH AVENUE BRIDGE NEARING COMPLETION FROM NORTH APPROACH WITH TEMPE BUTTE IN BACKGROUND. PRECAST CONCRETE POSTS FOR GUARDRAILS ARE SEEN AT LEFT; ONLY TWO LIGHT STANDARDS ARE IN PLACE.

AZ-29-5 Photocopy of photograph (original print located at Arizona Historical Foundation, Tempe, Arizona)
Photographer unknown, circa 1913.
VIEW OF COMPLETED ASH AVENUE BRIDGE FROM NORTH APPROACH WITH TEMPE BUTTE IN BACKGROUND.

AZ-29-6 Photocopy of photograph (original print located at Arizona Photographic Associates, Inc., Phoenix, Arizona)
Herb McLaughlin, photographer, circa 1965.
FROM TOP: MILL AVENUE BRIDGE, ASH AVENUE BRIDGE, AND SOUTHERN PACIFIC RAILROAD BRIDGE. AERIAL VIEW LOOKING SOUTHEAST TOWARD TEMPE BUTTE.

AZ-29-7 Photocopy of photograph (original print located in collection of William H. Caruthers, Jr., Richmond, Virginia and loaned by Susan A. Harter, Tempe, Arizona)
Photographer assumed to be William H. Caruthers, Sr., assistant (construction) engineer for the Ash Avenue Bridge, 1912.
ORIGINAL PHOTOGRAPH CAPTIONED "STOCKADE-TEMPE BRIDGE EAST [SIC] APPROACH." TEMPE BUTTE IS SEEN AT UPPER RIGHT. [Correct identification is "south" approach; view looking east from undetermined elevated position.]

AZ-29-8 Photocopy of photograph (original print located at Arizona Historical Foundation, Tempe, Arizona)
Photographer unknown, circa 1913.
ASH AVENUE BRIDGE UNDER CONSTRUCTION. VIEW FROM SOUTH BANK OF SALT RIVER. CONVICTS ARE COMMENCING WORK ON BALUSTRADE.

AZ-29-9 Photocopy of photograph (original print located in collection of William H. Caruthers, Jr., Richmond, Virginia and loaned by Susan A. Harter, Tempe, Arizona)
Photographer assumed to be William H. Caruthers, Sr., assistant (construction) engineer for the Ash Avenue Bridge, 1912.
VIEW LOOKING NORTH OF ASH AVENUE BRIDGE UNDER CONSTRUCTION SHOWING STEEL REINFORCEMENT IN DECK BEFORE PLACEMENT OF CONCRETE.

AZ-29-10 Photocopy of photograph (original print located in collection of William H. Caruthers, Jr., Richmond, Virginia and loaned by Susan A. Harter, Tempe, Arizona)
Photographer assumed to be William H. Caruthers, Sr., assistant (construction) engineer for the Ash Avenue Bridge, 1912.
VIEW LOOKING NORTH OF ASH AVENUE BRIDGE UNDER CONSTRUCTION. WORK IS PROGRESSING FROM THE SOUTH BANK TO THE NORTH BANK OF THE SALT RIVER.

AZ-29-11 Photocopy of photograph (original print located at Tempe Historical Museum, Tempe, Arizona)
Photographer unknown, circa 1912.
ASH AVENUE BRIDGE UNDER CONSTRUCTION WITH CONVICT LABOR; SALT RIVER IN FLOOD STAGE.

AZ-29-12 Photocopy of photograph (original print located at Tempe Historical Museum, Tempe, Arizona)
McCulloch, photographer, circa 1915.
VIEW OF ASH AVENUE BRIDGE FROM NORTH BANK OF SALT RIVER LOOKING SOUTHEAST TOWARD TEMPE BUTTE; RIVER IN FLOOD STAGE.

AZ-29-13 Photocopy of photograph (original print located at University Archives, Hayden Library, Arizona State University, Tempe, Arizona)
Photographer unknown, 1916.
VIEW OF ASH AVENUE BRIDGE FROM NORTH APPROACH WITH ARIZONA EASTERN RAILROAD BRIDGE AT UPPER RIGHT.

AZ-29-14 Photocopy of photograph (original print located at Tempe Historical Museum, Tempe, Arizona)
Photographer unknown, 1902.
TRAIN WRECK ON MARICOPA AND PHOENIX RAILROAD CAUSED BY BRIDGE FAILURE RESULTING FROM FLOOD DAMAGE.

Michael M. Much, Photographer
August 1990 (AZ-29-15 through AZ-29-28)

AZ-29-15 VIEW OF WEST SIDE OF BRIDGE SHOWING SAG IN DECK CAUSED BY SETTLEMENT OF PIER 9.

AZ-29-16 VIEW OF WEST SIDE OF BRIDGE WITH TEMPE BUTTE IN BACKGROUND.

AZ-29-17 DETAIL VIEW OF ARCH RIB FROM PIER TO PIER. LOOKING WEST WITH SOUTHERN PACIFIC RAILROAD BRIDGE IN BACKGROUND.

AZ-29-18 DETAIL VIEW OF TYPICAL CROWN HINGE AND DECK EXPANSION JOINT.

AZ-29-19 VIEW OF UNDERSIDE OF BRIDGE SHOWING RELATIONSHIP BETWEEN ARCH RIBS AND ARRANGEMENT OF PRECAST RIB STRUTS. MILL AVENUE BRIDGE AND TEMPE BUTTE ARE SEEN IN THE BACKGROUND.

AZ-29-20 DETAIL VIEW OF PIER HINGES, SPANDREL ARCHES, AND DECK OVERHANG SUPPORT BRACKETS.

AZ-29-21 DETAIL VIEW OF NORTH ABUTMENT SPANS WITH END PAIR OF LIGHT STANDARDS. NOTE THE DECORATIVE PANELS CAST INTO THE SPANDREL COLUMN.

AZ-29-22 VIEW LOOKING SOUTHWEST SHOWING MASSIVE CONCRETE PIERS AND DAMAGE CAUSED BY PIER FAILURE.

AZ-29-23 VIEW LOOKING ACROSS BRIDGE FROM NORTH END.

AZ-29-24 VIEW LOOKING SOUTHEAST WITH MILL AVENUE BRIDGE AND TEMPE BUTTE IN BACKGROUND.

AZ-29-25 VIEW LOOKING SOUTHWEST WITH SOUTHERN PACIFIC RAILROAD BRIDGE IN BACKGROUND. THE PAVEMENT OF THE NORTH APPROACH IS SEEN BURIED ON THE RIGHT. ROADWAY (CENTER) CROSSES THE USUALLY DRY CHANNEL OF THE SALT RIVER. A BALUSTRADE OF THE MILL AVENUE BRIDGE IS SEEN AT THE LOWER LEFT CORNER.

AZ-29-26 VIEW OF SOUTH APPROACH TO BRIDGE. THE UPRIGHTS IN THE BACKGROUND SUPPORT ELECTRICAL TRANSMISSION LINES.

AZ-29-27 VIEW LOOKING NORTHWEST SHOWING DAMAGED BALUSTRADE.

AZ-29-28 VIEW SHOWING DAMAGED SPANDREL POSTS AND EARLY REPAIR WORK.

Note: AZ-29-29 through AZ-29-50 are photocopies of original plans. The original plans are located at Arizona Department of Transportation, Structures Section, Bridge Maintenance Branch, Phoenix, Arizona. Original sheet titles are used below.

AZ-29-29 COVER SHEET
Dated 1911-1912

AZ-29-30 SHEET 1 OF 14 SHEETS
GENERAL LAYOUT (right half of Sheet 1)
Dated October 10, 1911

AZ-29-31 SHEET 1 OF 14 SHEETS
GENERAL LAYOUT (left half of Sheet 1)
Dated October 10, 1911

AZ-29-32 SHEET 2 OF 14 SHEETS
SOUTH ABUTMENT
Dated September 19, 1911

AZ-29-33 SHEET 3 OF 14 SHEETS
DETAILS SOUTH ABUTMENT
Dated September 27, 1911

AZ-29-34 SHEET 4 OF 14 SHEETS
DETAILS NORTH ABUTMENT
Dated November 24, 1911

AZ-29-35 SHEET 5 OF 14 SHEETS
INTERMEDIATE PIERS
Dated September 11, 1911

AZ-29-36 SHEET 6 OF 14 SHEETS
ABUTMENT PIERS
PIER No 2 AND PIER No 4
Dated September 12, 1911

AZ-29-37 SHEET 7 OF 14 SHEETS
INTERMEDIATE PIERS
PIER No 5 AND PIER No 6
Dated September 11, 1911

AZ-29-38 SHEET 8 OF 14 SHEETS
ABUTMENT PIERS
PIER No 7 AND PIER No 10
Dated September 12, 1911

AZ-29-39	SHEET 9 OF 14 SHEETS INTERMEDIATE PIERS PIER No 8 AND PIER No 9 Dated September 11, 1911
AZ-29-40	SHEET 10 OF 14 SHEETS MAIN ARCH RIBS Dated October 21, 1911
AZ-29-41	SHEET 11 OF 14 SHEETS MAIN ARCH RIBS Dated October 31, 1911
AZ-29-42	SHEET 12 OF 14 SHEETS DETAILS OF SPANDRELS & BALUSTRADE Dated November 28, 1911
AZ-29-43	SHEET 13 OF 14 SHEETS TYPICAL FLOOR SLAB & DETAILS AT CROWN Dated December, 2, 1911
AZ-29-44	SHEET 14 OF 14 SHEETS CONCRETE & STEEL Dated December 1, 1911
AZ-29-45	SHEET 15 OF 14 SHEETS [sic] REVISED DETAILS Dated February 6, 1913
AZ-29-46	SHEET 16 OF 14 SHEETS [sic] REVISED DETAILS Dated March 6, 1913
AZ-29-47	FORMS FOR SUPERSTRUCTURE Dated May 4, 1912
AZ-29-48	FORMS FOR SUPERSTRUCTURE Dated May 6, 1912
AZ-29-49	REPAIRS TO TEMPE BRIDGE (right half of sheet) "WORK CARRIED ON BY STATE FORCES DURING 1920"
AZ-29-50	REPAIRS TO TEMPE BRIDGE (left half of sheet) "WORK CARRIED ON BY STATE FORCES DURING 1920"

HISTORIC AMERICAN ENGINEERING RECORD

ASH AVENUE BRIDGE
(Tempe Bridge, Old Tempe Bridge, and Salt River Bridge)

Location: Spanning Salt River at foot of Ash Avenue, City of Tempe, Maricopa County, Arizona.

U.S.G.S. 7.5 minute series
Tempe Quadrangle, Arizona
Universal Transverse Mercator coordinates:
South End - Zone 12, Easting 412460, Northing 3699280
North End - Zone 12, Easting 412420, Northing 3699720

Construction Date: 1911-1913

Engineers: J. B. Girand, Territorial Engineer, and Carl E. Hasse, Design Engineer, Arizona Territory Highway Department

Builder: Arizona Territory Highway Department with convict labor

Present Owner: City of Tempe/State of Arizona acting through the Arizona Department of Transportation

Present Use: Abandoned highway bridge (Demolished 1991)

Significance: Constructed over the Salt River on the Phoenix-Tempe Highway, the Ash Avenue Bridge is the first concrete multi-arch bridge erected in Arizona. The structure is comprised of eleven spans of two-rib, open-spandrel, hinged arches. After the bridge was opened in 1913, it contributed immensely to the development of the Salt River Valley.

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Date: January 1991

HISTORICAL CONTEXT

The site of the Ash Avenue Bridge coincides with a historic ford across the Salt River (HAER photograph AZ-29-1). The ford undoubtedly was used by prehistoric Hohokam Indians, whose irrigated fields lay along the banks of the river. One of the first recorded crossings of the stream at this locale was made by Charles Trumbull Hayden in 1866, when that Tucson merchant made a journey from Tucson to Whipple Barracks, near Prescott, so he could submit a bid to the army for freighting and providing supplies. While waiting two days for a flood to subside, Hayden climbed to the top of what is now called Tempe Butte and viewed the wide Valley of the Salt River, then generally called Rio Salado.[1]

Sometime later, a settlement was established nearby, and farms began producing a variety of crops. In 1870, Hayden claimed two sections of land on the south side of the Salt, taking in two buttes on the main road from Phoenix to the Gila River. He also claimed "ten thousand inches of the water of the Salt River" (for irrigation purposes).[2] Hayden immediately began a number of business enterprises, including a mill to grind wheat; a store; and a ferry from which the settlement took its first name, Hayden's Ferry (HAER photograph AZ-29-2). The 1870 census counted only 9,655 non-Indians in Arizona, when the national population was approaching 40 million.

In 1876, Hayden married Sallie Davis, and she transformed his crude adobe house at the foot of the large butte into a comfortable hacienda, now Monte's La Casa Vieja restaurant. Sallie Davis Hayden soon became one of the Salt River Valley's most prominent women. In 1877, she gave birth to Carl, the first Anglo-American child born in Hayden's Ferry. Later on, daughters Sallie and Mapes were born.[3] Carl T. Hayden served in the United States Congress longer than any other person, first as a congressman from 1912 to 1927 and then as a senator from 1927 to 1969.

On the suggestion of "Lord" Darrell Duppa, who had already given Phoenix its name, the local irrigation company was christened "Tempe Canal Company," because of the similarity of the nearby countryside to the Vale of Tempe near Mount Olympus in Greece. As time went on, the name "Tempe" was more frequently used, and on May 5, 1879, Hayden's Ferry's name was officially changed to Tempe.

The 1880s brought the town a large number of settlers, many of them members of the Church of Latter-day Saints. In 1882, Hayden sold a large tract of land to Mormon pioneer Benjamin Franklin Johnson. By 1883, the <u>Arizona Gazette</u> reported:

> At Tempe, all is life and activity. The Mormon Colonists have started a cooperative store which is doing well. They have built several neat houses and several more are going up. There are twenty families in the colony and they expect ten more by fall.[4]

Four years later, many of the Mormons moved to a nearby area which later would be named "Mesa."

By this time, farmers were settling the Valley in large numbers, growing crops and taking their grain to the Hayden mill. In 1882, the <u>Phoenix Herald</u> praised Hayden's work:

> From a small country store has grown a business that occupies an extensive building and furnishes everything that is likely to be needed by farmers, mechanics or merchants, from a nail to the most delicate silks. Wagons, machinery, dry goods, stationary, provisions, canned goods, all find a place on the many tiers of shelving.[5]

In the following year, the <u>Arizona Gazette</u> reported that Tempe was destined to be number one in the industry of fruit raising, because of the unusually fertile soil.[6]

The first railroad into Arizona, the Southern Pacific, arrived in Tucson from Yuma in 1880 and connected with the Texas and Pacific at Sierra Blanca, Texas, in 1882. In the national scope, the Southern Pacific was one of the main contenders for the transportation development of the West and was instrumental in building the first line to Phoenix. Called the Maricopa and Phoenix Railroad, the line was a branch of the main Southern Pacific line to the south, running near the stage station at Maricopa on the old Butterfield Trail through Tempe and on to Phoenix. (Although the Southern Pacific supported the development of the Maricopa and Phoenix, the latter was an independent line.) The line arrived in Tempe in 1887 and crossed the Salt River on a timber structure, the first bridge in the area, near Hayden's river ferry.[7]

The second railroad to arrive in Tempe was the Phoenix and Eastern, an affiliate of the northerly Santa Fe transcontinental line. With the completion of this road in 1904, the communities of the Salt River Valley were connected to other Arizona Territory towns as well as to interstate rail lines (HAER photograph AZ-29-3).

The railroad in the Salt River Valley greatly increased the economic potential of this fast-developing agricultural region. When the rail system was completed, it enabled trading to grow between the cities of Salt River Valley and between the Valley and the rest of the nation. The growth and prosperity of the Valley radiated outward, attracting new settlers and investors. This development culminated in the move of the territorial capitol from Prescott to Phoenix in 1889.

Another factor of vital significance to the economy and development of Tempe was the creation of the Tempe Normal School in 1885. Today, the institution is Arizona State University, the largest university in the state with an enrollment of more than 40,000 students.

The growth of Tempe from its founding in the 1860s was rapid and echoed the expansion all over the Salt River Valley. On October 25, 1907, the Tempe News reported:

> The Arizona Republican has joined the Tempe News in its crusade for a wagon road across the Salt river. This morning's Republican contains the following:
>
> "The need of a good wagon bridge across Salt river at some convenient point is a proposition that few, if any, people will take issue with. Many suggestions have been made for the building of the bridge and some people have objected to each one of them, while most of them have seemed so expensive that almost everybody objected to them as being impracticable even if not undesirable.
>
> "But all this time the need of a bridge grows more and more apparent. As the country fills up with settlers on the south side there is a greater number of farmers who are inconvenienced in their communication with the county seat. And by this is not meant alone the farmers adjacent to Tempe and Mesa, but those south of Phoenix, those for whom Phoenix is the natural business center. Then there is the communication between Phoenix and the southside towns. If there were a half dozen railroads there would still be the need of a bridge for carriages, automobiles, etc. . . ."[8]

In 1909, the territorial legislature appropriated funds for the construction of a highway bridge at Tempe. Initially it was called a "wagon" bridge. Utilizing convict workers from the territorial prison at Florence, construction on the bridge began in the spring of 1911 on an alignment approximately 500 feet east of the 1905 Maricopa and Phoenix Railroad Bridge, which today, in an altered form, is the Southern Pacific Railroad Bridge. Upon completion in 1913, a year after the Territory of Arizona was admitted to the Union, the bridge provided the long-needed, all-weather link between Phoenix and the other Salt River Valley communities to the east, and between northern and southern Arizona (HAER photographs AZ-29-4 and AZ-29-5). It immediately began to receive extremely heavy use. The continuing rapid development of the area and the ever-increasing size of automobiles and trucks created more and heavier traffic than initially contemplated by the structure's designers. Weakened by overloading and periodic flooding of the river, the bridge began to deteriorate. In 1920, extensive repairs were made on the superstructure after one of the piers settled during a flood.

In 1928, a delegation of Tempe businessmen requested the Arizona Highway Commission to replace the Ash Avenue Bridge. The only bridge over the Salt River in the area, the eighteen-foot-wide structure carried traffic for U. S. highways 60, 80, and 89, as well as local Salt River Valley traffic. Its narrow width was the cause of many accidents. Later that year, Arizona Highway Department engineer Ralph Hoffman designed a multi-span, open-spandrel, concrete arch-rib bridge reminiscent of the Ash Avenue Bridge, to be located a short distance east of Ash Avenue. Completed and dedicated in July 1931, the Mill Avenue Bridge was individually listed on the National Register of Historic Places in 1981 as one of Arizona's significant vehicular structures (HAER photograph AZ-29-6).

HISTORY OF THE ASH AVENUE BRIDGE

Transportation in Tempe was an integral factor in the community's development. Passenger service by train in the Salt River Valley began in the late 1880s and reached a peak in the decade after the turn of the century. At that time, horse-drawn vehicles were the main mode of family transportation; buggies, buckboards, and surreys were privately owned or could be hired from local liveries. With the advent of the automobile at the end of the first decade of the twentieth century, "auto liveries" opened, and an "auto stage" operated throughout the Valley. The increasing popularity of the auto caused a sharp decline in the use of passenger trains in the Tempe area, as well as in other Valley communities.

When the first railroad bridge over the Salt River at Tempe was constructed by the Maricopa and Phoenix Railroad in 1887, Charles T. Hayden proposed that a wagon bridge be constructed with it to enable non-rail traffic to cross the Salt.[9] The Maricopa County Board of Supervisors opposed the measure, and travelers had to continue using Hayden's ferry to cross the river for another quarter of a century.

Then, on April 3, 1908, the Tempe News reported:

> The Tempe board of trade. . . . has addressed the following petition to the [Maricopa County] board of supervisors:
>
> Gentlemen - The board of trade of Tempe believing that the time has arrived when the best interests of Maricopa county demand that a wagon road be built across the Salt river; and recognizing that Tempe offers the most practical point of crossing for many miles up and down the river, the board of Trade respectfully petitions your honorable body to at once take such steps as your best judgement dictates, toward securing the building of a wagon bridge across the Salt river at Tempe.
>
> In connection with the above. . . ., the Maricopa Commercial Club reports that organization enthusiatically [sic] in favor of the Tempe wagon bridge movement and will aid in every possible way. The chambers of commerce of Phoenix and Mesa will join the crusade. . . . With such potent factors at work the prospects look very encouraging.[10]

On October 8, 1909, the Tempe News reported under the heading "NO BRIDGE FOR TEMPE":

> The News has it from the highest authority that nothing will be done toward building a bridge across the Salt river at Tempe this year. The reason is assigned to the lack of sufficient money in the territorial road fund from which the cost of constructing the bridge is to come. The shortage of funds is accounted for by the fact that certain counties did not make the full levy for territorial road purposes.[11]

However, at that time sufficient money was available for the construction of a bridge across the Salt in Phoenix at Center Street (now Central Avenue). As the largest community in the county and the county seat of government, Phoenix apparently had greater influence on the territorial legislature than Tempe, and Phoenix received the first bridge over the Salt. It was a short-lived structure, being washed away by one of the Salt River's frequent and heavy floods.

Finally, later in the year, the territorial legislature authorized the construction of a wagon bridge at Tempe, and on May 31, 1911, the superintendent of the territorial prison at Florence was instructed to send twenty-five convicts to work on the bridge. The prisoners were accompanied by six guards.

The original plans for the bridge were prepared under the supervision of James B. Girand, Territorial Engineer. They provided for a nine-span, concrete, solid-spandrel, arch-ring bridge some 1,225 feet in length and sixteen feet in width. However, soon after construction on the approaches began, the structure was totally redesigned by Carl E. Hasse, again under Girand's direction, to delineate an eleven-span, concrete, open-spandrel, arch-rib structure some 1,507 feet long and eighteen feet wide.[12] Documentation of the reasons for this change have not come to light. A detailed article on the project in the March 28, 1912, issue of Engineering News described the bridge as "somewhat out of the ordinary in design."[13]

Although the use of convict labor on public works was not unusual in the United States at the time, convicts generally worked in "chain gangs," where they were chained together or restrained with a heavy iron ball shackled to one leg. However, recently elected Governor George W. P. Hunt, who began serving his first of seven non-consecutive terms in January 1912, was a staunch prison reformer. At a Chamber of Commerce banquet in Prescott, he proclaimed his intention of employing convicts without guards. The governor was quoted as being so confident in his men that he offered to resign if one of them should escape.[14]

In July 1912, the Arizona honor system was launched, and Hunt confided to a close friend:

> Next week I am going to put a force of convicts to road building. THIS IS OUR FIRST EXPERIMENT, it is a picked body of men from the prison and what will be remarkable is that they are going to work on the roads WITHOUT GUARDS, and another thing is that two or three will be lifers.[15]

Convicts working on the bridge, however, were confined in a stockade at night, but during the day were not closely guarded and caused no concern to the townspeople, who often took an active interest in the affairs of the men (HAER photograph AZ-29-7). The prisoners organized a baseball team and played local and visiting teams.[16] The games were popular events with Tempe citizens, and they began the practice of "passing the hat" at Sunday games, so the convict team could purchase baseball equipment. On one occasion, the "bridge squad" even traveled to Phoenix. There it played one of that city's best teams and received a percentage of the gate. This unprecedented move was supported by Governor Hunt. Following the game, the governor took the entire team out to dinner.

Even though Hunt did not originate the convict honor system, he was the first governor to inaugurate it, and the honor system became closely associated with him, according to Thomas Mott Osborne, one of the nation's foremost experts on prison reform and one-time warden of Sing Sing. "As for the Honor System," he wrote to Hunt in 1925, "I have always believed that you deserve the credit of being the first Governor to insist on prisoners being treated with humane consideration."[17]

During the construction of the bridge, an average of fifty-seven prisoners was at the site. Forty-eight were employed on the bridge proper and nine on camp work (HAER photograph AZ-29-8). The paid force consisted of one engineer, one assistant engineer, five foremen, two carpenters, seven guards, and one bookkeeper.[18] For every day of faithful and conscientious labor performed on the bridge, a prisoner was allowed two days of credit to be deducted from his sentence in addition to the regular good-time allowance. The district engineer in charge of the project reported:

Paid labor force required to do the same amount of work per day as 48 prisoners:

1 Blacksmith	$ 4.00	
3 Derrick Engineers @ $3.50	10.50	
14 White laborers on foundation work, etc. @ $2.50	35.00	
8 Laborers on concrete work @ $2.00	16.00	
4 White teamsters @ $2.50	10.00	
6 Laborers on rock crusher @ $2.00	12.00	
1 Cook for Engineer's Mess	2.50	
		$ 90.00
48 Prisoners @ $1.11		53.28
Difference in favor of Prison Labor per day		$ 36.72[19]

Other persons, however, disagreed that the use of convict labor was cost effective, claiming the expense of guards, stockades, and better food than was served at the prison made the use of prisoners more costly than skilled contract workers.

On February 14, 1912, Arizona was admitted to the Union as the "Baby State," and work on the bridge was rapidly progressing. In an effort to hasten the bridge's completion, electric lights had been installed at the site and a three-shift program initiated.

Materials for the construction were acquired from various sources. Rock, gravel, and sand were obtained from the Salt River channel, and a rock crusher operated by convicts produced suitably sized aggregates for the concrete. Cement came from El Paso and steel reinforcing from Colorado (HAER photographs AZ-29-9 and AZ-29-10).[20] The steel caissons used in the pier foundations were delivered from Leavenworth, Kansas.[21] Castings for the crown hinges were manufactured by the American Iron Works in Phoenix.[22]

On April 14, 1912, the Arizona Republican commented on the project:

> The bridge is of special interest here, in that it is entirely a product of the west, and largely local. . . . It should be gratifying to local engineers to know that Arizona can claim the design, engineering and construction of the bridge, . . . Too often outside talent is called in to supervise work when local engineers familiar with local conditions, and equally able, are the logical men to solve Arizona's engineering problems.

When the bridge was completed in September 1913, approximately two hundred and fifty different convicts had worked on the project. Governor Hunt, however, did not keep his promise to resign if one should escape--during the twenty-seven months of construction, fifteen convicts did escape and only about nine were apprehended.

Initially estimated to cost $78,397,[23] the final cost of the bridge was about $120,000. Much of the cost increase probably can be attributed to the increase in length and width of the completed bridge over that provided in the original design, and to the difficulties caused by river floods during construction (HAER photograph AZ-29-11).

Although the designers of the bridge were well aware of the hazards of building in the channel of the Salt River, even after the construction of Roosevelt Dam in 1911 reduced the ferocity of periodic floods, and had taken particular care in the design of the supporting piers, the structure was endangered by settlement in the latter part of 1919 and the early part of 1920 (HAER photographs AZ-29-12). In the April 21, 1921, issue of the Engineering News - Record, Merrill Butler, bridge engineer with the Arizona Highway Department, explained what had happened:

> Shortly after the floods of Thanksgiving, 1919, the second pier from the north end of the bridge (Pier 9) settled about 4¼ in. Traffic was maintained, except during high water, until Feb. 13, 1920, when a further settlement occurred, about ½ in. A two-ton limit was then placed on the loads permitted to cross the bridge. On March 2 an additional settlement of 1 1/8 in. occurred, and the bridge was closed to traffic. The following day there was a sudden drop of nearly 5 in. At this time also it was noticed that the pier had shifted out of line about 0.1 ft., downstream.[24]

Flooding of the Salt River had threatened the railroad bridges at Tempe almost from the time of their construction. In fact, frequent bridge washouts were more commonplace than unusual, and Tempe residents were accustomed to the problems caused by the temperamental river.[25] The original Maricopa and Phoenix crossing washed out just four years after it was built. Other wood bridges were built in place of the one destroyed, but these too fell victim to seasonal floods. In October 1902, a train wreck caused by bridge failure resulted in great excitement locally (HAER photograph AZ-29-14).[26]

Because of the failure in 1905 of two piers of the Phoenix and Eastern Bridge located about 500 feet upstream from Ash Avenue, the piers of the Ash Avenue Bridge were intended to be founded on solid rock. Some of the piers were carried to the rock in open excavations, but others were supported by concrete-filled cylindrical steel caissons. It was one of the latter that settled.

Before the 1919 flood, Pier 9 was entirely surrounded by sand and gravel, which served to carry a considerable portion of the load by way of the base of the pier block. When the flood swept away this material, the pier was supported solely by the two concrete cylinders, which failed under the load. Engineer Butler speculated what had happened:

> . . . In the light of the difficulties subsequently experienced in sinking the new cylinders it is very probable that the concrete in the bottom of the original cylinders was of inferior grade, or that a foot or so of sand had filtered in after the rock had been cleaned off. The natural consequence would be a crumpling of the steel shells of the cylinders, and this is what actually happened, it is believed. Unbalanced live-load thrust would tend to accelerate such failure.[27]

Butler also reported other defective conditions had developed in the bridge:

> . . . A great number of the spandrel columns were found broken in horizontal shear near the extrados and several spandrel walls near the crown had pulled loose from the arch rings. In the vicinity of Piers 2, 3 and 4 the roadway slab and spandrel arches had cracked completely through; in the spans adjacent to these piers none of the spandrel columns were cracked.
>
> There was also trouble at the floor expansion joint. The type of joint used had proved unsatisfactory and large chuck holes had formed alongside each joint, causing serious impact whenever a heavy vehicle passed over the bridge; in some cases the concrete supporting the wooden strips which bridged the joints was found to be cracked and broken from traffic action.[28]

The state highway department began repair work in the spring of 1920. In order to safeguard the traffic while reconstruction was in progress, falsework was erected under the arches of two of the spans. One of the principal repair measures was the underpinning of Pier 9. It was decided to place six new cylinders around the original pier, which would allow the underpinning to be accomplished without disturbing the existing structure. Immediately after the completion of the falsework, a wood cofferdam was constructed around Pier 9, and the sinking of the steel cylinders began early in July. Buried debris, in the form of cottonwood logs, made the procedure difficult. Finally, the cylinders were in place, and reinforcing steel was installed. The cylinders were then filled to a level just below the cap concrete. Then the concrete caps were poured, up to the top of the original pier block. After the concrete caps had set, the original shaft was cut out in sections, and a reinforced beam that transferred the pier load to the new cylinders was poured. No effort was made to raise the pier or the bridge deck back to their original elevations (HAER photograph AZ-29-15). However, the balustrades were rebuilt to eliminate the appearance of sag. The repair work is detailed an Arizona Highway Department drawing (HAER photographs AZ-29-49 and AZ-29-59).

The bridge's problems did not end there. In its May 1925 issue, Arizona Highways published an article evidencing continuing concern about the bridge's structural integrity:

> A question of great importance to many persons of the Salt River valley is the ultimate life of the Tempe bridge. We are quite certain that its days are numbered. The life of the structure has been variously estimated and almost from the time of its inception the design has been of sufficient importance to call forth articles by some of the most noted consulting bridge engineers. . . .
>
> The settlement of the pier mentioned [Pier 9] subjected the superstructure to considerable strain and the deck took remarkable deflections without showing fractures, but these have been gradually developing under the impact vibrations set up by the passage of heavy traffic. New developments could be seen at each inspection and these were made at frequent intervals. It was thought that the immediate danger lay in a gradual destruction from vibrations, resulting from the impact at the faulty expansion joints and the recent repairs to these have sustained that belief.
>
> These vibrations were transmitted the full length of the bridge so that the effect of one truck passing over each of the thirteen joints was a succession of violent shocks. The traffic count for this highway was in the neighborhood of 3500 to 4000 per day, and hence some idea may be had of the destructive action of such forces.
>
> Plans were prepared for the replacement of the joints . . . . A joint composed of two heavy angles and a plate one-half inch in thickness and eight inches wide was selected. The plate was securely riveted to one angle and the angles provided with anchor bolts at four foot centers on both legs.
>
> The problem of backing these angles up with a thin section of concrete that would stay, was still with us until it was determined that the State had many uses for a cement gun other

> than making repairs to the columns and beams of the Tempe bridge, and that valuable piece of equipment was purchased.
>
> The cement gun was used for placing the joints as well as for the column repairs. . . .
>
> One outstanding feature was the use of Lumnite Cement for a majority of the concrete work. This was probably the first practical use of this quick-setting cement in the state. It was estimated that the use of the bridge was worth approximately $1,000 a day to the public and the use of the Lumnite Cement, giving twenty-eight day strength in twenty-four hours was a considerable advantage, shortening the period of closing by at least two weeks. . . .
>
> All of the thirteen crown joints were replaced with the new type. Several spandrel columns were entirely rebuilt with wire mesh and gunite and slight repairs made on others. Seven new steel cross-beams were placed at the crown sections of the two spans adjacent to Pier No. 9. These were also encased with gunite. The work was . . . completed on March 1, 1925, with only about two weeks interruption to traffic.[29]

With automobiles and trucks becoming larger and heavier and as traffic continued to increase in the Salt River Valley, motorists began to demand a new and larger bridge. In 1928, the Arizona Highway Commission recommended the construction of a new bridge, and plans for one were prepared. Construction of the new bridge, which became known as the Mill Avenue Bridge, began in March 1930, and it was opened to traffic in July 1931. With the completion of the New Tempe Bridge, the Commission closed the Ash Avenue Bridge to all but pedestrians, and in 1933 officially abandoned the structure. A few years later, the commission's attorney delivered an opinion that the Arizona Highway Department could not expend money to demolish the structure. In 1943, the Works Progress Administration decided not to demolish the bridge to salvage reinforcing steel. And so the old bridge, now in an advanced state of deterioration, still stands as a remarkable example of early twentieth century bridge technology. It is listed on the National Register of Historic Places under the Tempe Multiple Resource Area.

In May 1990, Donohue & Associates, Inc., Engineers, Phoenix, completed an evaluation of the historic bridge for the City of Tempe.[30] The study was designed to determine the structure's capability of accommodating pedestrian loading, and hydraulic loading under the present non-channelized condition and the proposed channelized configuration of the river.

The study concluded that the Ash Avenue Bridge had "failed," even though this failure has not yet resulted in collapse. Therefore, the engineers recommended that removal or extensive rehabilitation of the structure be undertaken, both being feasible alternative actions. The Arizona Department of Transportation concurred that removal or extensive rehabilitation of the Ash Avenue Bridge were the only measures that would provide assurance of a safe condition in the channel.[31] After considering the cost of rehabilitating even the south abutment and two adjacent spans of the bridge as a pedestrian overlook on a planned Salt River reservoir, the Tempe city council reluctantly authorized the structure's demolition.

Under a memorandum of agreement among the City of Tempe, the U. S. Army Corps of Engineers, and the Arizona State Historic Preservation Office, this HAER documentation was prepared to mitigate the impact of the Ash Avenue Bridge's removal by recording the historical and technological significance of its purpose, design, construction, and use. The study increased the understanding of the development of the Salt River Valley and of the utilization of prison labor on public works projects in Arizona. Additionally, it makes a contribution of knowledge to the history of bridge engineering.

Epilogue

On January 11, 1991, demolition of the old bridge was commenced by J.W.J. Contracting Corporation, Inc., of Phoenix. Utilizing a hoe-ram, the structure was collapsed into the dry channel of the Salt River, broken into manageable pieces, and hauled away. Only the south abutment, located near the edge of Tempe Beach Park, was retained for anticipated use as a viewing station on the planned reservoir and as a part of the tangible record of the nation's history.

SIGNIFICANCE OF THE BRIDGE

The Ash Avenue Bridge is one of the most historically and technologically significant bridges in Arizona--one of a handful of vehicular spans from the territorial period.

The bridge was one of the first major highway bridges constructed in the Territory of Arizona, and the first successful vehicle bridge over the Salt River.[32] Initially designated a "wagon" bridge, it served primarily as an automobile bridge from the time of its completion in 1913 until its abandonment in 1933. During those years, it was the only highway bridge across the Salt River in central Arizona and provided an essential link between northern and southern Arizona, and between Phoenix and other Salt River Valley communities, especially Tempe and Mesa. As an important element of Arizona's highway system, the bridge played a vital role in the state's economic development.

Additionally, the bridge is one of the few structures remaining in the state that was constructed largely by convict labor. In 1911, convicts were commonly used on public works throughout the country, frequently under conditions that were harsh and oppressive. However, a noteworthy program of prison reform had been introduced in the Territory of Arizona. This program was not based entirely upon the economic advantage of using convict labor, but also upon sociological enlightenment. After his inauguration in 1912, Governor George W. P. Hunt, somewhat naively, stated, "Arizona's statehood will bring a new day for her prisoners as well as her citizens, since many are in there [prison] primarily because of an adverse environment over which they had little control." He urged that a special effort be made to rescue first offenders by separating them from hardened criminals, and giving them useful activity both for mind and hands.[33]

Because the construction of complex engineering projects with convict labor is now uncommon, the Ash Avenue Bridge has become a noteworthy example of such an undertaking and provides an exceptional illustration of twentieth-century prison reform.

The bridge, however, derives its greatest measure of significance from its engineering technology. One of the first large arch-rib structures built in the United States, it is a remarkable example of early reinforced concrete construction.

The invention of portland cement in England in 1824, and the subsequent development of concrete in France and Germany during the 1850s, provided a new material for bridge construction. In the early uses of concrete for bridges, only its great compressive strength was exploited. Therefore, for a while, the semicircular, solid arch was the only feasible shape for the superstructures of concrete bridges, because an arch works only through compression. Several such bridges were built in Europe through the 1870s. In the United States, a little 31-foot concrete arch bridge was built in Brooklyn's Prospect Park in 1871. It was designed to look as much as possible like a conventional masonry arch bridge, such as those constructed since Roman times.

Equally important to the development of modern bridge technology, were the experiments of the American, W. E. Ward, who in 1871 and 1872 established the need to reinforce the lower, "stretched" portion of concrete beams. These experiments led to the use of iron reinforcement in concrete arches, which first occurred in the United States in 1889 in a thirty-five-foot span at Golden Gate Park in San Francisco.[34] Even with the development of the idea of reinforcing concrete with iron bars, it took a number of years for bridge builders to free themselves of the desire to make concrete bridges appear as if they were built of masonry. As time passed, bridge engineers and architects began to realize that, in order to achieve the most pleasing result, concrete must be treated differently than natural stone, and that the obvious forms of cut-stone masonry should not be imitated in concrete, which, because of its plasticity, could take virtually any shape.

Before the turn of the century, serious work on reinforced concrete construction was going on in Europe. From the office of François Hennebique (1842-1921) in France, came a number of textbooks on working with reinforced concrete. The most notable of his actual bridges was built for the International Exposition in Liège, Belgium, in 1905, just six years before construction began on the bridge over the Salt River in Tempe.

Associated with Hennebique in the first years of the century was a young Swiss structural engineer, Robert Maillart (1872-1940). Maillart has since become one of the most celebrated designers of reinforced concrete bridges. He gained a great deal of experience in using reinforced concrete from his association with Hennebique, but soon overtook the older man in the field of bridge design.

Maillart's work is noted for the use of the minimum amount of material required to carry the loads and the use of shapes upon which shrinkage, creep, temperature change, and foundation settlement would have the least effect. Among his innovations was the use of the three-hinged arch. Although such arches were not uncommon in steel, they had not been considered practical in concrete. In 1905, Maillart built the Tavanasa Bridge, the proto-type three-hinged concrete arch, over the Rhine River in Switzerland. The forces of that structure were concentrated on the three hinges, at the crown and at the abutments, much as the forces in the Ash Avenue Bridge would be concentrated a few years later. Although the hinges were concrete, and strongly reinforced, their flexibility allowed movements of the bridge without harming its members. Also, as in all of Maillart's work, enormous care went into the design of the steel reinforcement to obtain maximum effect. Since Maillart was committed to the idea of minimum materials, the placement and quantity of the reinforcing steel was critically important. Much like Maillart's structures in the use of minimal materials, the Ash Avenue Bridge is remarkable for the slenderness of its members.

Prior to the development of reinforced concrete, timber bridges were common in the United States, having been used since colonial times. They were vulnerable to excessive loads, fire, and inclement weather, and deteriorated rapidly, especially under Arizona's relentless sun. Arizona Territory's first railroad bridges, including those erected across the Salt River at Tempe, were built of wood. The second generation of Arizona's railroad bridges, including spans at Tempe, was largely constructed of steel, a material favored by American engineers at the time. The territory developed a strong tradition of steel bridges, especially of the Pratt-truss-type, which was popularized by the railroads. Steel truss bridges were economical in the industrialized regions of the county where iron was readily available, easy to erect, and resistive to the elements. However, steel bridges of the common type were unattractive and uninspired. A new generation of imaginative American bridge designers began to seek new solutions to the age-old problems of creating attractive, economical, and permanent spans at river crossings.

With most of the major rail lines completed by the end of the first decade of the twentieth century, American engineers turned their attentions to highway and bridge design and construction. Many looked toward Europe and the work of Hennebique and Maillart for inspiration and a new technology--the technology of reinforced concrete.

Until the end of the century, road and bridge construction in Arizona were largely county government functions. However, in the sparsely populated territory, county revenues were minimal, and few bridges were constructed for public use. None of these nineteenth-century structures is known to remain today.

During the first decade of the twentieth century, it became evident that many road and bridge projects were beyond the capability of the counties. To take a more active role in the development of highways, the territorial legislature, on March 18, 1909, established a road tax and created the office of Territorial Engineer. James B. Girand was appointed to the position by the governor of the territory.

Girand was born May 20, 1873, at Austin, Texas. He studied civil engineering at the Agricultural and Mechanical College of Texas from 1888 to 1891, but did not receive a degree. On the organization of Moore County, Texas, in 1891, Girand was elected county surveyor, apparently at the age of eighteen. During the next several years he held a variety of surveying positions, many of them with railroads. During 1901-02, he was engaged in general engineering practice in northern Arizona, having an office in Prescott. In 1903, he accepted a position as engineer in charge of the United Gold and Platinum Mines Co. After several other positions with mining and railroad companies, he served as Territorial Engineer from 1909 until 1912, when he was appointed chief engineer of the Gila Water Company. By 1914, he had established a private engineering firm, Girand, Hasse & Lewis, in Phoenix. The firm Johannessen Girand is still in practice in Phoenix.[35]

Before being appointed Territorial Engineer in 1909, Girand does not appear to have had any noteworthy experience in the design of concrete arch-rib bridges, although at Texas A & M he undoubtedly became familiar with the basic concepts of masonry arch structures. Therefore, it is hypothesized that he administered the activities of his office and, perhaps, designed highways, while his assistants performed the actual design work on the bridges.

Immediately after his appointment, Girand began to plan and build a territorial highway system. His strategy was to link the county seats and more populous towns with a network of roads. In connection with this highway construction, he supervised the construction of a handful of important bridges at key river crossings, the most noteworthy of which was across the Salt River at Tempe. Curiously, none of these bridges resembled each other even remotely, suggesting each had a different designer. Girand's first bridges consisted of a concrete girder structure across the Gila at Florence, a single-span concrete arch over Mule Gulch near Bisbee, the solid-spandrel Lowell Arch Bridge in Cochise County, a timber-iron Howe truss span over the Black River southwest of Fort Apache, a three-span, pin-connected truss over the Verde River at Camp Verde, and a timber trestle over Forest Wash.

Without question, Girand's most spectacular, expensive, and important undertaking was the multi-span concrete bridge at Tempe. Initially, plans were prepared for a nine-span, solid-spandrel, arch-ring structure with a total length of 1,225 feet. However, soon after site work began, Girand directed his assistant, bridge engineer Carl E. Hasse, to redesign the bridge.[36] The new design delineated eleven spans of two-rib, open-spandrel, three-hinged arches. The reason for this abrupt change has never been determined, but may have resulted from anticipated economies in an open-spandrel, arch-rib design over a solid-spandrel, arch-ring design, or from a desire by Girand to utilize a unique opportunity to produce a memorable structure with an innovative technology.[37]

At that time, few reinforced concrete, arch-rib bridges had been constructed either in Europe, where Robert Maillart had first used the technique only six years earlier, or the United States. Maillart's designs often were elegant but mistrusted by his clients. However, they were so economical that engineering authorities simply could not ignore them.[38]

Regardless of the reasons for Girand and Hasse deciding to build a reinforced concrete, arch-rib bridge, it was a bold action. Such a complex and innovative engineering endeavor had never before been undertaken in Arizona, which at the time of the project's conception was a sparsely populated, seldom-visited, frontier territory.

Elsewhere in the country, reinforced concrete, open-spandrel, arch-rib designs were still in their infancy, and few, if any, undertakings equaling the Ash Avenue Bridge in size and inventiveness had yet been completed in 1911, the year Girand and Hasse finished their construction documents.

It is difficult to say with certainty when or where the first three-hinged, arch-rib bridge was constructed in the United States. However, some of the earliest were built in California. One of the first was probably the Main Street Bridge in Los Angeles. Constructed in 1910, it remains today. The bridge has three spans of 87.5 feet and a total length of about 363 feet. Eight rows of ribs were utilized to achieve a width of seventy feet.[39] In an article published in 1910, it was reported that the Main Street Bridge "is of a type, known as three hinged ribbed arch, never before used in the Southwest and rare in the United States. . . ."[40]

Among the first large multi-span, open-spandrel, arch-rib bridge built in California is the North Broadway Bridge, also in Los Angeles. Under construction in 1910, the seven-span structure still stands and has a total length of 968 feet; the largest of its arches has a span of 119 feet. As with the Main Street Bridge, six rows of ribs are utilized to achieve a width of seventy feet.[41]

Girand and his associates appear to have been in the vanguard of the reinforced concrete, open-spandrel, arch-rib bridge designers. And certainly, their Ash Avenue Bridge was a forerunner in the new concrete technology, exceeding other similar undertakings in length, difficulty, and artistic qualities. At the same time, J. A. L. Waddell, noted American bridge engineer and author of several well-known textbooks on bridge design and construction, was working on a similar project.[42] His Colorado Street Bridge in

Pasadena, California, was completed in 1913, the same year as the Ash Avenue Bridge.

The Colorado Street and Ash Avenue bridges are remarkably similar. Both are eleven-span, open-spandrel, arch-rib structures. The Pasadena bridge has a total length of 1427.75 feet, a maximum arch span of 222.5 feet, and a typical arch span of about 94 feet.[43] The Tempe bridge has a total length of 1507.75 feet and a typical arch span of 131 feet.

These two bridges, and undoubtedly others not identified, gave impetus to reinforced concrete, arch-rib construction, which became increasingly popular throughout the United States in subsequent years. By 1916, spectacular arch-rib structures were being erected. One of the most noteworthy of these is the Tunkhannock Viaduct on the Delaware, Lackawanna & Western Railroad at Nicholson, Pennsylvania. This descendant of the Ash Avenue Bridge has a total length of 2,375 feet and a typical arch span of 180 feet.

Unlike Girand's design that expresses the inherent plastic quality of concrete in an inventive way, the Tunkhannock arches are divided into imitation voussoirs in the traditional manner. Another detail used in the design of the viaduct and in many other early concrete bridges, which is obviously superfluous to concrete construction, is the use of the projecting cornice at the top of the spandrel posts. The Ash Avenue Bridge, in contrast, derives its remarkable aesthetic quality from its simplicity, articulated quality, absence of ornamentation, and slenderness.

However, in their efforts to achieve this slenderness in the bridge's members, probably for both economic and aesthetic reasons, the designers of the Ash Avenue Bridge failed to provide adequate concrete coverage over the steel reinforcement and sufficient distance between bars (especially at their laps), thereby weakening the structure. These deficiencies, resulting perhaps from the engineers' inexperience in reinforced concrete design, were prominent among the causes for the bridge's demise and ultimate removal in 1991.

By the 1920s, the use of arch-rib bridges was becoming commonplace. Some of the most noteworthy examples are located in Minnesota's Twin Cities, where the Mississippi and Minnesota rivers offered engineers numerous challenges. According to David Plowden, prominent American bridge authority, the Fort Snelling-Mendota Bridge across the Minnesota River is usually considered to be the most sophisticated design for a concrete arch built in the 1920s, apart from the West Coast bridges.[44] Although much larger than the Ash Avenue Bridge and constructed with continuous arches rather than hinged arches, the Fort Snelling-Mendota Bridge is obviously in direct lineage from the Ash Avenue Bridge.[45]

Labor intensive, and consequently expensive to construct in the United States, arch-rib bridges are no longer used for public highways. They have largely been supplanted by standardized concrete girder and steel girder structures, which have added a measure of monotony to the American streetscape, especially along the interstate highways.

Unfortunately, the high cost of rehabilitating the early arch-rib bridges has limited such actions, and these interesting examples of engineering inventiveness are disappearing from the American scene. Only the south abutment of the Ash Avenue Bridge remains to commemorate this remarkable example of innovative American engineering accomplishment in the early years of the twentieth century.

PHYSICAL DESCRIPTION OF BRIDGE PRIOR TO DEMOLITION

The Ash Avenue Bridge is an open-spandrel, reinforced concrete, three-hinge-arch-rib structure with an overall length of 1,507.75 feet and an overall width of twenty feet. The clear roadway width is eighteen feet. The bridge consists of eleven main spans and two abutment spans. Individual main-span lengths are approximately 131 feet between the centerlines of the pier units, and the north and south abutment span lengths are 32.42 feet and 40.33 feet, respectively. The arch ribs have a rise of approximately 19.4 feet (HAER photograph AZ-29-16). The bridge is fully delineated in the original construction plans (HAER photographs AZ-29-29 through AZ-29-48). The various components of the bridge, as described below, are identified in Figure 1.

The superstructure of the main arch spans consists of a reinforced concrete deck slab supported by transverse deck beams spaced at 10.83 feet on centers and by longitudinal deck beams located on the longitudinal center line of the bridge between the transverse deck beams. The transverse deck beams are supported by vertical spandrel posts rising from the main arch ribs and by vertical spandrel columns rising from the pier units. The spandrel posts and spandrel columns are interconnected at their tops longitudinally with semicircular spandrel arches and transversely with the deck beams. The main arch ribs and spandrel arches are the principal character-defining architectural features of the bridge (HAER photograph AZ-29-17).

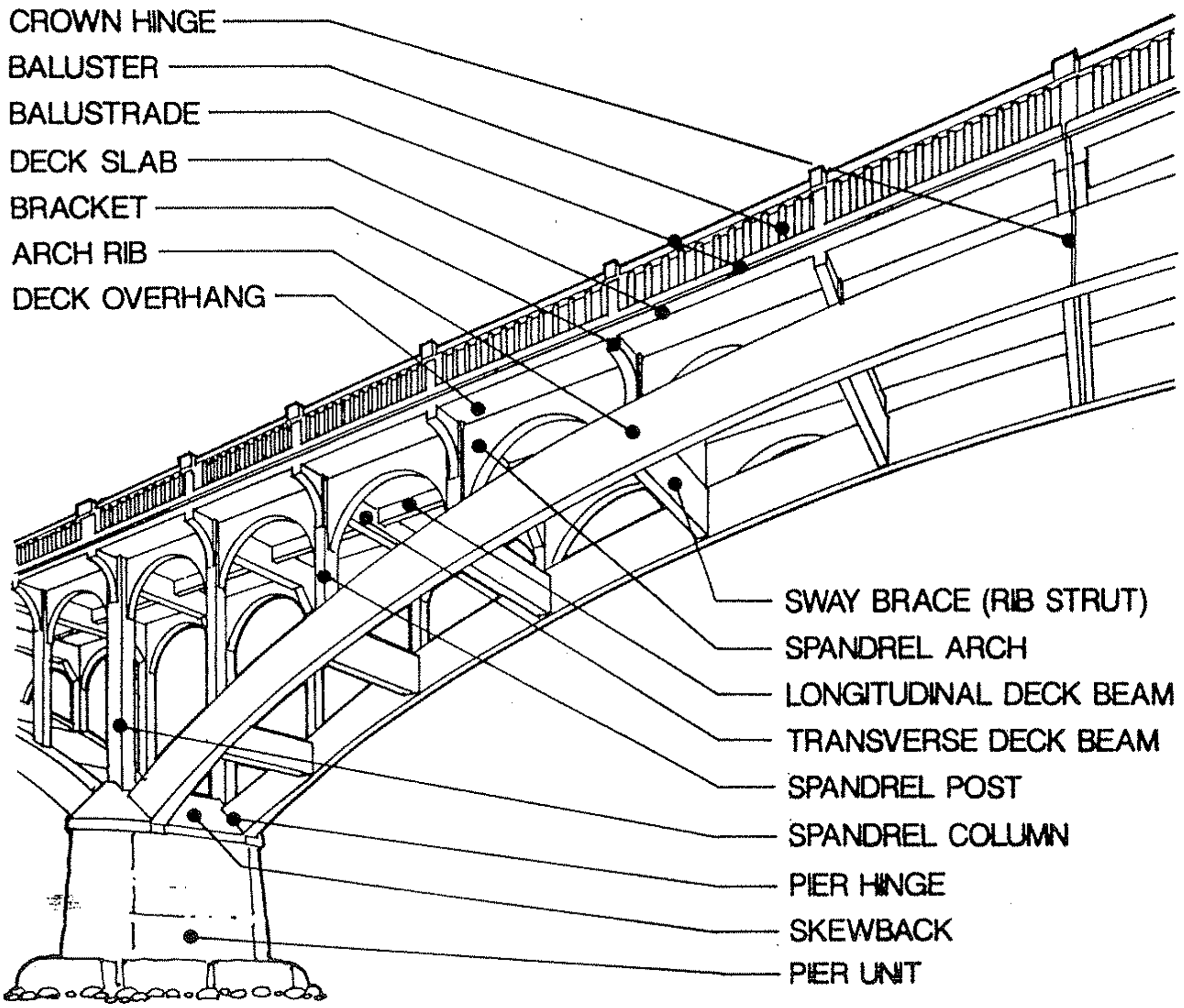


Figure 1. Identification of bridge components.

The main arch ribs consist of two variable-depth, cast-in-place concrete segments. The pier hinges are simple sheet-metal-lined pockets cast into the skewbacks on top of the piers that retain the rounded ends of the rib segments. The crown hinges, located at the centers of the arches, consist of a cast-iron (or cast-steel) spider-web plate cast into the upper ends of each of the arch segments and connected with an iron (or steel) pin (HAER photographs AZ-29-18 and AZ-29-40). At the main river channel, the roadway is approximately 48 feet above the dry stream bed.

The main arch ribs have a center-to-center transverse spacing of 12.66 feet and are tied to each other with sway braces, or rib struts, located at the spandrel posts. These braces were precast on the site, placed between the arch ribs, tightened with iron turnbuckles, and then sheathed in concrete to create solid members that connect the main arches on opposite sides of the bridge (HAER photograph AZ-29-19).

The deck slab overhangs the main arch ribs on both sides of the bridge. Each overhang terminates in a curb at the outer edge of the deck slab. The curbs, overhangs, and parapet balustrades are carried by brackets that are continuations of the transverse deck beams, which, as previously noted, are supported by the spandrel posts and spandrel columns (HAER photograph AZ-29-20).

The superstructure of the abutment spans is similar to that of the main spans except for the vertical spandrel columns. These columns are supported on a large footing with caissons to bedrock at the south abutment, and directly on bedrock at the north abutment (HAER photograph AZ-29-21).

All the pier units are massive, reinforced concrete shafts supported by various types of foundation combinations: Piers 1, 3, 5, 6, and 8 are supported on two six-foot-diameter excavated caissons spaced at thirteen feet on centers; Pier 2 is supported on two seven-foot by twenty-six-foot rectangular caissons spaced at thirteen feet on centers; Pier 4 is supported on six excavated caissons with a transverse spacing of thirteen feet and a longitudinal spacing of twenty feet; Pier 7 is supported on two four-foot by twenty-four-foot rectangular caissons spaced at thirteen feet on centers; Pier 9 is founded on six five-foot-diameter excavated caissons with thirteen-foot transverse and longitudinal spacings; and Pier 10 is supported directly on bedrock (HAER photograph AZ-29-22). Pier 9 was rebuilt in 1920, at which time the six caissons were installed (HAER photographs AZ-29-49 and AZ-29-50).

The parapet balustrades are three-feet high and run continuously for the length of the bridge on each side. The top rail is supported on four-inch-diameter precast balusters spaced at nine inches on centers, and on eight-inch by twelve-inch posts, one of which is located at each spandrel post and spandrel column (HAER photograph AZ-29-23).

Concrete lighting standards originally were located at intervals on top of both parapet railings. The standards at the extreme north and south ends of the bridge remain, although the electric lamp holders have disappeared. Remnants of the attachments of other posts are still apparent along the railing (HAER photograph AZ-29-24).

The north approach to the bridge has been largely obliterated; no pavement remains (HAER photograph AZ-29-25). The south approach remains in place, although the concrete pavement immediately adjacent to the bridge has been removed, and Ash Avenue has been relocated a short distance to the west. The approach is approximately the same width as the bridge, and the pavement terminates on each side in a concrete curb (HAER photograph AZ-29-26). A guardrail, as evidenced by remnants of concrete posts, was located on top of each curb. This feature was undoubtedly identical to the one seen in HAER photograph AZ-29-5.

PHYSICAL CONDITION OF BRIDGE PRIOR TO DEMOLITION

The Ash Avenue Bridge has undergone considerable distress, as evidenced by the numerous areas of cracking, spalling, and general deterioration of load-carrying members. Much of this distress appears to have occurred during the early life of the structure and before its abandonment in 1933. In general, the deterioration has been caused by settlement of the piers, vibration and impact loading from trucks, excessive traffic, and thermal forces.

Deck Surface

The asphalt wearing surface is in poor condition. It is severely cracked, weathered, and spalled in numerous locations.

Concrete Deck

Since the concrete deck is covered with an original asphalt wearing surface, only the bottom side of the deck is visible. In this surface there are numerous transverse cracks throughout the deck exhibiting water penetration and efflorescence. In several locations the cracks extend into the spandrel arches. Additionally, in several locations the underside of the deck slab is severely spalled and delaminated, exposing the reinforcing steel.

Expansion Joints

The joints in the deck, located over the piers and the crown hinges, have failed and the surrounding concrete is spalled and delaminated.

Parapet Balustrades

The balustrades are in poor condition, and many balusters and segments of the top railing are missing. The curbs under the balusters are severely spalled and the longitudinal reinforcing steel in the curbs is exposed in many locations. Although several concrete lighting fixture standards remain atop the balustrades, most are missing (HAER photograph AZ-29-27).

Spandrel Posts

The posts are in poor to failed condition; many are severely spalled, delaminated, and cracked vertically and horizontally. At some of the post locations only the exposed reinforcing steel remains in place, the concrete encasement having completely disappeared. Many of the posts were expeditiously repaired with gunite, which is now cracked, spalled, and delaminated (HAER photograph AZ-29-28).

Spandrel Columns

The spandrel columns exhibit minor spalling, many have horizontal cracks at their pier connections, and several have one or more vertical cracks. Additionally, some of the columns located at deck expansion joints have cracks near their tops.

Main Arch Ribs

The main arch ribs are in poor condition. Most exhibit severe cracking and some spalling at their crown hinges. Many of the ribs have longitudinal cracks parallel to the main reinforcing steel near the tops or the bottoms of the members. These cracks may be full width of the ribs, since some appear in the same position on both interior and exterior faces of the same rib.

Other ribs exhibit horizonal cracks, exposed and buckled reinforcing steel, and cracks perpendicular to the rib curvature that are continuous around the rib.

Field Sampling and Testing

Concrete core samples were taken from various locations in the structure and were tested in accordance with the American Society of Testing Materials (ASTM) Specification C-42. Typical results were:[46]

Location	Core Size	Compressive Strength
Deck slab, Span 6	2-inch	5,230 psi
Deck slab, Span 8	2-inch	3,657 psi
Spandrel arch, Span 5	2-inch	3,590 psi
Spandrel arch, Span 7	2-inch	3,020 psi
Main arch rib, Span 6	2-inch	3,540 psi
Main arch rib, Span 2	6-inch	2,115 psi
Pier shaft, Pier 6	2-inch	3,060 psi
Footing, Pier 9	2-inch	6,960 psi

Reinforcing steel specimens were taken from various deck locations and tested in accordance with ASTM procedures to determine strength characteristics. Typical results were:

Location	Yield Strength	Ultimate Strength
Span 2	50,000 psi	68,000 psi
Span 3	58,500 psi	79,000 psi
Span 4	72,500 psi	97,500 psi

Summary of Physical Condition

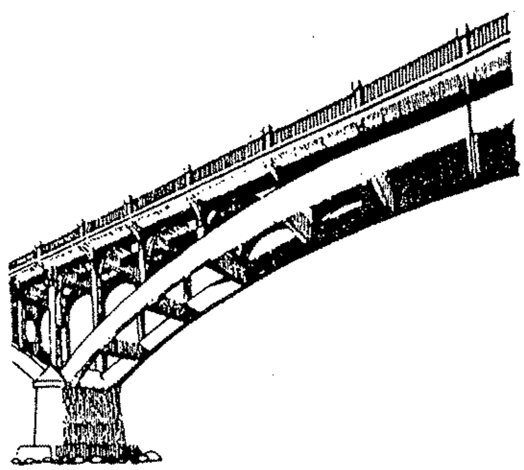
The bridge is in poor condition and numerous members have failed. No maintenance has been performed on the structure since 1933.

Field evaluation of the structure by Donohue & Associates, Inc., identified several design and construction deficiencies that are negatively affecting the structural capacity, serviceability, and functional aspects of the bridge. These deficiencies have resulted in an overstressed or failed condition in numerous principal members.

Bar development and lap lengths are inadequate to transfer the imposed loads at the connections between the spandrel posts and main arch ribs, thereby causing many of these joints to fail. Also, in the early years of the structure's life, excessive live-load deflections were documented. Considering the slenderness (depth, width, and length ratios) of principal load-carrying members, it can be suspected that deflections were always of a magnitude to cause concern.

Moreover, pier settlement in 1919 and 1920 significantly impacted the bridge, inducing numerous cracks in structural members. These cracks permitted rain and flood water to rust the reinforcing steel, causing the concrete to spall and delaminate during the following years.

Acting in concert, the bridge's design and construction deficiencies and weather-induced debilities were more than the audacious structure could sustain, leading to its untimely abandonment and ultimate removal. Nevertheless, the remaining south abutment of the old bridge gives recall to the era of experimentation in reinforced concrete construction at the turn of the century and memorializes the efforts and accomplishments of Arizona's pioneer engineers.



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1. Hayden Papers (Charles Trumbull Hayden), Hayden Library, Arizona State University, Tempe, Arizona.

2. Arizona Miner, Prescott, December 10, 1870.

3. "Sallie Davis Hayden--Thoroughbred Pioneer," unpublished manuscript, Hayden Papers, Hayden Library, Arizona State University, Tempe, Arizona.

4. Arizona Gazette, Phoenix, November 22, 1883.

5. Phoenix Herald, Phoenix, September 29, 1882.

6. Marsha L. Weisiger, This History of Tempe, Arizona 1871 - 1930, A Preliminary Report, unpublished manuscript, Arizona Collection, Arizona State University, Tempe, Arizona, 1977.

7. The Arizona Eastern was a successor to the Maricopa and Phoenix. It was a separately owned affiliate of the Southern Pacific until 1955, when the two lines merged under the Southern Pacific name. See David F. Myrick, Railroads of Arizona, Vol II: Phoenix and the Central Roads, San Diego: Howell-North Books (1980), for detailed information on early railroads in the area and the construction of the Maricopa and Phoenix.

8. Tempe News, October 25, 1907, located in clipping file at Tempe Historical Museum, Tempe, Arizona. A copy of the document is contained in the HAER field notes.

9. HAER No. AZ-18, Arizona Eastern Railroad Bridge, Written Historical and Descriptive Data, 12, Barbara Behan, 1990, Library of Congress, Washington, D. C.

10. Tempe News, April 3, 1908, located in clipping file at Tempe Historical Museum, Tempe, Arizona. A copy of the document is contained in the HAER field notes.

11. Tempe News, October 8, 1909, located in clipping file at Tempe Historical Museum, Tempe, Arizona. A copy of the document is contained in the HAER field notes.

12. The term "arch-rib" is used to designate a free-standing arch having a width much less than that of the bridge, usually in pairs, and supporting spandrel columns. The term "arch-ring" is

used to designate the arch proper without the spandrels, fill, or other elements, and is applied to arches that are the full width of the bridge. The term "spandrel" refers to the triangular space between the extrados curve of an arch and the enclosing right angle, or to the space between the extrados of two contiguous arches and the horizontal line (roadway) above them.

13. Engineer News, Vol. 67, no. 13 (March 28, 1912), 578. A copy of the document is contained in the HAER field notes.

14. Tucson Citizen, March 12, 1912.

15. Letter from Hunt to Dr. A. F. Maisch, dated June 30, 1912, Arizona Department of Library, Archives and Public Records, Phoenix, Arizona.

16. Arizona Republican, January 27, 1912, 2. A copy of the document is contained in the HAER field notes.

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19. Ibib., 158.

20. Arizona Republican, April 14, 1912. A copy of the document is contained in the HAER field notes.

21. Arizona Republican, June 23, 1911. A copy of the document is contained in the HAER field notes.

22. Arizona Republican, April 14, 1912. A copy of the document is contained in the HAER field notes.

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27. Engineering News-Record, (April 21, 1921), 675. A copy of the document is contained in the HAER field notes.

28. Ibid., 675-76.

29. Arizona Highways, (May 1925), 16. A copy of the document is contained in the HAER field notes.

30. Bridge Evaluation Study: Ash Avenue Bridge (Salt River Crossing), City of Tempe Project 876191B, Donohue & Associates, Inc., Engineers, May 4, 1990. A copy of the document is contained in the HAER field notes.

31. Letter from W. R. Bruesch, Bridge Operations Engineer-Manager, Structures Section, Arizona Department of Transportation, Highways Division to Steve L. Nielsen, Rio Salado Project Manager, City of Tempe, July 5, 1990. A copy of the document is contained in the HAER field notes.

32. The first bridge across the Salt River was constructed at Center Street (now Central Avenue) in Phoenix in about 1911. However, it was soon destroyed by a river flood.

33. Marjorie Haines Wilson, The Gubernatorial Career of George W. P. Hunt of Arizona, 113, unpublished manuscript, Arizona Collection, Arizona State University, Tempe, Arizona, September 1973.

34. Engineering Record, (August 13, 1910), 169. A copy of the document is contained in the HAER field notes.

35. For additional information on J. B. Girand see Who's Who in Arizona, vol. I, 1913, 779-81, compiled and published by Jo Conners, copy available at Arizona Room, Main Branch, Phoenix Public Library, Phoenix, Arizona. A copy of the document is contained in the HAER field notes.

36. Both Girand's and Hasse's names appear on the plans for the completed bridge. These plan sheets have various dates from "9-11-11" to "12-2-11." Two additional plan sheets relate to minor superstructure modifications. One dated Feb. 6, 1913, is marked "Drawn by C.E.H. & S.M.C."; and the other dated March 6, 1913, is marked "Drawn by T.F.N. & S.M.C." "C.E.H." is Carl E. Hasse, "S.M.C." is unknown, and "T.F.N." is Thomas F. Nichols. For additional information on Nichols see <u>Arizona Prehistoric--Aboriginal--Pioneer--Modern: The Nation's Youngest Commonwealth Within A Land Of Ancient Culture--Biographical</u>, 131, Vol. III, Chicago: The S. J. Clarke Publishing Co., 1916. A copy of the document is contained in the HAER field notes.

37. J. A. L. Waddell, <u>Bridge Engineering</u>, 940, Vol. 1, London: John Wiley and Sons, 1916.

38. Martin Hayden, <u>The Book of Bridges, The history technology and romance of bridges and their builders</u>, 134, New York City: Galahad Books, 1976.

39. Stephen D. Mikesell, historian, California Department of Transportation, Sacramento, in a telephone conversation with Gerald A. Doyle on August 16, 1990.

40. <u>Southwest Contractor and Manufacturer</u>, May 7, 1910. A copy of the document is contained in the HAER field notes.

41. See Endnote 39.

42. For more information on Waddell see Endnote 37.

43. Conversation between Dale F. Schaub, P.E., project engineer for the evaluation of the Ash Avenue Bridge, and Alan Charmatz, P.E., bridge engineer for the City of Pasadena, California, on August 17, 1990.

44. David Plowden, <u>Bridges: The Spans of North America</u>, New York: Viking Press, 1974.

45. Walter H. Wheeler, "Long Concrete-Arch Road Bridge Over Minnesota River," unknown publication. A copy of the document is contained in the HAER field notes.

46. <u>Bridge Evaluation Study: Ash Avenue Bridge (Salt River Crossing)</u>, City of Tempe Project 876191B, Donohue & Associates, Inc., Engineers, May 4, 1990, 12. A copy of the document is contained in the HAER field notes.

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EXHIBIT 192

QUANTITY OF UNDERGROUND WATER.

THE UNDERFLOW.

WATER ENTERING THE VALLEY.

In order to secure a measure of the water entering the valley fill as underflow, it would be necessary to measure all streams, both permanent and intermittent, as well as the occasional waters entering as sheet wash from the surrounding hills. It would be necessary, furthermore, to measure the quantity of surface water escaping from the valley. The greater part of the supply is from Salt River and the total quantity entering from this source is known from the records of the gaging stations on Salt and Verde rivers. The amount taken from the river by the canals is known, but the loss from the valley during times of flood is unknown on account of the want of a gaging station at the outlet of the valley. It is, therefore, obviously impossible to arrive in this way at even an approximate measure of the water entering the underflow. Other methods must be resorted to in order to obtain a quantitative estimate.

RETURN WATER.

The Tempe canal diverts all the surface water of the river north of Mesa. Near Tempe the underground water returns to the surface, making a flow of about 35 second-feet. West of Phoenix the underground water again returns to the surface. It is not possible at present, however, to state what proportion of the seepage water comes from Salt River, since its underflow joins that from Gila River. It is probable, however, as previously stated, that the underflow of the Gila is fed in large measure by the waters from Salt River passing as underflow east of Salt River Mountains. In Gila Valley west of Florence all the waters diverted from the river, except during occasional floods, are seepage waters. The flow in the Gila channel and in the Indian ditches at Gila Crossing was 800 inches when measured on August 17, 1902. Mr. M. M. Murphy estimated the water diverted by the Indian ditches east of the junction of Gila and Salt rivers in January, 1903, as 500 inches, leaving 1,000 inches in the river. The smaller canals of Salt River, between Tempe and the Buckeye, divert water as follows:

Water received by canals west of Phoenix, Ariz.

[Information furnished by M. M. Murphy.]

Canal.	June, 1902.	June, 1903.
	Inches.	*Inches.*
Leon	265	None.
Peninsula	35	234
Lambeye	74	138
Meridian	153	180
Indian	82	72
Total	609	624

The winter flow is about double the above. Available summer flow at the head of St. Johns canal is 400 inches.

Maximum winter flow (not flood) at St. Johns is 800 inches.

Indian ditches on the lower Gila take a minimum of 400 inches.

The amount taken by the Salt River and Maricopa canals—joint head—for June, 1903, averaged 1,344 inches. This is slightly more than usual.

The amount diverted by the Buckeye canal is given by Mr. W. A. Apgar, as follows:

Flow in Buckeye canal.

	Second-feet.
July, 1902	78
July, 1902[a]	80
May 14, 1903	129
May 23, 1903	133
May 24, 1903	128

Davis[b] says:

The amount of seepage water was measured by Mr. Cyrus C. Babb in June, 1896, and the results showed in one case an increase of over 80 second-feet in a distance of 7 miles.

Code[c] states that "the return flow picked up by the head of the Maricopa and Salt River canals in ordinary years is found to approximate 60 cubic feet per second. This flow has naturally decreased during the past summer owing to the scanty irrigations received by the Mesa, Utah, and Tempe lands above, and to the gradual lowering of the underground supply." He states further that—

at the head of the Buckeye canal, some 24 miles farther down the stream, is again found a volume approximating in ordinary summers 150 cubic feet per second. * * * Some 20 miles below the Buckeye, I am told, another flow of approximately 50 cubic feet per second is to be picked up.

[a] A few days later.

[b] Davis, A. P., Irrigation near Phoenix, Ariz.: Water-Sup. and Irr. Paper No. 2, U. S. Geol. Survey, 1897, p. 43.

[c] Code, W. H., Irrigation in Salt River Valley, in Report of irrigation investigations for 1900, No. 2: U. S. Dept. Agric., Bull. 104, 1901, p. 103.

According to Code's estimate the return water is 210 second-feet, whereas the estimate given above is only 150.

There is no time for which measurements are available for all the canals diverting seepage water. The amount, however, of the seepage water does not vary to any great extent. The average amount, then, according to the best measurements and estimates available is something over 150 second-feet, making a total of more than 100,000 acre-feet per year.

If Code's estimate be accepted the return water east of the Buckeye canal is something over 150,000 acre-feet per year. A small part of this is return water from irrigated lands, but the greater part is from the natural underground flow. A considerable but undetermined part of it is from the Gila underflow, but the greater part is from Salt River.

The seepage waters estimated at 100,000 acre-feet per year are only those returning to the surface east of the Buckeye canal, and take no account of a large quantity of return water diverted by the several canals farther down the river. Furthermore no account is taken of the quantity passing as underflow through the gravels at the lower end of the valley, at the Buckeye head-gates. The 100,000 acre-feet is a measure of the spill from the top of the underflow—water which the valley fill for some reason is unable to hold. The total volume of underflow is therefore something greater than 100,000 acre-feet per year.

MEASURING THE UNDERFLOW.

SLICHTER'S METHOD.

The most elaborate and scientific method of arriving at a quantitative estimate of the underground waters of the valley is obtained from the application of Slichter's[a] method. On account of the great importance of arriving at as accurate an understanding as possible of the underflow and its probable volume, I quote from this paper such portions as apply to the principles and methods of procedure. After a discussion of the principles relating to the movement of underground waters, Professor Slichter proceeds:

Formula.—The formula which the writer has devised for determining the flow of water through a column of sand is as follows:

$$q = 0.2012 \frac{pd^2s}{\mu hK} \text{ cubic feet per minute.} \quad (3)$$

In this formula q stands for the quantity of water transmitted by the column of sand in one minute; p is the difference in pressure at the ends of the columns, or the head under which the flow takes place, measured in feet of water; s is the area of the cross section of the sand column, measured in square feet; h is the length of

[a] Slichter, Charles S., The motions of underground waters: Water-Sup. and Irr. Paper No. 67, U. S. Geol. Survey, 1902, pp. 24-30.

EXHIBIT 193

NPS Form 10-900-b
(Jan. 1987)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Multiple Property Documentation Form

This form is for use in documenting multiple property groups relating to one or several historic contexts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. For additional space use continuation sheets (Form 10-900-a). Type all entries.

A. Name of Multiple Property Listing

Vehicular Bridges in Arizona

B. Associated Historic Contexts

Vehicular Transportation in Arizona, 1863-1940

C. Geographical Data

The State of Arizona

☐ See continuation sheet

D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards for Planning and Evaluation.

Signature of certifying official   Date

State or Federal agency and bureau

I, hereby, certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper of the National Register   Date

E. Statement of Historic Contexts

Discuss each historic context listed in Section B.

Bridges, as integral elements of a developing transportation network, have played a pivotal part in the spanning of America. Generally the most sophisticated components of any overland transportation system, from the early primitive territorial roads to transcontinental highways, they are also the most prominent. Bridges serve not only as gauges of technological advancement in design and construction, but as singular indicators of the tenets, values and ambitions of the people who erected them. This is particularly true for Arizona, a state in which overland transportation forms a central historical theme. From the earliest wooden spans on the territorial toll roads to the later steel trusses and concrete arches, bridges have facilitated - and in some instances, created - settlement across the state.

Whether spanning rivers, creeks, draws, arroyos or canyons, bridges have functioned similarly since the first log was thrown across a stream, with differences only in dimensions and capacity. Beyond this, however, the idea soon unravels, as a variety of forms to achieve that function has sprung up through centuries of empirical usage. Bridge types are generally classified by material stone, timber, concrete, iron/steel. The inherent strengths and weaknesses of each tends to dictate its form and usage, as does availability of materials. By the time the country was undergoing initial settlement, most of the principal bridge types and materials had been used or at least experimented with. What remained over the last two centuries has been a process of refinement - a vast refinement to be sure - revolving principally around the introduction and proliferation of structural metals and concrete as building materials.

As recent as America is in terms of bridge development, Arizona is younger still. In the 1840s, when most of the major trusses were invented, Arizona was not even under United States control. When the rest of the country was experiencing what was probably the greatest period of roadway bridge construction in the 1880s and 1890s, Arizona was not a member of the union. When Daniel Luten patented his arch in 1900, Arizona Territory had built only a handful of permanent crossings. And by the time Arizona was admitted as a state in 1912, frankly little was left to develop in bridge technology. Despite this, a number of outstanding bridges have been constructed on Arizona's roads and highways. Fortunately, most of the best of them have survived.

Between 1848, when the Arizona territory was acquired from Mexico by the treaty of Guadalupe, to the Federal Organic Act of February 24, 1863, which designated the Territory after its separation from New Mexico, Arizona was crossed by only two main overland routes. Both traversed the state east-west. Known as the Gila Trail because it largely paralleled the Gila River, the southern route was popular for those rushing to California for gold. The northern route, known as Beale's Road, was used almost entirely by hunters and trappers and the military traveling to California. Other secondary routes - no more than trails, really - developed intermittently by usage, with maintenance, such as it was, performed by users as needed.

After formation in 1863, the Arizona Territorial Assembly immediately recognized the need for transportation routes to connect the widely scattered settlements and foster economic growth. Money for road construction was scarce, however. In 1864, the First Territorial Assembly did what government bodies have traditionally done when short of funds themselves: it authorized others to build roads. Privately held toll companies were given the authority and exclusive right to build and administer toll roads and collect fees based upon predetermined schedules. To raise capital for construction, they were allowed to issue stock, and to protect their sometimes considerable investments, the

[X] See continuation sheet

companies were granted franchises for definite periods of time. In return for these exclusive rights, the territorial auditor collected part of the gross proceeds from each road.

The acts of incorporation for the toll companies were similarly structured and contained the same general provisions: the roads were to be completed and a specified amount spent on their improvement within a designated period. Water wells were to be dug and maintained at intervals along the roads and facilities provided for use by both men and animals. The roads were to be kept safe and passable. And finally, exclusive rights to maintain the roads and collect tolls would be granted as long as they did not encroach on other existing toll roads. Toll rates were generally set on a per-mile basis, depending on the mode of transportation. As a free-market function, they varied from road to road, but usually reflected the road's use, location and difficulty of construction.

The law did little to encourage excellence in construction, and the toll road operators tried to avoid bridge construction as unnecessarily expensive. The few bridges that were built rarely lasted beyond the statutory limits of the franchise. Often poorly constructed and unevenly maintained, these crude structures typically washed out in floods or collapsed under load. Only two such toll road structures from the territorial period **[8150; 8151]** are known to exist still in Arizona. Both were built in 1907 in Graham (now Greenlee) County on the Clifton-Solomonville Road. They are unusual in that they were built as grade separations over railroads (the earliest datable overpasses in Arizona), they were constructed using substantial concrete arch construction, and they were built relatively late in the toll road milieu.

In a region in which government revenues were minimal, toll roads were regarded as a necessary evil: an expedient way to develop a much-needed roadway system. At the same time the First Territorial Assembly recognized the need for free highways to promote transportation and settlement. The assembly tried to legislate a balance between roads built by private capital and supported by tolls and those over which no tolls could be extracted. To prevent toll operators from monopolizing transportation by incorporating every road, the lawmakers designated several existing roads, developed solely by previous use, as free routes. This formed the basis for a free-highway network in Arizona, upon which subsequent legislatures would expand. Succeeding sessions of the territorial legislature incorporated toll road companies, while simultaneously declaring other existing roads as toll-free.

Road construction and administration were largely county-level functions in America at this time, and Arizona's territory-level management soon proved burdensome. The legislators began to transfer this responsibility to the counties in 1866 by authorizing the boards of supervisors to divide their counties into road districts and appoint overseers to supervise roads in each district. To fund road construction and maintenance, the counties were empowered to issue bonds and levy road taxes. In 1871 the Assembly further transferred road administration to the counties by giving them the right to incorporate toll road proprietors. The requirements for incorporation were generally the same as those for the territory, and the counties retained the option to purchase the privately built roads after five years, based upon the value established by five independent appraisers. With this, the county administrators possessed all the tools needed to pursue active road and bridge programs. They rarely used them well. Seldom following a premeditated plan, county supervisors would authorize the surveying and clearing of roads and construction of bridges as needed, usually in response to urgent local petitions. In the sparsely populated areas outside of the major cities, however, with minimal government revenues, relatively few vehicular bridges were erected before the turn of the century, and none is known to remain today.

Many of the earliest county bridges, like those on the toll roads, tended more to the flimsy than the substantial. Some consisted of little more than two parallel boards laid across a streambed to carry vehicles' tires. Often made up of timber stringer spans on timber or crude concrete abutments and piers, these questionable structures failed with distressing regularity. Only a handful proved more substantial. In 1885 Pinal County built what was perhaps the first vehicular truss in Arizona and probably the longest county bridge - over the Gila River at Florence. Completed in November, the bridge consisted of two 180' Pratt spans, with 719' of timber trestle over an island and slough. The bridge consumed 30 tons of iron, 174,375' of lumber and cost $14,280. Navajo County built a single-span Pratt through truss to carry the Winslow-Holbrook Highway over Chevelon Creek and another bridge to carry the road over Clear Creek. The county also built a truss over the Little Colorado River at Holbrook. Greenlee County built a four-span Pratt through truss over the Gila River at Duncan. One of these earliest county trusses is still known to remain: the Solomonville Bridge over the San Simon River in Graham County. Built in 1909 by the El Paso Bridge and Iron Company, it consisted of a single Pratt pony truss supported by steel cylinder piers.

The Territorial Legislature during this period made only minimal impact on vehicular transportation in Arizona other than to authorize toll road companies and enact laws passing the responsibility to the counties. The legislature issued road bonds totaling $70,000 between 1871 and 1881, and $15,000 in 1885. In 1905, the legislature appropriated funds for the repair of the Florence Bridge. But other than these tentative steps, the territory contributed little to road and bridge construction. Indeed, no territorial organization or staff had even been established to administer roads.

After the turn of the century it had become apparent that many major road and bridge projects were beyond the capacity of the counties. Further, the county supervisors were building roads on an individual basis, without regard to the roads in adjacent counties. This tended to create an uneven patchwork of dissimilar routes, making travel difficult for all but a few destinations. To take a more active role in the development of intrastate highways, the Territorial Assembly on March 18, 1909, established a road tax and created the office of the Territorial Engineer. A political appointment made by the governor, the position carried a two year term and functioned under the supervision of the Board of Control. J.B. Girand was the first and only Territorial Engineer. His entire staff consisted of a clerk and a draftsman.

Immediately after his appointment, Girand began to plan and build several territorial highways in Arizona. The strategy was to link the county seats and more populous towns through a network of graded, but unpaved, roads that varied in width from 16' to 24' according to terrain and projected traffic loads. In connection with this highway work, Girand supervised the construction of a handful of important bridges over key crossings on the territorial network. Curiously, none of these bridges resembled each other even remotely.

One of the first bridges that Girand undertook was a replacement structure for the truss at Florence. In September 1909 Girand designed a 700' multiple-span concrete girder structure. He submitted the plans and specifications to the Board of Control in November, and advertised for competitive bids. Five contractors responded, but Girand rejected all bids and recommended to the board that the Florence Bridge be built using prison labor. With a territorial prison nearby in Florence, the idea had merit. The board agreed. In March 1910 a prison force of 14 men began the preliminary excavation for the foundations. The crew averaged 55 men as full-scale construction proceeded through the year; the Florence Bridge was completed in December.

What was perhaps the most unusual territorial bridge was not located on a territorial highway at all, but was built on a remote military road to Fort Apache. Since its construction by the army in 1899, the Rice-Fort Apache road road forded the Black River southwest of the fort. In 1911, however, the Arizona Territorial Legislature funded the construction of a wagon bridge over the Black. Designed by Girand in December, the 214' Black River Bridge **[3128]** featured two timber/iron Howe deck trusses, carried high above the river by tapered concrete piers. (The trusses were replaced in 1929, but the original piers carry the new superstructure.) Girand built three other major structures - a three-span, pin-connected truss over the Verde River at Camp Verde, and 60' concrete arch between Bisbee and Douglas and a 100' timber trestle over Forest Wash - and numerous 10'-16'-span concrete slabs built from standard plans.

Without question, the most spectacular, expensive and important of the territorial bridges was the multi-span concrete structure over the Salt River in Tempe. For this, Girand originally delineated a nine-span, filled spandrel concrete arch structure with a total length of 1225', estimating its cost at $80,000. He later changed the design to eleven spans of two-rib open-spandrel arches, and in February 1911 the plans were submitted to the Board of Control for approval. To build the immense structure, Girand recruited laborers from the territorial prison at Florence - 25 men when construction began in June and up to 57 men during the course of the project. A total of 250 prisoners worked on the bridge between 1911 and 1913. In September 1913, the Tempe Bridge was opened and immediately carried the heaviest traffic of Arizona's highway spans. Total cost: $118,919.

By the time Arizona was admitted to the Union on February 14, 1912, the territory had constructed over 243 miles of highway at an average cost of $2500 per mile. Additionally, 1812 linear feet of bridges over 100' in length had been built, totaling $144,000 in value. Girand estimated that an additional 740 miles of trails and county roads would soon be improved to form highways, "completing the great east and west and the north and south roads." Thus, preliminary surveys and construction had been undertaken on over 1000 miles of highways, broken down as follows (asterisks indicate completed projects):

*Prescott - Phoenix	131.5 miles	*Bisbee - Tombstone	24.0 miles
*Globe - Roosevelt	90.0 miles	*Glendale - Mesa	24.0 miles
Phoenix - Yuma	201.6 miles	*Flagstaff - Camp Verde	75.0 miles
Globe - San Carlos	32.0 miles	Dewey - Camp Verde	45.0 miles
San Carlos - Clifton	114.3 miles	*Florence - Tucson	66.0 miles
San Carlos - Douglas	170.8 miles	Bisbee - Tucson	106.2 miles
*Bisbee - Douglas	23.3 miles		

On June 20, 1912, the new state legislature passed enabling legislation for the state engineer's office. Like the territorial law, the state act authorized property taxes, sufficient to raise $250,000 annually, to fund the road and bridge programs. To augment these revenues, the legislature passed the first of a series of acts providing for the licensing and governing of motor vehicles the following year. Road and bridge construction continued as before using the same administrative process. In fact, several road and bridge projects begun under Girand's administration - including the Tempe Bridge - were taken over by State Engineer Lamar Cobb without interruption. The major difference lay in the level of activity. Less than $200,000 were spent on road and bridge construction through the territory in the year that Girand took office. Six years later in 1915 over $500,000 were spent by the counties alone.

Under direction of Cobb and his successors, B.M. Atwood, Thomas Maddock and W.C. Lefebvre, the state engineer's office pursued an aggressive policy of road and bridge construction during the 1910s and 1920s. This corresponded with the dramatic increase of instate vehicular traffic, and was especially spurred by the rapid influx of overland tourist trade. The 1910s marked the initiation of a number of transcontinental highways across the country and several regional highways in the West, spawned by the nationwide Good Roads movement. Arizona was traversed east-west by two such routes, as Beale's Road in the northern part of the state evolved into the Old Trails Highway and the Gila Trail through the southern part became the Ocean-to-Ocean Highway.

As the workload and bureaucracy grew, the state engineers themselves became less often involved directly with bridge design and construction. Instead, they depended on bridge engineers and the growing staff of the bridge department. Arizona's first bridge engineer, R.V. Leeson, was retained on a consulting basis in 1917. In addition to his design responsibilities in Arizona, Leeson functioned as the Assistant Chief Engineer for the Topeka Bridge and Iron Company and even consulted independently on at least two county bridges **[8441; 8442]** in the state. Leeson's most noteworthy commission as consulting engineer for Arizona was the Gila River Bridge [8152] in Greenlee County. By 1920, the state had hired Merrill Butler as the first permanent staff bridge engineer. Butler was later succeeded by Ralph Hoffman, who served with distinction for several years. When the design responsibilities proved too much for a single engineer in the mid-1920s, Hoffman in turn hired ex-bridge contractor L.C. Lashmet as his designing engineer.

Several of Arizona's most important vehicular bridges date from this early state period. The Chevelon Creek Bridge [8158] and the Jack's Canyon Bridge were two of the earliest state-built structures, built in Navajo County on the Santa Fe Highway. The Santa Cruz Bridge [8166] was an outstanding multiple-span concrete girder completed in 1917 on the Nogales-Patagonia Highway. Built in 1923, the Allentown [3073] and Sanders [3074] bridges formed important crossings of the Rio Puerco on the Santa Fe Highway, and the Hell Canyon and Little Hell Canyon bridges carried the Prescott-Ash Fork Highway. The Antelope Hill Bridge, completed in 1915 using prison labor, carried the Ocean-to-Ocean Highway over the Gila River in Yuma County.

The State of Arizona during the 1910s and 1920s had taken a far more active role in road and bridge construction than the territory had ever done. But the amount of work still needed to complete Arizona's highway network was staggering. Using their 75% of the State Road Fund and adding considerable amounts from county road funds, the counties were still doing the lion's share of road work. Many of the bridges in use today on secondary roads in Arizona were funded and contracted for by the individual counties as part of their bridge construction programs. Unlike the state engineer, the counties rarely had the in-house facilities to design major bridges and could not tap the sizable labor pool in the state's prisons. Counties, therefore, had to hire bridge contractors for all but the smallest of roadway spans.

For a county contemplating construction of a major vehicular bridge, the decision was a serious one. Strapped for funds, as most perennially were, counties could usually afford no more than a handful - and often only one - major span per fiscal year. Costing several thousand dollars each, the bridges soon depleted road and bridge budgets. Counties frequently issued bonds of indebtedness when they lacked the cash. Or they simply delayed bridge projects because all of the available funds for the year had been expended.

The decision to build a bridge usually would be made in the late spring or summer, after flooded rivers and creeks washed away existing spans, or in late fall, when riverbeds were dry and foundations and falsework could be constructed economically. Usually, for all but the shortest spans, the supervisors would direct the county clerk or surveyor to advertise for competitive bids, often giving only the location and span length of the proposed bridge, and require the contractors to submit their own designs. For those counties with a population base to support a staff engineer, the designs were produced in-house - often by copying those of others - and full plans and specifications issued to competing bridge firms. After solicitation and receipt of proposals, the construction contract was then awarded to the "lowest and best" bidder.

A typical solicitation for bids in the local newspapers and engineering journals would be answered by a few local or regional bridge contractors. Steel for trusses and girders was produced typically in the major foundries - Carnegie, Lackawanna, Cambria, Inland - of the Pennsylvania and Illinois mill towns. The foundries supplied rolled steel parts to bridge fabricators such as Hansell-Elcock or the American Bridge Company of Chicago, the Omaha Structural Steel Works of Nebraska, Minneapolis Steel and Machinery Company of Minnesota, the Midwest Steel and Iron Works of Denver or the Phoenix-based Allison Steel Company. These companies in turn marketed complete, prefabricated trusses to bridge firms that would build the superstructures and assemble them on-site.

Because the government entities of Arizona contracted for so few steel bridges, no indigenous steel bridge company of note ever developed. Those few local firms such as S.T. Clark of Bisbee that occasionally built steel trusses were far more dependent on other forms of contracting. The counties relied heavily upon out-of-state contractors for both design and construction, and virtually all of the major contracted steel bridges in the state were erected by out-of-state firms. Among the out-of-state bridge companies active in Arizona were: the El Paso Bridge and Iron Company (Walnut Grove Bridge **[8227]**, Solomonville Bridge); Midland Bridge Company (Allentown Bridge **[3073]**, Desert Wash Bridge **[8116]**, Hereford Bridge **[9214]**, Cameron Bridge); Monarch Engineering Company of Denver (Sanders Bridge **[3074]**, Little Hell Canyon Bridge); Missouri Valley Bridge and Iron Company (Chevelon Creek Bridge **[8158]**, Fish Creek Bridge **[0027]**, Lewis and Pranty Creek Bridge **[0028]**); James J. Burke of Salt Lake City (Sand Hollow Wash Bridge **[8662]**); Levy Construction Company of Denver (Holbrook Bridge **[0048]**, Dome Bridge); Kansas City Structural Steel Company (Navajo Bridge **[0051]**, Topock Bridge); and the Omaha Structural Steel Works of Nebraska (Saint Joseph Bridge **[8157]**, Yuma Bridge **[8533]**).

Given Arizona's proximity to southern California, it is surprising that almost all of the contract work went to companies from the South and Midwest. Although California firms occasionally submitted proposals, only one major bridge - the Winslow Bridge **[8156]**, built in 1915-16 by Los Angeles-based Mesmer and Rice - was built by a California company. And it was composed of trusses manufactured by the American Bridge Company.

But what Arizona lacked in steel bridges, it more than compensated for in concrete structures. Concrete technology was generally more rudimentary than steel. Material distribution was more decentralized, and the designs were almost all supplied by the counties. As a result, the state supported a large number of small-scale concrete bridge contractors.

On July 11, 1916, Congress passed the Federal Aid Road Act, also known as the Bankhead Act, which would radically alter the complexion of road and bridge construction in Arizona. The law directed the Secretary of Agriculture to distribute highway construction funds and cooperate with the various state highway departments in the planning, construction and maintenance of rural post roads in each state. To administer the provisions of the Act and disburse the funds, the U.S. Bureau of Public Roads [BPR] was formed as an agency under the Department of Agriculture.

On March 8, 1917, the Arizona State Legislature assented to the provisions of the Bankhead Act. The State Engineer, with the approval of the State Board of Control, was empowered to enter into agreements with the BPR. Arizona's share of the federal aid fund amounted to $3.7 million - or about 1.4% of the $75 million total - distributed over a five-year period. Despite promises by the state legislature and state engineer, the highway department soon encountered difficulties in matching the increasing federal allotments. The infusion of such large amounts of capital funds was welcome, but federal aid created a number of logistical problems. Immediately before passage of the Act, the agency had been organized to handle $1 million of construction and maintenance work annually, under the direction of the State Engineer. Federal Aid quadrupled this capacity and added several new layers of bureaucracy to the process. The paperwork increased accordingly. The Bureau of Public Roads established more stringent bridge and highway guidelines and required more detailed planning, surveying and engineering for federal aid projects.

State Engineer Thomas Maddock was further stymied by the $10,000 per mile limitation on highway funding. Arizona's rugged terrain, especially in the mountains east of Superior where a major highway had been planned, would require far more expensive construction for roadbuilding. To help alleviate the problem, he sought considerable cooperation of the county supervisors in planning and funding projects. He even urged them to issue bonds of indebtedness to commit money for future projects. Subsequently, twelve of Arizona's fourteen counties voted bond issues, totaling $15 million (Maricopa issued $8.5 million; Graham and Gila counties were the holdouts).

For better or worse, the changes brought by federal aid transformed the state's road and bridge construction mechanism, as the state engineer's office grew into the Arizona Highway Department. By the end of 1920, AHD employed more personnel than all other state agencies combined. The department's total allocation of funds that year exceeded the total expenditures of every state, county, city, school and road district in the state combined for 1914. AHD was the largest employer of engineers in the state. The department's maintenance and construction vehicles constituted Arizona's largest truck fleet. It purchased more supplies for its various construction camps than all other state institutions combined. The department was Arizona's largest consumer of explosives. And following a change in state law in January 1919 that allowed the highway department to contract for road construction, AHD constituted the largest contracting entity in the state.

Federal Aid Project No. 1, appropriately enough, involved construction on the Florence Bridge. One of the earliest county bridges and one of the first bridges built by Arizona Territory, it needed extensive repairs in 1917. Unlike the Florence Bridge, most of the bridges built on the state highway system were small-scale concrete drainage structures, laid over dry washes or intermittent streams. For these, the bridge department of AHD used standard designs taken from BPR specifications. Most of the drainage structures were contracted for under the umbrella contracts of the adjacent road construction. A few of the bridges, however, were of sufficient scale to warrant individual contracts.

The Arizona Highway Department and the individual counties and municipalities accounted for the overwhelming majority of bridges in the state, but a third entity (or group of entities, actually) was active in bridge work as well. The federal government, through its various agencies, has built several spans associated with highway programs. Coming from a variety of bureaucratic sources and circumstances, these bridges display a wide technological range, some of which were as esoteric as they were dramatic. The bridges themselves are remarkable enough, but what was perhaps even more remarkable was the fact that they were built at all. Virtually every major bridge built by the federal government in Arizona required individual Congressional approval.

Three of the state's oldest bridges were built by the government in connection with one of the Bureau of Reclamation's (BOR) first projects. In passing the Newlands Act in 1902, Congress authorized the construction of the Tonto Dam on the Salt River northeast of Phoenix. Before work could begin, though, an access road had to be graded from the railhead at Mesa to the damsite. BOR engineers routed the road alongside the ancient Apache Trail on its serpentine route through the rugged mountains. Grading began in 1903. The road, including the Alchesay Canyon Bridge **[1532]**, a small concrete arch, was completed in March 1905. Construction on the dam began immediately, proceeding despite several setbacks between 1906 and 1910 under Hill's supervision. A 16' roadway crossed the dam crest, and over the giant spillways that flanked the dam on both sides, BOR engineers designed medium-span, segmental concrete arches. Arch centering for the North and South Spillway bridges **[3000; 3001]** was built as one of the last pieces of the work completed before the structure's dedication on March 18, 1911, as the Theodore Roosevelt Dam.

With much of Arizona set aside for Indian reservations, the Indian agencies were active in bridge construction in the state. Earliest of these structures was the Cameron Bridge over the Little Colorado River. Built in 1911 to provide access to Flagstaff from the Navajo and Hopi Reservations, the 680' suspension bridge is both historically and technologically significant. Two years after completion of the Cameron Bridge, Congress approved legislation for a wagon bridge across the Gila River on the San Carlos Reservation. Completed in 1913, the multi-span San Carlos Bridge **[9474; 3228]** carried traffic until the south approach washed away in a 1915 flood, rendering it impassable. Never known for an expeditious manner, the U.S. Indian Service waited until February 1921 to reopen the bridge by erecting four new through trusses.

Two of Arizona's most significant spans were initiated by the Indian Office and funded in tripartite agreements with Arizona and California. Congress in 1913 approved a steel bridge over the Colorado River at Yuma. Ostensibly to provide a crossing for the Yuma Indian Reservation across the river, the bridge also carried the Ocean-to-Ocean Highway as the only bridged crossing of the Colorado for some 600 miles. The Yuma bridge was completed in March 1915. As the contractors were building the Yuma Bridge in 1914, the Indian Office solicited help from Arizona and California to erect another major span over the Colorado at Topock. This bridge would carry the Old Trails Highway, Arizona's other transcontinental route. An extraordinarily graceful span, the Topock Bridge was at the time of its completion in 1916, the lightest and longest three-hinged steel arch in America.

Another outstanding bridge built by the Indian Office was notable for its multiplicity of spans rather than its technological daring. Congress in May 1916 authorized the San Carlos Irrigation Project in Pinal County. A major component of the project involved construction of a diversion dam on the Gila River near the Indian village of Sacaton. A multi-span concrete bridge would carry vehicular traffic over the dam. Exceeded in total length by only Antelope Hill Bridge and the Tempe Bridge, the 25-span Sacaton Dam Bridge **[3165]** was completed using largely Indian labor in 1925.

These major bridges were all special projects, steered through Congress by Arizona Congressman Carl Hayden and Senator Marcus Smith and built under atypical circumstances. To build the hundreds of smaller scale drainage structures on federal roads, the Bureau of Public Roads was a more suitable agency. The Bureau was active directly in Arizona in building numerous roads and bridges through the Indian reservations, national forests and national parks and monuments. Functioning much like AHD in bridge design and contracting, BPR developed minor drainage structures from standard designs and contracted for them as parts of overall road grading and drainage projects. Larger and more technologically ambitious bridges were designed individually (but still often using standard designs) by engineers in the BPR's San Francisco, Denver or Phoenix offices and contracted for on an individual basis. Several important BPR bridges can still be found in Arizona: the Salt River Bridge **[0037]**, a long-span steel truss built in 1919-20 in the Tonto and Crook National Forest; the Rio Puerco Bridge **[3010]**, a handsomely arched steel deck girder built in 1931-32 in the Petrified Forest National Monument; the Dead Indian Canyon Bridge **[0032]**, a deck-truss trestle built in 1933-34 on the NavaHopi Highway to Grand Canyon National Park; the Pumphouse Wash **[0079]**, Oak Creek **[0128]** and Midgley **[0232]** bridges on the Oak Creek Canyon Road through the Coconino National Forest; and the Walnut Canyon Bridge **[9225]** in the Prescott National Forest.

Each government entity had structural configurations that it relied upon principally. Counties tended to erect steel trusses because they could obtain the engineering free or at nominal cost as part of the bridge solicitation. The federal agencies built bridges of all types, reflective of their non-central administration and individual policies. And the state engineer depended heavily on reinforced concrete for a wide range of bridge applications. Concrete had a number of advantages in Arizona. First, a properly constructed concrete bridge was rightly considered more substantial than a steel or wood structure. Concrete was more flood-resistant and more stable under load. Short concrete spans could be built using standard plans, allowing a minimal staff of engineers to design a disproportionately large number of structures. Unlike steel, which had a centralized system of manufacturing and marketing, concrete could be manufactured locally, using local materials. Finally, concrete technology was more rudimentary than steel, allowing the state to bid bridge projects to local contractors or build bridges using unskilled crews of convicts or day laborers.

The earliest concrete structures featured relatively modest spans - either simple slab or slab-and-girder - used singly or in multiples. These served well for minor dry wash crossings or for crossings of rivers with exceedingly wide flood plains. When the state engineer began planning bridges for intermediate watercourses and rugged canyons, however, it became immediately evident that long-span structures were needed. Long spans in concrete at that time meant arches. For these earliest structures, State Engineer Lamar Cobb turned to the engineering of America's pre-eminent arch builder, Daniel Luten.

Arizona's first association with Luten occurred in 1913. That year, Cobb surveyed a bridge site over Canyon Padre, a rock-walled chasm on the Santa Fe Trail. Cobb's office in July advertised for competitive proposals and designs for a 136' span. The Topeka Bridge and Iron Company, western representative of Luten's National Bridge Company, was awarded the construction contract for $7900. For the crossing, Luten designed a 140' Luten, or horseshoe, arch with a cantilevered roadway. Construction began in September and was completed in April 1914.

A few months after the Canyon Padre Bridge was completed, Cobb contacted with Topeka for another long-span Luten arch on the Old Trails Highway. This bridge would span rugged Canyon Diablo just west of Two Guns, some eleven miles east of Canyon Padre. In 1914, Cobb selected and surveyed the site over the canyon and purchased plans and specifications from Topeka for $500. Although the drawings were submitted by Topeka, Luten himself engineered the 128' arch from his office in Indiana. Like the Canyon Padre Bridge, the Canyon Diablo arch featured a cantilevered roadway with reinforced concrete brackets and parapet walls. Late in 1914, Cobb's office let the construction contract to the lowest bidder, Thomas Maddock of Williams, Arizona, for $9000. Using concrete and reinforcing steel supplied by the state, Maddock built the Canyon Diablo Bridge that winter. It was opened to traffic in March 1915. This was soon followed by a third Luten arch: over the Little Colorado River near Holbrook. Completed in March 1916 for a cost of almost $19,000, the Holbrook Bridge was the state's longest concrete arch.

Thomas Maddock, contractor for the Canyon Diablo Bridge, succeeded Lamar Cobb as State Engineer in 1917. Like Cobb, Maddock soon enlisted the help of the Topeka Bridge and Iron Company for a major highway span: the Gila River Bridge **[8152]** near Clifton. First designed in 1917 as a single-span steel arch, then a concrete arch, the bridge was built by convict labor the next year as a two-span Luten arch. Succeeding state engineers contracted for a handful of other Luten arches around the state, but almost all have since been razed. One Topeka-built arch that remains is the Queen Creek Bridge **[8440]**, completed in May 1919 as part of the Mesa-Superior Highway in Pinal County.

Because Luten arches used proprietary designs, which were protected vigorously by Daniel Luten and his staff of attorneys, they were perceived as more expensive than other highway bridge types. For this reason, they were rarely built by Arizona's individual counties or municipalities. Two notable exceptions were the Kelvin **[8441]** and Winkelman **[8442]** bridges, constructed in 1916-17 under a single contract between Topeka Bridge and Iron Company and Pinal County. Actually, given their scale and technology, the Winkelman and Kelvin structures proved to be bargains, compared with other similar spans. Costing almost $22,000, the 419' four-span Winkelman Bridge cost almost a third of the 288' two-span Gila River Luten arch **[8152]** and only slightly more than the 190' one-span Holbrook arch, completed earlier that same year. These figures are even more remarkable given that the Winkelman Bridge was founded on driven timber piles, a more expensive construction technique than the spread footings of the Holbrook Bridge. The Winkelman and Kelvin bridges cost about as much as the four-span through truss built near Winslow by Navajo County in 1916-17 **[8156]** and almost half as much as the Santa Cruz Bridge #1 **[8166]**, a 457' concrete girder built in 1916 near Nogales.

No government entities in Arizona pinched pennies more than the cities and towns, and the only municipality in the state to use Luten's design was the Town of Miami. In December 1919, Town Engineer Thomas ordered a set of plans and specifications from the Topeka Bridge and Iron Company for a shallow 50' arch to span Bloody Tanks Wash in the center of town. The following May, the town purchased 3500 barrels of cement and began construction of the Keystone Avenue Bridge **[8588]** with force-account labor, using Luten's design. The project proceeded so successfully that Thomas soon began a bridge on Cordova Avenue **[8586]** using the same design. In 1921, identical bridges were completed over the channel on Reppy **[8585]**, Inspiration **[8587]** and Miami **[8589]** Avenues. The Miami bridges marked the only short-span application of the Luten arch design in the state.

In an experimental move to provide an alternative to the Luten arch for long-span applications, the AHD bridge department in 1919-20 designed three almost identical open-spandrel concrete arches. The Cienega Bridge **[8293]** - a long-span arch with a concrete girder viaduct over a branch of the Southern Pacific Railroad - was to be built on the Borderland Highway in Pima County. The other bridges were located over Queen Creek in Pinal County and Hell Canyon in Yavapai County. The design of the Hell Canyon Bridge was later changed to a multi-span concrete girder, but the other two structures were constructed as drawn in 1920-21. The bridges proved expensive and difficult to erect, however, and AHD shelved the design. The Mill Avenue Bridge in Tempe **[0083]** would be the only other open-spandrel arch designed by AHD.

The Arizona state engineer's office used Luten and open-spandrel arches for long spans, but for short- to medium-span concrete arches the bridge engineers developed a another standard design. This arch featured a filled spandrel, with cantilevered roadway and reinforcing clustered in a manner noticeably similar to Luten's patent. The major difference between the Luten arch and what AHD termed as its "common arch" was the arch profile. Luten's bridges were distinguished by the hallmark horseshoe shape. AHD's common arches were more truly elliptical. The oldest AHD common arch remaining in the state is the Devil's Canyon Bridge, a 65' span located on the Miami-Superior Highway in Pinal County. Built in 1921-22, this handsomely proportioned bridge featured a moderate barrel rise, a roadway which cantilevered over the arches on both sides, a corbeled arch ring and paneled parapets with steel pipe guardrails. The Devil's Canyon Bridge was followed soon by other AHD single-span common arches, including the Lynx Creek Bridge **[8256]** (built 1922; 91' span), the Verde River Bridge **[8236]** (built 1922-23; 100' span) and the Fossil Creek Bridge **[3215]** (built 1924-25; 70' span).

Although the concrete bridges built by the state engineer's office were demonstrably stronger and more durable and stable under load than their steel truss counterparts, many soon displayed a dangerous and expensive weakness. The superstructures could carry traffic well enough. The piers in the multi-span bridges, however, were often founded on spread footings poorly placed on alluvial sand or shallow bedrock. To exacerbate this, the engineers made little or no provision to prevent scouring at the piers' bases. For rivers which dwindled to a trickle in most seasons, this type of substructure served adequately. But during flash floods, the water quickly undermined the piers and approaches. As a result, the bridges collapsed in whole or part when the piers toppled over.

One of the most notorious of these early structures was the Antelope Hill Bridge over the Gila River. Ceremoniously opened to traffic on August 18, 1915, after several construction delays, this starcrossed structure began to fail almost immediately. In January 1916, floodwaters quickly washed away almost two miles of approach grading and widened the river's channel at the north end of the bridge by approximately 300'. To correct this, the Arizona State Legislature in March 1917 appropriated $50,000 to build an extension onto the north end. The new construction consisted of five additional 65' concrete girder spans and an extensive timber trestle approach. Completed in autumn 1918, the bridge carried traffic more-or-less as intended until a flood a week after Thanksgiving, 1919, destroyed some 500' of the north approach and shifted some of the concrete piers on the extension.

Further flooding three months later dropped about 300' more of trestle, the north abutment and the northernmost girder. Worse, the flood caused several of the piers on the extension, already damaged by the previous flood, to sink further and shift downstream. Within two years, the highway department had rerouted the road to bypass the Antelope Hill crossing entirely; the bridge was replaced in 1929 with the Dome suspension bridge. Virtually all of the other multi-span concrete crossings built in the state in the 1910s proved problematical. The Florence Bridge over the Gila River required extensive repairs to its approaches after almost every major flood. Similarly, the San Carlos Bridge over the Gila, built by the U.S. Indian Service in 1913, was impassable for five of its first seven years until the erection of four through trusses on one end. AHD bridge engineers were forced to post a 2-ton restriction and undertake major repairs on the Tempe Bridge after it experienced pier settlement and superstructural cracking after flooding in 1919-20.

Significantly, most of these bridges spanned the Gila River. Outlet for several other rivers and subject to extremely violent fluctuations in stream flow at any time of the year, the Gila proved almost as difficult for bridge engineers in Arizona as did the larger Colorado. In fact, among the early multiple-span concrete bridges over the Gila, only the Sacaton Dam Bridge **[3165]** managed to survive without major damage. This was due in large part because the bridge was situated over a diversion dam, which blunted the force of the river at this point.

Ironically, when the Arizona Highway Department sought to bridge the Gila River for the Ocean-to-Ocean Highway in the early 1920s, the bridge engineers opted for a steel truss instead of a multi-span concrete bridge. But even this enlightenment came relatively late in the design process. AHD began planning for a bridge for the highway in western Maricopa County even before Oklahoman Frank Gillespie built his dam over the Gila in 1921. Despite the problems with other multi-span concrete bridges over the Gila, AHD bridge engineers initially planned a series of concrete girders for this crossing, too. After reconsideration in 1925, they hired a consulting engineer to help design and locate the structure. At the consultant's advice, AHD scrapped the girder design in favor of a series of steel through trusses with a concrete deck. The trusses were supported by solid concrete piers, set as deep as 45' below the riverbed on the compact caliche hardpan. The Gillespie Dam Bridge **[8021]**, completed in July 1927, did not experience the pier and approach failures of its predecessors.

Upon its completion in July 1927, the Gillespie Dam Bridge was notable as the longest steel highway bridge in Arizona. A list of the five longest vehicular structures in the state in 1926 indicates the tremendous impact that the Gila River had on bridge construction. Four of the five spanned the Gila, and the fifth - the Tempe Bridge over the Salt River - spanned a tributary of the Gila near the two rivers' confluence. The bridges are:

Antelope Hill Bridge	1765'	(extant; abandoned and deteriorated)
Gillespie Dam Bridge	1660'	(extant; in off-system service)
Tempe Bridge	1508'	(extant; abandoned)
Sacaton Bridge	1486'	(extant; in off-system service)
Florence Bridge	1430'	(demolished)

The Gila prompted long bridges, but it was the Colorado that historically has presented the most formidable barrier to bridge construction. The Yuma and Topock bridges, completed in 1915 and 1916, had proved exceedingly expensive and difficult to erect, even on relatively flat sites. This was due to the unpredictable nature of the Colorado River, and its propensity to flood at odd times. When the Arizona Highway Department sought to bridge the river a third time in the 1920s, the problem of flooding on the river was eclipsed by the bridge site's great height and remoteness. In 1923, AHD began planning for a bridge over the Grand Canyon near Lee's Ferry. AHD engineers originally considered a suspension bridge like the Cameron Bridge, then a through arch like the Topock Bridge, but eventually AHD Bridge Engineer R.A. Hoffman designed a long-span steel deck arch. With funding provided by the State of Arizona and the Navajo Tribal Fund, AHD contracted with the Kansas City Structural Steel Company in June 1927 to fabricate and erect the arch. The contractors combated severe logistical problems to build the immense structure and by the following April had set the concrete foundations into the sheer canyon walls. The first steel was swung on April 16, 1928, the main span completed on June 14, 1929.

Completion of the Navajo Bridge **[0051]** marked a culmination of sorts for highway bridge engineering in Arizona. The Arizona Highway Department would design a few other exotic bridges - most notable of which was the Dome Bridge, a 798'-span suspension bridge over the Gila River in Yuma County - but by and large the experimentation with different structural types that had marked the 1910s and early 1920s had given way to design standardization. The only structural type of note with which AHD continued to experiment was the steel arch. The Navajo Bridge was the only spandrel-braced arch undertaken by AHD. (The Bureau of Public Roads did erect one spandrel-braced arch: the Midgley Bridge **[0232]** in Coconino County). But the bridge department soon turned to another arch configuration: the girder-ribbed deck arch, made up of five or more riveted plate girders. Completed in 1934, the Salt River Canyon Bridge **[0129]** in Gila County was AHD's first girder-ribbed arch. It was soon followed by three other such arches: the Cedar Canyon **[0215]**, Corduroy Creek **[0216]** and Canyon Padre bridges. The end of the 1930s generally meant the end of truss construction in Arizona. Although a few trusses and arches have been built since, more modern concrete and steel beam designs, well illustrated by the multi-span Winslow Bridge **[0229]**, have received greater use. As county roads have been widened and paved and state roads superseded by interstate highways, the make-up of Arizona's road systems have changed. But enough significant bridges have survived to form a tangible record of history.

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HABS/HAER INVENTORY

See "HABS/HAER Inventory Guidelines" before filling out this card.

1. NAME(S) OF STRUCTURE
Tempe Bridge (Ash Avenue Bridge; Salt River Bridge)

2. LOCATION
Abandoned highway over Salt River
Tempe; SW1/4 S15 T1N R4E
Maricopa County, Arizona

3. DATE(S) OF CONSTRUCTION
1911-13

4. USE (ORIGINAL/CURRENT)
highway bridge / abandoned

5. RATING
NRHP eligible: state significance

6. CONDITION
fair / deteriorated

owner: City of Tempe, Arizona

7. DESCRIPTION

span number : 11
span length : 125.0'
total length: 1507.7'
roadway wdt.: 18.0'

superstructure: reinforced concrete, two-rib three-hinge open spandrel deck arch
substructure : concrete abutments and piers set on 6' diameter steel cylinders
floor/decking : asphalt over concrete deck
other features: moulded concrete guardrails w/ round concrete balusters and paneled bulkheads

8. HISTORICAL DATA

One of the first bridges undertaken by Territorial Engineer J.B. Girand was a major span over the Salt River on the Phoenix-Tempe Highway. Girand's office originally delineated a 9-span, filled spandrel arch structure with a total length of 1225', estimating its cost at almost $80,000. His assistant Carl Hasse later changed the design to 11 spans of 2-rib open-spandrel arches, and on February 24, 1911, the plans were submitted to the Board of Control. To build the immense structure, Girand recruited laborers from the territorial prison at Florence - 25 men when construction began in June and up to 57 men during the course of the project. A total of 250 prisoners worked on the bridge between 1911 and 1913. In September 1913, the Tempe Bridge was opened and immediately carried heavy traffic. Total cost: $118,919. The bridge functioned as the only crossing of the Salt River in the city until its replacement in 1931 by another multi-span concrete arch: the Mill Avenue Bridge. The Tempe Bridge now stands abandoned in deteriorating condition.

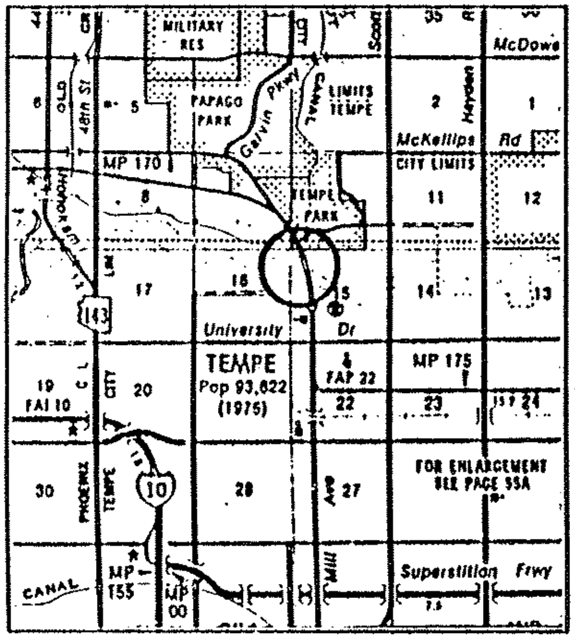
9. SIGNIFICANCE

As only the second major concrete structure designed by the territorial engineer (the first: Florence Bridge over Gila River), the Tempe Bridge provided an all-weather crossing of the Salt River to connect Phoenix with the eastern part of the state. Additionally, the bridge formed a pivotal link on the north-south territorial highway then under construction. Until the completion of the Mill Avenue Bridge, it formed the only permanent crossing of the Salt near Phoenix. The Tempe Bridge is one of the few structures remaining in the state which had been built using prison labor (others: Clifton Bridge, Antelope Hill Bridge). It is technologically important as the first open-spandrel arch built in Arizona and one of the longest and earlist vehiclar bridges in the state. As one of the most technologically and historically significant bridges in Arizona - one of a handful of vehicular spans from the territorial period - the Tempe Bridge is an important remnant of early road construction.

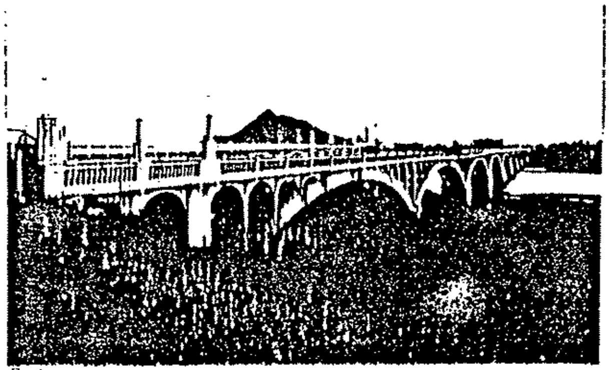
10. NAME(S) OF STRUCTURE

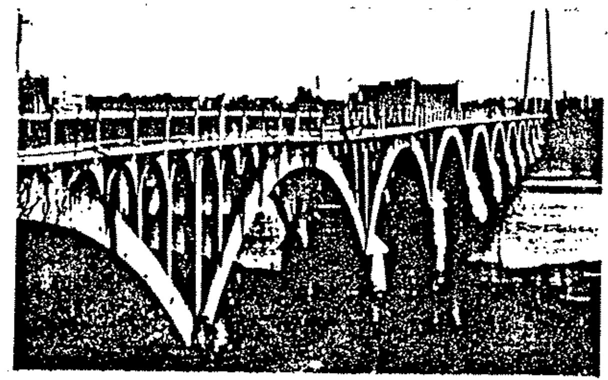
Tempe Bridge (Ash Avenue Bridge; Salt River Bridge)

11. PHOTOS (W/ FILM ROLL & FRAME NO.) AND SKETCH MAP OF LOCATION



LOCATION MAP
TAKEN FROM DEPARTMENT OF TRANSPORTATION
GENERAL HIGHWAY MAP





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Field inspection by Clayton B. Fraser, 25 March 1987.

13. INVENTORIED BY:	AFFILIATION	DATE
Clayton B. Fraser	Fraserdesign Loveland Colorado	1 April 1987

EXHIBIT 194

March 3, 1899.

CHAP. 425.—An Act Making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

Appropriations for rivers and harbors.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, to be immediately available, and to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers, for the construction, completion, repair, and preservation of the public works hereinafter named:

Moosabec Bar, Me.

Improving Moosabec Bar, Maine: Completing improvement, eleven thousand dollars.

Breakwater, Mount Desert, Me.

For construction of breakwater from Mount Desert to Porcupine Island, Maine: Continuing improvement, twenty thousand dollars.

Harbors. Sullivan Falls, Me.

Improving harbor at Sullivan Falls, Maine, in accordance with the approved project, five thousand dollars.

Vinalhaven, Me.

Improving Carvers Harbor, at Vinalhaven, Maine: Continuing improvement, fifteen thousand dollars.

Cape Porpoise, Me.

Proviso. Contracts.

Improving harbor at Cape Porpoise, Maine, in accordance with the report printed in House Document Number One hundred and sixty, Fifty-fifth Congress, third session, seventy thousand dollars: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to complete the project recommended in said report, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate fifty-five thousand dollars, exclusive of the amount herein appropriated.

Little Harbor, N. H.

Improving harbor of refuge at Little Harbor, New Hampshire: Continuing improvement, twelve thousand dollars.

Burlington, Vt.

Improving harbor at Burlington, Vermont: Continuing improvement, fifteen thousand dollars.

Boston, Mass.

Provisos. —Great Head, etc.

Chelsea Creek.

Contracts.

Channel from ship channel, President Roads, etc.

Improving harbor at Boston, Massachusetts: Continuing improvement, seventy-five thousand dollars: *Provided*, That this sum may, in the discretion of the Secretary of War, be used in the preservation and improvement of said harbor, including the protection of Great Head and other headlands and islands in and about said harbor, to prevent further washing away by the sea: *Provided further*, That five thousand dollars of this sum may, in the discretion of the Secretary of War, be used in improving Chelsea Creek: *Provided further*, That the Secretary of War may use five thousand dollars thereof and enter into a contract or contracts for such materials and work as may be necessary for the completion of the improvement in accordance with the project recommended in the report printed on pages eight hundred and eighty-seven et sequentes of the Report of the Chief of Engineers for eighteen hundred and ninety-eight; such improvement to provide for a channel one thousand two hundred feet wide and thirty feet deep from the main ship channel in President Roads through Broad Sound Channel, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate four hundred and fifty thousand dollars, exclusive of the amount herein and heretofore appropriated.

Nantucket, Mass.

Improving harbor of refuge at Nantucket, Massachusetts: Continuing improvement, twenty thousand dollars.

Newburyport, Mass.

Proviso. —removing "North Rock."

Improving harbor at Newburyport, Massachusetts: Continuing improvement, twenty-five thousand dollars: *Provided*, That of this appropriation a sum not exceeding three thousand dollars may, in the discretion of the Secretary of War, be expended in removing from Newburyport Harbor, a rock, called "North Rock."

Plymouth, Mass.

Improving harbor at Plymouth, Massachusetts: For maintenance, ten thousand dollars; for repairs made necessary by the great storm of November, eighteen hundred and ninety-eight, according to plans and estimate submitted January twentieth, eighteen hundred and ninety-nine, seventy-five thousand dollars.

Provincetown, Mass.

Improving harbor at Provincetown, Massachusetts: For maintenance, ten thousand dollars.

until funds for the commencement of the proposed work shall have been actually appropriated by law.

Isthmus of Panama. Investigation of, for construction of canal.

SEC. 3. That the President of the United States of America be and he is hereby authorized and empowered to make full and complete investigation of the Isthmus of Panama with a view to the construction of a canal by the United States across the same to connect the Atlantic and Pacific oceans; That the President is authorized to make investigation of any and all practicable routes for a canal across said Isthmus of Panama, and particularly to investigate the two routes known respectively as the Nicaraguan route and the Panama route, with a view to determining the most practicable and feasible route for such canal together with the proximate and probable cost of constructing a canal at each of two or more of said routes: And the President is further authorized to investigate and ascertain what rights, privileges and franchises if any may be held and owned by any corporations, associations or individuals, and what work, if any, has been done by such corporations, associations or individuals in the construction of a canal at either or any of said routes, and particularly at the so-called Nicaraguan and Panama routes respectively; and likewise to ascertain the cost of purchasing all of the rights, privileges and franchises held and owned by any such corporations, associations and individuals in any and all of such routes, particularly the said Nicaraguan route and the said Panama route; and likewise to ascertain the probable or proximate cost of constructing a suitable harbor at each of the termini of said canal, with the probable annual cost of maintenance of said harbors respectively. And generally the President is authorized to make such full and complete investigation as to determine the most feasible and practicable route across said Isthmus for a canal, together with the cost of constructing the same and placing the same under the control, management and ownership of the United States.

Nicaraguan and Panama routes.

Existing franchises.

—cost of purchasing.

Cost of harbors at termini.

Engineers.

SEC. 4. To enable the President to make the investigations and ascertainments herein provided for, he is hereby authorized to employ in said service any of the engineers of the United States army at his discretion, and, likewise to employ any engineers in civil life, at his discretion, and any other persons necessary to make such investigation, and to fix the compensation of any and all of such engineers and other persons.

Appropriation for expenses.

SEC. 5. For the purpose of defraying the expenses necessary to be incurred in making the investigations herein provided for, there is hereby appropriated out of any money in the Treasury not otherwise appropriated, the sum of one million dollars, or so much thereof as may be necessary, to be disbursed by order of the President.

Report.

SEC. 6. That the President is hereby requested to report to Congress the results of such investigations, together with his recommendations in the premises.

Report of Chief of Engineers to show deterioration in works, etc.

SEC. 7. That the Secretary of War shall cause the Chief of Engineers of the United States Army, in submitting his annual reports to Congress with regard to works of river and harbor improvement under his charge, to state what deterioration, if any, has taken place by destruction, decay, obstructions, or otherwise, in connection with any of such works, together with an estimate of the cost of rebuilding, or repairing such works, or removing such obstructions; and he shall also cause the said Chief of Engineers to recommend, with his reasons therefor, the discontinuance of appropriations for any river and harbor work which he may deem unworthy of further improvement.

Report of Government piers, etc., occupied by private corporations.

SEC. 8. That the Secretary of War is directed to cause to be prepared and reported to Congress a list of all piers, wharves, and other structures or property pertaining to river and harbor works belonging to the Government of the United States now occupied by private corporations or persons, together with the terms upon which such piers, wharves, or other property are occupied, and the date of the agreement or permission granting the privilege to occupy the same, and shall make such recommendations as he may deem desirable in connection therewith.

Congress to authorize construction of bridges over navigable waters.

—approval of plans.

Sec. 9. That it shall not be lawful to construct or commence the construction of any bridge, dam, dike, or causeway over or in any port, roadstead, haven, harbor, canal, navigable river, or other navigable water of the United States until the consent of Congress to the building of such structures shall have been obtained and until the plans for the same shall have been submitted to and approved by the Chief of Engineers and by the Secretary of War: *Provided*, That such structures may be built under authority of the legislature of a State across rivers and other waterways the navigable portions of which lie wholly within the limits of a single State, provided the location and plans thereof are submitted to and approved by the Chief of Engineers and by the Secretary of War before construction is commenced: *And provided further*, That when plans for any bridge or other structure have been approved by the Chief of Engineers and by the Secretary of War, it shall not be lawful to deviate from such plans either before or after completion of the structure unless the modification of said plans has previously been submitted to and received the approval of the Chief of Engineers and of the Secretary of War.

Provisos.

Legislatures to authorize on waters wholly within State.

Deviation from plans.

No obstruction to navigation not authorized.

Works outside harbor lines forbidden.

Sec. 10. That the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is hereby prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of War; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same.

Excavations, alterations, etc., in channels only where authorized.

Establishment of harbor lines.

Sec. 11. That where it is made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of harbors he may, and is hereby, authorized to cause such lines to be established, beyond which no piers, wharves, bulkheads, or other works shall be extended or deposits made, except under such regulations as may be prescribed from time to time by him: *Provided*, That whenever the Secretary of War grants to any person or persons permission to extend piers, wharves, bulkheads, or other works, or to make deposits in any tidal harbor or river of the United States beyond any harbor lines established under authority of the United States, he shall cause to be ascertained the amount of tide water displaced by any such structure or by any such deposits, and he shall, if he deem it necessary, require the parties to whom the permission is given to make compensation for such displacement either by excavating in some part of the harbor, including tide-water channels between high and low water mark, to such an extent as to create a basin for as much tide water as may be displaced by such structure or by such deposits, or in any other mode that may be satisfactory to him.

Proviso.

Compensation for tide water displaced.

Penalties: removal of structures.

Sec. 12. That every person and every corporation that shall violate any of the provisions of sections nine, ten, and eleven of this Act, or any rule or regulation made by the Secretary of War in pursuance of the provisions of the said section fourteen, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding twenty-five hundred dollars nor less than five hundred dollars, or by imprisonment (in the case of a natural person) not exceeding one year, or by both such punishments, in the discretion of the court.

And further, the removal of any structures or parts of structures erected in violation of the provisions of the said sections may be enforced by the injunction of any circuit court exercising jurisdiction in any district in which such structures may exist, and proper proceedings to this end may be instituted under the direction of the Attorney-General of the United States.

Depositing refuse in navigable waters forbidden.

Sec. 13. That it shall not be lawful to throw, discharge, or deposit, or cause, suffer, or procure to be thrown, discharged, or deposited either from or out of any ship, barge, or other floating craft of any kind, or from the shore, wharf, manufacturing establishment, or mill of any kind, any refuse matter of any kind or description whatever other than that flowing from streets and sewers and passing therefrom in a liquid state, into any navigable water of the United States, or into any tributary of any navigable water from which the same shall float or be washed into such navigable water; and it shall not be lawful to deposit, or cause, suffer, or procure to be deposited material of any kind in any place on the bank of any navigable water, or on the bank of any tributary of any navigable water, where the same shall be liable to be washed into such navigable water, either by ordinary or high tides, or by storms or floods, or otherwise, whereby navigation shall or may be impeded or obstructed: *Provided*, That nothing herein contained shall extend to, apply to, or prohibit the operations in connection with the improvement of navigable waters or construction of public works, considered necessary and proper by the United States officers supervising such improvement or public work: *And provided further*, That the Secretary of War, whenever in the judgment of the Chief of Engineers anchorage and navigation will not be injured thereby, may permit the deposit of any material above mentioned in navigable waters, within limits to be defined and under conditions to be prescribed by him, provided application is made to him prior to depositing such material; and whenever any permit is so granted the conditions thereof shall be strictly complied with, and any violation thereof shall be unlawful.

Provisos.
—not applicable to public works.
—permits for depositing in defined limits.

Using, etc., wharves, levees, etc., forbidden.

Sec. 14. That it shall not be lawful for any person or persons to take possession of or make use of for any purpose, or build upon, alter, deface, destroy, move, injure, obstruct by fastening vessels thereto or otherwise, or in any manner whatever impair the usefulness of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States, or any piece of plant, floating or otherwise, used in the construction of such work under the control of the United States, in whole or in part, for the preservation and improvement of any of its navigable waters or to prevent floods, or as boundary marks, tide gauges, surveying stations, buoys, or other established marks, nor remove for ballast or other purposes any stone or other material composing such works: *Provided*, That the Secretary of War may, on the recommendation of the Chief of Engineers, grant permission for the temporary occupation or use of any of the aforementioned public works when in his judgment such occupation or use will not be injurious to the public interest.

Proviso.
—permits for temporary use.

Obstructions by anchoring vessels.
—sunken vessels, timber, etc.
—duties of owner of sunken vessel.

Sec. 15. That it shall not be lawful to tie up or anchor vessels or other craft in navigable channels in such a manner as to prevent or obstruct the passage of other vessels or craft; or to voluntarily or carelessly sink, or permit or cause to be sunk, vessels or other craft in navigable channels; or to float loose timber and logs, or to float what is known as sack rafts of timber and logs in streams or channels actually navigated by steamboats in such manner as to obstruct, impede, or endanger navigation. And whenever a vessel, raft, or other craft is wrecked and sunk in a navigable channel, accidentally or otherwise, it shall be the duty of the owner of such sunken craft to immediately mark it with a buoy or beacon during the day and a lighted lantern at night, and to maintain such marks until the sunken craft is removed or abandoned, and the neglect or failure of the said owner so to do shall be unlawful; and it shall be the duty of the owner of such sunken craft to commence the immediate removal of the same, and prosecute such removal diligently, and failure to do so shall be considered as an abandonment of such craft, and subject the same to removal by the United States as hereinafter provided for.

Penalties.

SEC. 16. That every person and every corporation that shall violate, or that shall knowingly aid, abet, authorize, or instigate a violation of the provisions of sections thirteen, fourteen, and fifteen of this Act shall be guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding twenty-five hundred dollars nor less than five hundred dollars, or by imprisonment (in the case of a natural person) for not less than thirty days nor more than one year, or by both such fine and imprisonment, in the discretion of the court, one-half of said fine to be paid to the person or persons giving information which shall lead to conviction. And any and every master, pilot, and engineer, or person or persons acting in such capacity, respectively, on board of any boat or vessel who shall knowingly engage in towing any scow, boat, or vessel loaded with any material specified in section thirteen of this Act to any point or place of deposit or discharge in any harbor or navigable water, elsewhere than within the limits defined and permitted by the Secretary of War, or who shall willfully injure or destroy any work of the United States contemplated in section fourteen of this Act, or who shall willfully obstruct the channel of any waterway in the manner contemplated in section fifteen of this Act, shall be deemed guilty of a violation of this Act, and shall upon conviction be punished as hereinbefore provided in this section, and shall also have his license revoked or suspended for a term to be fixed by the judge before whom tried and convicted. And any boat, vessel, scow, raft, or other craft used or employed in violating any of the provisions of sections thirteen, fourteen, and fifteen of this Act shall be liable for the pecuniary penalties specified in this section, and in addition thereto for the amount of the damages done by said boat, vessel, scow, raft, or other craft, which latter sum shall be placed to the credit of the appropriation for the improvement of the harbor or waterway in which the damage occurred, and said boat, vessel, scow, raft, or other craft may be proceeded against summarily by way of libel in any district court of the United States having jurisdiction thereof.

Legal proceedings, by whom conducted, etc.

SEC. 17. That the Department of Justice shall conduct the legal proceedings necessary to enforce the foregoing provisions of sections nine to sixteen, inclusive, of this Act; and it shall be the duty of district attorneys of the United States to vigorously prosecute all offenders against the same whenever requested to do so by the Secretary of War or by any of the officials hereinafter designated, and it shall furthermore be the duty of said district attorneys to report to the Attorney-General of the United States the action taken by him against offenders so reported, and a transcript of such reports shall be transmitted to the Secretary of War by the Attorney-General; and for the better enforcement of the said provisions and to facilitate the detection and bringing to punishment of such offenders, the officers and agents of the United States in charge of river and harbor improvements, and the assistant engineers and inspectors employed under them by authority of the Secretary of War, and the United States collectors of customs and other revenue officers, shall have power and authority to swear out process and to arrest and take into custody, with or without process, any person or persons who may commit any of the acts or offenses prohibited by the aforesaid sections of this Act, or who may violate any of the provisions of the same: *Provided*, That no person shall be arrested without process for any offense not committed in the presence of some one of the aforesaid officials: *And provided further*, That whenever any arrest is made under the provisions of this Act, the person so arrested shall be brought forthwith before a commissioner, judge, or court of the United States for examination of the offenses alleged against him; and such commissioner, judge, or court shall proceed in respect thereto as authorized by law in case of crimes against the United States.

Power to arrest granted certain officials.

Provisos.
—offense to be committed in presence of.
—examination of prisoner.

Obstruction to navigation by bridges.

SEC. 18. That whenever the Secretary of War shall have good reason to believe that any railroad or other bridge now constructed, or which may hereafter be constructed, over any of the navigable waterways of the United States is an unreasonable obstruction to the free navigation of such waters on account of insufficient height, width of span, or otherwise, or where there is difficulty in passing the draw opening or the draw span of such bridge by rafts, steamboats, or other water craft, it shall be the duty of the said Secretary, first giving the parties reasonable opportunity to be heard, to give notice to the persons or corporations owning or controlling such bridge so to alter the same as to render navigation through or under it reasonably free, easy, and unobstructed; and in giving such notice he shall specify the changes recommended by the Chief of Engineers that are required to be made, and shall prescribe in each case a reasonable time in which to make them. If at the end of such time the alteration has not been made, the Secretary of War shall forthwith notify the United States district attorney for the district in which such bridge is situated, to the end that the criminal proceedings hereinafter mentioned may be taken. If the persons, corporation, or association owning or controlling any railroad or other bridge shall, after receiving notice to that effect, as hereinbefore required, from the Secretary of War, and within the time prescribed by him willfully fail or refuse to remove the same or to comply with the lawful order of the Secretary of War in the premises, such persons, corporation, or association shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding five thousand dollars, and every month such persons, corporation, or association shall remain in default in respect to the removal or alteration of such bridge shall be deemed a new offense, and subject the persons, corporation, or association so offending to the penalties above prescribed: *Provided*, That in any case arising under the provisions of this section an appeal or writ of error may be taken from the district courts or from the existing circuit courts direct to the Supreme Court either by the United States or by the defendants.

—notice to alter.

—penalty.

Proviso.
—appeal.

Removal of obstructions to navigation.

SEC. 19. That whenever the navigation of any river, lake, harbor, sound, bay, canal, or other navigable waters of the United States shall be obstructed or endangered by any sunken vessel, boat, water craft, raft, or other similar obstruction, and such obstruction has existed for a longer period than thirty days, or whenever the abandonment of such obstruction can be legally established in a less space of time, the sunken vessel, boat, water craft, raft, or other obstruction shall be subject to be broken up, removed, sold, or otherwise disposed of by the Secretary of War at his discretion, without liability for any damage to the owners of the same: *Provided*, That in his discretion, the Secretary of War may cause reasonable notice of such obstruction of not less than thirty days, unless the legal abandonment of the obstruction can be established in a less time, to be given by publication, addressed "To whom it may concern," in a newspaper published nearest to the locality of the obstruction, requiring the removal thereof: *And provided also*, That the Secretary of War may, in his discretion, at or after the time of giving such notice, cause sealed proposals to be solicited by public advertisement, giving reasonable notice of not less than ten days, for the removal of such obstruction as soon as possible after the expiration of the above specified thirty days' notice, in case it has not in the meantime been so removed, these proposals and contracts, at his discretion, to be conditioned that such vessel, boat, water craft, raft, or other obstruction, and all cargo and property contained therein, shall become the property of the contractor, and the contract shall be awarded to the bidder making the proposition most advantageous to the United States: *Provided*, That such bidder shall give satisfactory security to execute the work: *Provided further*, That any money received from the sale of any such wreck, or from any contractor for the removal of wrecks, under this paragraph shall be covered into the Treasury of the United States.

Provisos.
—notice.

—proposals to remove.

—bond of bidder.

Disposition of funds from sale of wrecks.

Vessels grounding, etc.
—destruction, etc., of.

SEC. 20. That under emergency, in the case of any vessel, boat, water craft, or raft, or other similar obstruction, sinking or grounding, or being unnecessarily delayed in any Government canal or lock, or in any navigable waters mentioned in section nineteen, in such manner as to stop, seriously interfere with, or specially endanger navigation, in the opinion of the Secretary of War, or any agent of the United States to whom the Secretary may delegate proper authority, the Secretary of War or any such agent shall have the right to take immediate possession of such boat, vessel, or other water craft, or raft, so far as to remove or to destroy it and to clear immediately the canal, lock, or navigable waters aforesaid of the obstruction thereby caused, using his best judgment to prevent any unnecessary injury; and no one shall interfere with or prevent such removal or destruction: *Provided*, That the officer or agent charged with the removal or destruction of an obstruction under this section may in his discretion give notice in writing to the owners of any such obstruction requiring them to remove it: *And provided further*, That the expense of removing any such obstruction as aforesaid shall be a charge against such craft and cargo; and if the owners thereof fail or refuse to reimburse the United States for such expense within thirty days after notification, then the officer or agent aforesaid may sell the craft or cargo, or any part thereof that may not have been destroyed in removal, and the proceeds of such sale shall be covered into the Treasury of the United States.

Provisos. —notice.

—expense of removal.

—reimbursement.

Such sum of money as may be necessary to execute this section and the preceding section of this Act is hereby appropriated out of any money in the Treasury not otherwise appropriated, to be paid out on the requisition of the Secretary of War.

Appropriation.

That all laws or parts of laws inconsistent with the foregoing sections ten to twenty, inclusive, of this Act are hereby repealed: *Provided*, That no action begun, or right of action accrued, prior to the passage of this Act shall be affected by this repeal.

Repeal.

Proviso. —prior actions excepted.

Sec. 21. Whenever in this Act the amount provided for the completion of any project under continuing contract is less than the cost as estimated by the engineers, proposals for bids shall be invited without further action by Congress.

Appropriation for completion of project less than estimated cost; bids.

Sec. 22. That the Secretary of War is hereby directed to cause preliminary examinations or surveys to be made at the localities named in this section as hereinafter provided. In all cases a preliminary examination shall first be made, which shall embrace information concerning the commercial importance, present and prospective, of the river or harbor mentioned, and a report as to the advisability of its improvement. Whenever such preliminary examination has been made, in case such improvement is not deemed advisable, no further action shall be taken thereon without the direction of Congress; but in case the report has been or shall be to the effect that such river or harbor is worthy of improvement, the Secretary of War is hereby directed, at his discretion, to cause surveys to be made and the cost of improving such river or harbor to be estimated and to be reported to Congress, to wit:

Preliminary examinations and surveys directed.

Scope of preliminary examination, etc.

CALIFORNIA.

California.

Inner Harbor, San Pedro.
Napa River.
Sonoma Creek.
Suisun Creek.
Crescent Bay.
Channel between the straits of Carquinez and the Golden Gate, off Point Pinole, Point Wilson, and Lone Tree Point, with a view to obtaining a channel three hundred feet in width, of a depth of thirty feet.
Harbor of South San Francisco, San Mateo County.

CONNECTICUT.

Connecticut.

Milford Harbor.

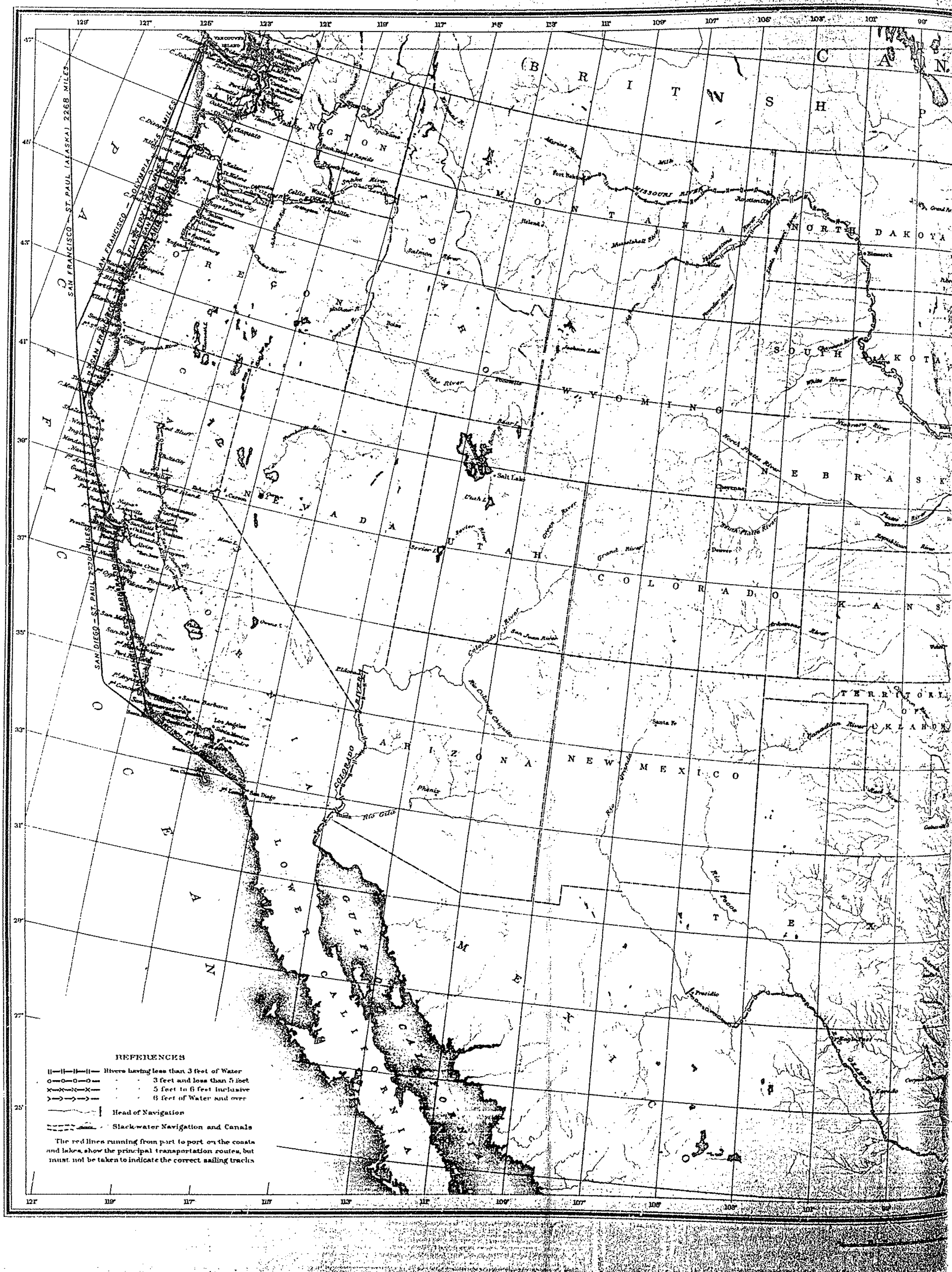
DELAWARE.

Delaware.

Saint Jones River, Delaware, from its mouth to the highest point of feasible navigation.

EXHIBIT 195

370. NAVIGABLE RIVERS AND PRINCIPAL TRANSPORTATION ROUTES



ORTATIO[N] ROUTES ON THE SEA COAST AND GREAT LAKES: 1890.

PLATE 9.

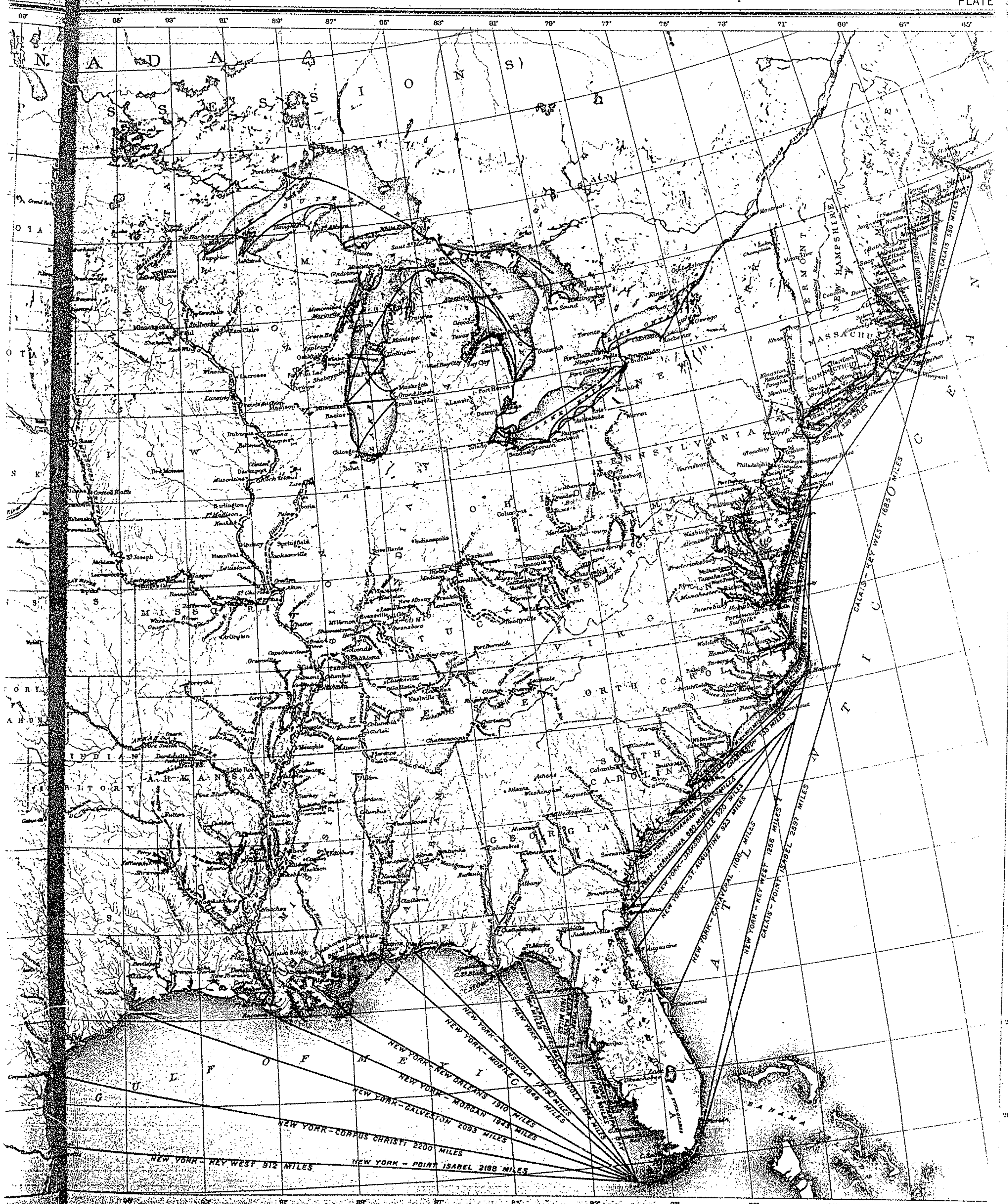


EXHIBIT 196

OWNERSHIP AND ADMINISTRATION

OF PUBLIC LANDS IN ARIZONA

Prepared by

Planning Division

Department of Economic
Planning and Development

State of Arizona

July 1971

The preparation of this report was financed
in part through a comprehensive planning
grant from the U. S. Department of
Housing and Urban Development

In addition to the land granted for common schools, the following land grants were made to the state for other purposes:

For University Purposes	200,000 acres
For Public Buildings	100,000 acres
For Penitentiaries	100,000 acres
For Insane Asylums	100,000 acres
For Schools and Asylums for the Deaf, Blind and Dumb	100,000 acres
For Miners Hospital	50,000 acres
For Normal School	200,000 acres
For State Cahritable, Penal, and Reformatory Institutions	100,000 acres
For Agriculture and Mechanical Colleges..........	150,000 acres
For Military Institutions	100,000 acres
For Payment of Maricopa, Pima, Yavapai and Coconino County Bonds	1,000,000 acres
TOTAL	2,350,000 acres

This land was to be selected from the surveyed, unreserved, unappropriated, and non-mineral public lands, located in the state.

In total, the Enabling Act granted approximately 8,076,800 acres for common school purposes, and 2,350,000 for other institutional purposes. The total grant to the state was 10,426,800 acres, or about 16,292 square miles. This grant amounts to 14.34% of the total land within the state. This figure is larger than the actual amount of land the state now holds, or will hold after the selection process is complete. This is because of the land within National Forests, sales, and other contingencies which have arisen.

The lands granted by the enabling act gave the state the raw materials. State constitutional provisions, statutes, and the administrative

EXHIBIT 197

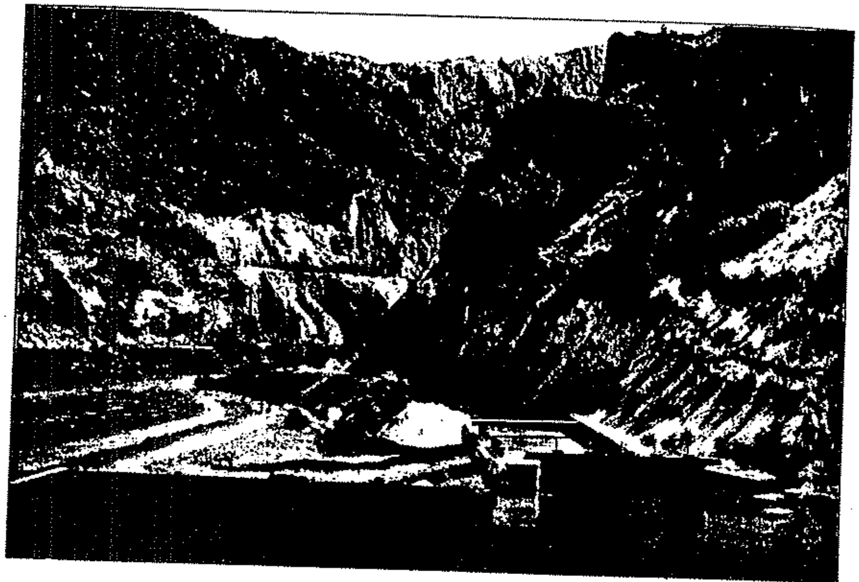


FIG 1.—HEADGATE, BEAR RIVER CANAL, UTAH.

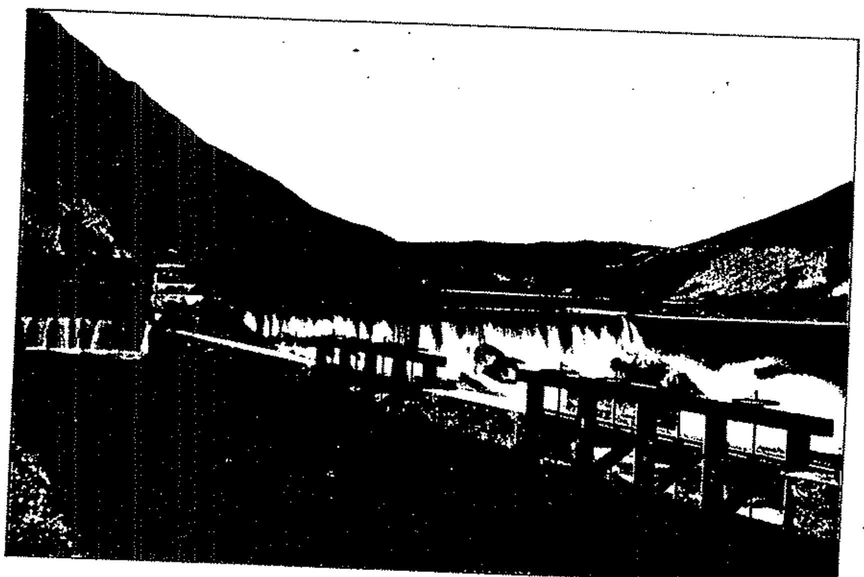


FIG 2.—HEADWORKS, BEAR RIVER CANAL, UTAH.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 104.

A. C. TRUE, Director.

U. S. – Experiment Stations Office

REPORT

OF

IRRIGATION INVESTIGATIONS FOR 1900

UNDER THE SUPERVISION OF

ELWOOD MEAD,

Expert in Charge of Irrigation Investigations.

INCLUDING REPORTS BY SPECIAL AGENTS AND OBSERVERS W. M. REED, W. H. CODE, A. J. McCLATCHIE, W. IRVING, J. M. WILSON, R. C. GEMMELL, G. L. SWENDSEN, O. V. P. STOUT, W. H. FAIRFIELD, D. W. ROSS, O. L. WALLER, S FORTIER, AND J. C. NAGLE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

tled to receive in ordinary stages of the river, and effects a great saving of water by so doing. Previous to its construction, the water of the Tempe Canal was allowed to flow down the river, passing through a wide sandy section of the channel some 7 miles in length. This portion of the river bed seemed to absorb water like a sponge, and frequent measurements by different engineers determined the fact that in the summer season especially there was a great waste of water between the dam of the Tempe Canal and that of the Consolidated system located about 7.5 miles farther up the river. The Consolidated Canal Company, in constructing its canals, planned to carry the water of the Tempe Canal in its waterway and make an intermediate use of the water for power purposes by turning it over a 40-foot bluff, through a power house, and subsequently into the Tempe Canal, which parallels the base of the bluff in the vicinity of the power plant. The Consolidated Canal Company further claims the right to the saving effected by taking the Tempe water into its canal instead of allowing it to flow down the river channel as in former times. Its right to the intermediate use of the Tempe water for power purposes was confirmed by the courts, and it has been using a good portion of the minimum flow for several years in pumping water and operating electrical machinery, but its right to any specific amount of saved water has not yet been determined.

The water of nearly all the canals of the valley is therefore delivered to them by means of two large systems—the Arizona on the north side of the river, and the Consolidated on the south. The Arizona system in seasons of low and medium supply intercepts the entire flow of Salt River at its dam (Pl. VII), with the exception of the several hundred inches of seepage water which leaks under the dam, and carries this volume in its canal for a distance of about 4 miles, turning that portion of it belonging to the south side canals back into the river channel at a point immediately above the dam of the Consolidated Canal Company. A crosscut canal has been recently built by the Arizona Water Company from its main canal to the edge of the river bluff (fig. 12), and at this point the company contemplates the erection of a water-power plant in order that it may make intermediate use of the south side water supply for power purposes. The Consolidated Canal Company in turn intercepts the water thus turned to it, which includes the combined supply of the Tempe, Mesa, and Utah canals.

The water of the Utah system is carried a distance of only 2.5 miles, and is then turned back into the river channel through wastegates located about one-half mile above the Utah dam. The supply of the Mesa and Tempe canals is brought down a distance of 8 miles from the headgates to a point known as the Division Gates. Here the Mesa water is delivered to the Mesa Canal proper, and the Tempe supply turned westward through the Consolidated Crosscut Canal, leading summers 150 cubic feet per second. This return flow, however, does not all come from the Salt River, as the head of the Buckeye Canal is below the junction of the Salt and Gila rivers, and immediately below the mouth of the Aqua Fria wash.

The river channel is again robbed of its supply at the Buckeye dam, but at the head of the new Arlington Canal, some 20 miles below the Buckeye, I am told another return flow of approximately 50 cubic feet per second is to be picked up by the new canal and utilized by the farmers west of the Hassayampa wash. Just what proportion of the water applied to the lands of the valley returns to the river is manifestly a hard question to determine.

The writer submits the following data, based on the assumption previously given, viz, that the supply of the Maricopa and Salt canals (jointhead) in normal stages of the river is largely return water from the irrigated lands above. Nearly all of such lands above the said canal are on the south side of Salt River, but to cover the supply furnished to Scottsdale and the Indian reservation, which are situated under the Arizona Canal above the said jointhead, I have added 500 inches constant flow to that allowed the south side of the river. Since there have been but seven days of excess of flood waters received by the Jointhead Canal during the past year, the conditions have been very favorable for determining the proportion of water it has received each month in comparison to the amount furnished to the irrigated lands above.

Proportion between the waters received by Jointhead Canal and the amount used for irrigation on lands above same from October 1, 1899, to October 1, 1900.

Month.	Average monthly flow in jointhead.	Average monthly flow on irrigated lands above jointhead.[1]	Water received by Jointhead as compared to amount applied on irrigated lands above same.
1899.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Per cent.*
October	63.40	316.9	20.8
November	52.40	231.5	22.6
December	66.40	224.6	29.5
1900.			
January	52.60	232.6	22.6
February	51.60	232.8	22.1
March	50.25	216.5	23.2
April	48.70	230	21.1
May	46.20	243.6	18.9
June	40.30	83.1	48.5
July	35.60	56.7	62.7
August	43	151.4	28.4
September	43.50	135	32.3
Average amount for year			29.8

[1] Including 12.5 cubic feet per second for Indian supply and Scottsdale.

While it is impossible to determine just what proportion of the average volume received by the Jointhead Canal is return flow, it is the belief of the writer that by far the greater portion of it is due to the irrigation of the sixty-odd thousand acres of land situated above the headgates of the canal. In average years a table prepared as above would be of little value, as during flood seasons the upper canals are frequently unable to take all the water, and it flows on down the river, giving the Jointhead and the other canals below the benefit of an additional supply. It would clearly be impossible, therefore, under such conditions, to determine even roughly what proportion of the water received by the lower canal is return water.

The investigations of Professor Forbes of the University of Arizona tend to prove the correctness of the above theory as regards seepage or return water. He has made the analysis of water taken from the river at the upper end of the valley above the irrigated lands, and upon comparing it with samples taken the same day from above the Jointhead, Buckeye, and Arlington canals, he found that the percentage of salts became greater as the distance from the upper end of the valley increased. Professor Forbes reasons, therefore, that the increase of salts found in the water at the heads of the lower canals is due to the leaching out of a portion of the alkali from the soils above the canals by means of irrigation.

FOREST RESERVES.

There has been considerable anxiety felt during the past year by the residents of this valley concerning the prospective throwing open of the forest reserves within our drainage area for grazing purposes. A commission was sent from Washington to examine these reserves and its personnel was of such a high order that the citizens of the valley feel confident that justice will be done all parties interested in their decision. The authorities in Washington have studied this great national question carefully for years, and in a report by B. E. Fernow, then Chief of the Division of Forestry of the United States Department of Agriculture, appears the following extract which is pertinent to the subject:

The favorable influence which the forest growth exerts in preventing the washing of the soil, and retarding the torrential flow of water, and also in checking the winds and thereby reducing rapid evaporation, further in facilitating subterranean drainage and influencing climatic conditions, on account of which it is desirable to preserve certain parts of the natural forest growth and extend it elsewhere; this favorable influence is due to the dense cover of foliage mainly, and to the mechanical obstruction which the trunks and the litter of the forest floor offer. Any kind of tree growth would answer this purpose, and all the forest management necessary would be to simply abstain from interference and leave the ground to nature's kindly action.

Another very strong reason for the preservation of the forest reserves within the boundaries of our drainage area is the fact that the forests prevent, or at least check, to a great extent, the disastrous erosion in the ground and located in an alfalfa patch which was kept closely cropped. Measurements were taken every two weeks, and the results are smaller than those shown in the records of Professor Boggs. This may be accounted for by the presence of trees and surrounding vegetation, the former shutting off the breeze to a greater or less extent, though not in the immediate vicinity of the tank, and the latter, particularly the alfalfa, cooling the surface of the ground surrounding the tank. The summer was also cooler than usual, with the exception of the month of July. The results of the measurements are as follows:

Record of evaporation near Mesa, Ariz., 1900.

	Inches.
May 2-16	3
May 16-30	3.25
May 30-June 13	3.37
June 13-27	3.67
June 27-July 10	5.12
July 10-24	4.25
July 24-August 7	4
August 7-21	3.75
August 21-September 4	3.50
September 4-18	3
September 18-October 1	2.75
October 1-15	2.50
October 15-29	2.25
October 29 November 12	2
Total	47.41

RETURN WATER.

The amount of water that returns to the Salt River after being used for irrigation on the higher lands above is an interesting study, and one that disproves to some extent the old adage, "You cannot eat your cake and have it."

The entire low water supply of the Salt River is taken from the river channel by the time it reaches the head of the Utah Canal. Practically no water passes the Utah dam, and the river bed for several miles below is as dry as dust. After following the river channel, however, for a distance of 6 or 7 miles, water again appears, and at a distance of 12 miles below the Utah dam, where the return flow is picked up by the jointhead of the Maricopa and Salt canals (see map, fig. 16) the flow in ordinary years is found to approximate 60 cubic feet per second. This flow has naturally decreased during the past summer, owing to the scanty irrigations received by the Mesa, Utah, and Tempe lands above, and to the gradual lowering of the undergound supply.

The river bed is again dry below the dam of the Maricopa and Salt canals, but at the head of the Buckeye Canal, some 24 miles farther down the stream, is again found a volume approximating in ordinary

EXHIBIT 198

QUEEN CREEK AT WHITLOW'S RANCH, ARIZONA.

This creek is a tributary of the Gila, and has its source in the Pinal Mountains, 40 miles northeast of Florence, Arizona. A short distance below Whitlow's ranch its waters ordinarily are lost in the sands of the desert, and it is only during protracted floods that the discharge continues southwestward, entering Gila River below the Sacaton Range. This basin was under examination in connection with the investigation of the water supply of Gila River.[1]

The discharge of this creek is intermittent, depending upon sudden and violent floods, which are generally of short duration, usually extending over a period of only one day. In order to obtain an accurate estimate of its flow, it is necessary to have an observer constantly on the ground. The station at Whitlow's was established in February, 1896, and was discontinued in April, 1897. It was resumed November 16, 1898, when the original rod was extended, lowering the zero 3 feet. On the same day a sloping rod, referred to the same datum, was placed 431 feet upstream from the main gage. Measurements can be made from a cable and car. It was impracticable, during 1899, to use a meter at this point, so the observer, during the flood stages, observed both gages at short intervals and took soundings from which a cross section could be computed. The discharges were figured by Kutter's formula from these measurements of soundings, and from the slope as determined by the observations of heights on the two rods. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 293; 1897, Nineteenth Annual Report, Part IV, page 418. The following table shows the dates on which there was a discharge in the creek, together with the number of second-feet.

Discharge measurements of Queen Creek at Whitlow's ranch, Arizona.

1899.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Second-feet.*		*Feet.*	*Second-feet.*
January 12	2.00	....	June 26	2.30	10
January 12	3.00	....	July 9	3.00	81
January 13	2.60	....	July 10	3.10	148
January 13	2.40	....	July 13	4.50	884
January 14	2.30	....	July 13	2.40	3
January 14	2.20	....	July 16	4.00	529
February 3	3.00	87	July 18	3.50	274
February 3	2.80	57	July 25	2.50	2
February 4	2.70	49	July 26	2.50	2
February 4	2.50	11	July 29	2.60	27
February 5	2.40	8	July 30	7.10	5,515
March. } April.. } Creek dry May... }	....	....	August 1	4.60	492
			August 2	8.00	4,600
			August 2	6.00	1,562
June 2	2.70	62	September 7	7.50	....
June 2	2.30	16	September 8	7.00	....
June 25	5.00	1,171			

[1] Storage of water on Gila River, Arizona, by J. B. Lippincott: Water-Supply and Irrigation Paper No. 33.

SALT RIVER AT MCDOWELL, ARIZONA.

This river is the principal tributary of Gila River, and rises in Graham County, Arizona, its headwater tributaries adjoining those of San Francisco River. A large portion of its course is through the mountainous district of the White Mountain Indian Reservation. Irrigation is practiced to a small extent in what is known as Tonto Valley, but shortly after Tonto Creek joins it the river enters a canyon again and continues in it until a short distance above the mouth of Verde River. At this point the river reappears from its canyon, and its course is thence across the Plains district until it enters Gila River at the northwest corner of Gila River Indian Reservation. From the mouth of Verde River down to Gila River a number of large canals divert the water of Salt River and serve the extensively irrigated lands in the vicinity of Phœnix on the north side and Mesa on the south side of the river. During ordinary seasons all of the water of Salt River is diverted, and at the present time there is a shortage in the summer months. The gaging station, established April 20, 1897, is located one-half mile above the mouth of the Verde and 30 miles northeast of Phœnix. The gage consists of a 2 by 6 inch scantling bolted to rocks on the south side of the river about 300 feet above the cable. The bench mark is a nail in a palo verde tree about 75 feet west of the north cable anchorage and is 17.33 feet above gage zero. The bed of the river is sandy and shifting, and it is necessary to make a large number of measurements in order to obtain an accurate estimate of the discharge. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 420; 1898, Twentieth Annual Report, Part IV, page 406. The following discharge measurements were made by W. A. Farish during 1899:

Discharge measurements of Salt River at McDowell, Arizona.

1899.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Second-feet.*		*Feet.*	*Second-feet.*
January 15	11.40	530	July 16	10.35	204
January 22	11.05	367	August 22	10.55	244
February 12	11.20	390	September 4	10.20	144
February 28	11.20	426	September 10	11.50	716
March 12	11.20	519	October 8	10.40	178
March 31	11.30	602	October 15	11.90	496
April 29	10.85	481	November 30	11.00	226
April 30	10.89	475	December 1	10.95	331
June 29	10.10	173			

A series of measurements of canals diverting water from Salt River in the vicinity of Phœnix were made by Cyrus C. Babb from June 12 to 5, inclusive, in order to determine the amount of return water to the river through seepage. A similar series of measurements were made in June, 1896. A discussion of these two sets of seepage measurements will be made in the Twenty-first Annual Report.

Miscellaneous discharge measurements in Salt River Valley, Arizona.

1899.

Date.	Stream.	Locality.	Discharge.
			Second-feet.
June 12	Salt River	Gaging station	197.0
June 12	Verde River	Gaging station	140.0
June 13	Arizona canal	Below waste gate	185.0
June 13	Arizona waste	At river	88.0
June 13	Salt River	Opposite Arizona waste gate.	18.7
June 13	Highland canal	Opposite Arizona waste gate.	31.7
June 13	Mesa Consolidated	Below waste gate	67.7
June 13	Small flume	Mesa waste gate	1.8
June 13	Mesa Consolidated waste.	Near gate	15.3
June 13	Salt River	Opposite Mesa Consolidated waste gate.	5.8
June 13	Tempe canal	Ford near head	70.6
June 13	Salt River	Opposite Tempe canal head.	0.0
June 13	Salt River	Railroad bridge	59.8
June 15	Salt River	South of Phœnix	0.0
June 15	St. Johns canal	At head	7.8
June 15	Salt River	Below head of St. Johns canal.	23.9
June 15	Buckeye canal	At head	102.3
June 15	Salt River	Below Buckeye canal	1.0

Daily gage height, in feet, of Salt River at McDowell, Arizona, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	10.80	10.95	11.20	11.30	10.90	10.25	10.10	13.50	10.30	10.30	10.95
2	10.85	11.00	11.15	11.25	10.95	10.35	10.10	17.00	10.35	10.30	10.80
3	10.70	11.10	11.10	11.20	10.80	10.40	10.10	14.30	10.30	10.30	10.80
4	10.70	11.40	11.10	11.15	10.75	10.45	10.05	13.00	10.40	10.40	10.80
5	10.70	11.30	11.15	11.15	10.80	10.45	10.10	12.90	10.40	10.40	10.90
6	10.65	11.25	11.20	11.10	10.75	10.40	10.10	12.70	10.40	10.40	10.90
7	10.70	11.20	11.25	11.20	10.75	10.35	10.05	12.20	10.35	10.40	10.90
8	10.70	11.15	11.25	11.30	10.70	10.35	10.05	11.90	10.30	10.45	10.90
9	10.70	11.10	11.20	11.30	10.65	10.35	10.05	11.10	11.45	10.40	10.90
10	10.70	11.05	11.20	11.30	10.60	10.40	10.10	11.95	12.60	10.40	10.90
11	10.65	11.30	11.20	11.35	10.55	10.30	10.25	11.30	11.65	10.40	10.90
12	11.05	11.20	11.25	11.30	10.50	10.25	10.60	11.40	11.50	10.55	10.90
13	11.90	11.30	11.30	11.35	10.50	10.20	10.50	11.20	11.30	12.70	10.90
14	11.65	11.35	11.25	11.35	10.45	10.20	10.80	11.00	11.00	11.90	11.00
15	11.70	11.30	11.20	11.35	10.50	10.20	10.50	11.00	10.80	11.85	11.00
16	11.30	11.20	11.15	11.35	10.55	10.20	10.40	10.90	10.70	12.30	11.00
17	11.20	11.15	11.10	11.30	10.55	10.20	10.90	11.05	10.60	11.80	11.00
18	11.15	11.15	11.05	11.35	10.55	10.15	10.90	10.95	10.55	11.50	11.00
19	11.15	11.10	11.05	11.35	10.50	10.15	10.80	10.80	10.50	11.30	11.00
20	11.25	11.10	11.10	11.30	10.55	10.10	10.70	10.60	10.45	11.00	11.00
21	11.10	11.10	11.10	11.25	10.55	10.20	11.00	10.60	10.45	11.00	11.00
22	11.10	11.10	11.10	11.25	10.55	10.15	10.75	10.55	10.45	11.00	11.00
23	11.05	11.10	11.10	11.20	10.55	10.20	11.50	10.40	10.40	11.00	11.00
24	11.05	11.15	11.10	11.15	10.60	10.30	11.40	10.40	10.35	11.00	11.00
25	11.00	11.15	11.10	11.15	10.60	10.20	12.50	10.45	10.35	11.00	11.00
26	11.00	11.20	11.10	11.15	10.55	11.10	11.60	10.40	10.35	11.00	11.00
27	10.90	11.20	11.20	11.10	10.50	10.50	11.70	10.40	10.35	10.95	11.00
28	10.90	11.20	11.35	11.10	10.45	10.15	11.60	10.35	10.35	10.95	11.00
29	10.90	......	11.30	11.05	10.40	10.10	12.70	10.30	10.35	10.95	11.00
30	10.90	......	11.40	10.90	10.35	10.10	12.80	10.30	10.30	10.90	11.00
31	10.90	......	11.30	......	10.30	......	13.00	10.40	......	10.90	......

Station discontinued November 30.

VERDE RIVER AT MCDOWELL, ARIZONA.

This river rises in north-central Arizona and flows in a general southerly direction, entering Salt River 30 miles northeast of Phœnix. A number of large irrigation enterprises have recently been planned and are now in course of construction, designed to divert water from the lower stretch of the river to irrigate lands north of Phœnix. The results of measurements of this river combined with those of Salt River show the amount of water available for the irrigable lands of Phœnix Valley. The dam of the Arizona Canal Company is located on Salt River immediately below the mouth of the Verde. The gaging station of this latter stream is located three-fourths of a mile above its mouth and 30 miles northeast of Phœnix. It was established April 20, 1897. The station is equipped with a cable, car, and tagged wire. The gage consists of a 2 by 4 inch inclined rod fastened to posts driven into the east bank of the river about 400 feet below the gaging cable. The bench mark is on a cat's claw tree about 100 feet southeast from the old gage, on a cottonwood tree, which latter is 60 feet below the cable. The elevation of the bench mark is 27.02 feet above gage datum. The channel of the river is similar to that of Salt River—sandy and liable to change during a slight rise, and a large number of measurements are necessary in order to accurately determine the discharge. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 420; 1898, Twentieth Annual Report, Part IV, page 407. The following measurements of discharge were made by W. A. Farish during 1899.

Discharge measurements of Verde River at McDowell, Arizona.

1899.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Second-feet.*		*Feet.*	*Second-feet.*
January 15	7.65	454	July 16	7.50	254
January 22	7.50	356	August 5	8.90	1,213
February 12	7.70	374	August 22	7.35	139
February 28	7.55	324	September 4	7.40	146
March 12	7.55	262	September 10	8.20	481
March 30	7.50	231	October 8	7.50	206
April 29	7.35	191	October 15	9.20	1,670
April 30	7.40	209	November 30	7.80	303
June 29	7.15	127	December 1	7.75	265

EXHIBIT 199

eling car suspended from a cable. The following measurements were made by W. Richins during 1901:

List of discharge measurements of Salt River at the reservoir site, Arizona.

Date	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
July 8	6.76	119.72	September 14	7.10	215.69
July 10	6.70	99.71	September 16	7.10	201.31
July 11	6.60	80.16	September 27	6.82	129.74
July 13	6.64	83.00	October 1	6.82	135.80
July 20	6.59	74.33	October 5	6.80	122.29
July 23	7.02	201.28	October 8	6.91	163.36
July 25	7.40	331.55	October 12	6.90	155.97
July 27	8.02	885.65	October 15	6.89	153.23
July 30	10.15	4,402.28	October 18	6.89	157.01
Do	10.35	4,433.83	October 23	6.91	160.86
August 3	8.00	850.70	October 26	6.95	179.58
August 5	7.80	604.85	October 29	6.97	175.72
August 10	7.50	389.46	November 1	7.07	211.65
August 15	7.70	557.50	November 4	7.01	184.24
August 17	7.45	362.90	November 8	7.01	179.20
August 20	7.27	285.57	November 23	7.05	187.96
August 24	7.25	284.60	December 2	7.03	180.97
August 28	7.10	209.36	December 6	7.05	189.64
August 31	7.21	250.64	December 9	7.05	189.98
September 3	7.16	252.78	December 13	7.03	179.61
September 7	6.93	169.59	December 16	7.04	180.25
September 10	7.16	195.86	December 20	7.02	172.92
September 12	7.16	224.51			

Daily gage height, in feet, of Salt River at the reservoir site, Arizona, for 1901.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	8.50	7.95	8.30	7.69	6.88	7.85	7.14	6.82	7.06	7.04
2	......	8.50	7.95	8.27	7.68	6.86	7.80	7.16	6.81	7.04	7.04
3	......	8.50	7.93	8.35	7.64	6.83	7.90	7.17	6.80	7.03	7.04
4	......	8.70	7.87	8.28	7.61	6.80	7.75	7.10	6.79	7.01	7.05
5	......	8.75	7.90	8.25	7.57	6.79	8.04	7.02	6.80	7.02	7.05
6	......	8.60	7.95	8.18	7.50	6.78	7.79	6.97	6.82	7.02	7.05
7	2.85	8.60	7.95	8.05	7.49	6.74	7.78	6.92	6.88	7.01	7.05
8	2.55	8.60	7.95	8.00	7.45	6.78	7.64	6.90	6.91	7.01	7.04
9	2.40	9.30	8.02	8.01	7.42	6.70	7.73	6.89	6.90	7.01	7.05
10	2.35	9.80	8.07	8.00	7.38	6.68	7.53	6.92	6.90	7.01	7.05
11	3.40	9.40	8.08	7.96	7.36	6.67	8.20	7.38	6.90	7.02	7.05
12	3.10	8.75	8.07	7.95	7.34	6.67	9.05	7.25	6.90	7.02	7.03
13	2.82	8.70	8.03	7.96	7.28	6.64	8.10	7.08	6.90	7.07	7.03
14	2.68	8.60	8.00	7.94	7.27	6.62	8.10	7.10	6.89	7.06	7.04
15	2.05	8.40	8.02	7.92	7.25	6.61	7.75	7.12	6.89	7.10	7.04
16	1.85	8.40	8.15	7.90	7.21	6.59	7.55	7.09	6.89	7.10	7.02
17	1.82	8.30	8.35	7.85	7.20	6.58	7.47	7.03	6.89	7.10	7.01
18	1.70	8.25	8.37	7.80	7.16	6.59	7.37	7.88	6.89	7.08	7.00
19	3.15	8.20	8.30	7.78	7.14	6.58	7.30	7.83	6.89	7.08	7.00
20	3.45	8.20	8.27	7.78	7.12	6.65	7.28	7.82	6.88	7.08	7.02
21	3.00	8.25	8.28	7.80	7.09	6.61	7.33	7.79	6.88	7.07	7.00
22	2.85	8.20	8.35	7.80	7.07	6.67	7.37	7.77	6.91	7.05	7.01
23	3.10	8.20	8.45	7.80	7.05	6.92	7.66	7.75	6.91	7.05	7.03
24	3.10	8.15	8.45	7.73	7.03	7.11	7.25	7.73	6.92	7.05	7.04
25	2.70	8.15	8.50	7.69	7.01	7.43	7.18	7.72	6.94	7.06	7.03
26	2.50	8.15	8.57	7.65	7.00	7.33	7.13	7.33	6.95	7.05	7.04
27	2.10	8.05	8.55	7.67	6.97	7.75	7.08	6.81	6.95	7.05	7.04
28	1.75	8.00	8.48	7.62	6.95	8.28	7.10	6.81	6.97	7.04	7.04
29	......	8.00	8.42	7.67	6.90	8.13	7.20	6.81	6.98	7.05	7.04
30	......	7.95	8.33	7.69	6.89	9.85	7.23	6.81	7.03	7.04	7.02
31	......	7.95	......	7.68	......	8.40	7.20	......	7.10	......	7.01

TONTO CREEK NEAR LIVINGSTON, ARIZ.

The station, established April 1, 1901, by H. G. Heisler, is 15 miles west of Livingston, Ariz. It is about half a mile above the mouth.

The gage is a vertical rod nailed to a cliff of cemented gravel on the left bank. The following measurements were made by W. Richins during 1901:

List of discharge measurements of Tonto Creek near Livingston, Ariz.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
July 10	2.57	2.34	August 28	2.90	3.31
July 13	2.56	2.02	August 31	2.85	2.79
July 20	2.55	1.92	September 2	2.85	2.80
July 24	2.85	18.50	September 7	2.85	2.60
July 25	3.20	54.00	September 10	3.00	7.52
July 27	3.50	99.17	September 14	2.85	2.30
August 3	3.82	108.02	September 27	2.65	1.85
August 5	2.90	37.50	October 5	2.70	2.05
August 10	2.60	5.90	October 12	2.70	1.78
August 11	4.60	279.00	October 23	2.75	2.08
August 15	2.90	34.61	November 6	2.85	1.86
August 17	2.75	16.33	December 2	2.85	1.80
August 20	2.63	11.24	December 13	2.85	2.54
August 24	3.10	4.98	December 20	2.85	2.34

Daily gage height, in feet, of Tonto Creek near Livingston, Ariz., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	2.75	2.66	2.58	3.00	2.85	2.70	2.80	2.85
2	3.05	2.75	2.65	2.58	2.75	2.85	2.70	2.80	2.85
3	3.05	2.75	2.65	2.57	3.55	2.85	2.70	2.80	2.85
4	3.02	2.75	2.65	2.57	3.05	2.85	2.70	2.80	2.85
5	3.00	2.75	2.65	2.57	2.85	2.85	2.70	2.85	2.85
6	2.95	2.70	2.65	2.57	2.83	2.85	2.70	2.85	2.85
7	2.95	2.70	2.65	2.57	2.78	2.85	2.70	2.85	2.85
8	2.90	2.65	2.65	2.57	2.69	2.84	2.70	2.85	2.85
9	2.90	2.65	2.65	2.57	2.68	2.83	2.70	2.85	2.85
10	2.90	2.68	2.65	2.57	2.60	2.91	2.70	2.85	2.85
11	2.90	2.70	2.60	2.57	4.10	2.84	2.70	2.85	2.85
12	2.90	2.67	2.58	2.57	3.45	2.88	2.70	2.90	2.85
13	2.90	2.75	2.58	2.56	3.45	2.85	2.70	2.85	2.85
14	2.90	2.70	2.58	2.59	3.13	2.85	2.70	2.85	2.85
15	2.85	2.69	2.65	2.55	2.90	2.85	2.70	2.85	2.85
16	2.85	2.69	2.65	2.55	2.77	2.85	2.70	2.85	2.85
17	2.85	2.68	2.65	2.55	2.75	2.85	2.70	2.85	2.85
18	2.90	2.68	2.58	2.57	2.65	2.82	2.70	2.85	2.85
19	2.85	2.65	2.58	2.56	2.65	2.85	2.70	2.85	2.85
20	2.85	2.65	2.58	2.57	2.63	2.80	2.70	2.85	2.85
21	2.85	2.65	2.58	2.56	2.50	2.79	2.70	2.85	2.85
22	2.85	2.65	2.57	2.58	2.50	2.77	2.70	2.85	2.85
23	2.85	2.64	2.57	2.57	3.35	2.75	2.75	2.85	2.85
24	2.85	2.63	2.56	3.25	3.05	2.73	2.75	2.85	2.85
25	2.85	3.08	2.55	3.48	3.00	2.72	2.75	2.85	2.85
26	2.85	2.81	2.55	2.92	2.96	2.70	2.75	2.85	2.85
27	2.80	2.78	2.53	3.28	2.94	2.70	2.75	2.85	2.85
28	2.80	2.81	2.50	4.30	2.90	2.70	2.75	2.85	2.85
29	2.75	2.78	2.50	3.55	2.90	2.70	2.75	2.85	2.85
30	2.75	2.83	2.50	5.50	2.88	2.70	2.78	2.85	2.85
31	......	2.90	......	3.30	2.85	......	2.80	......	2.85

SALT RIVER AT McDOWELL, ARIZ.

The station, established April 20, 1897, is a half mile above the mouth of Verde River. It is described in Water-Supply Paper No. 50, page 386. The station was temporarily discontinued during 1900, but measurements were resumed in 1901. During 1901 the following measurements of discharge were made by F. P. Trott, J. F. Appleby, and J. C. Myrick.

List of discharge measurements of Salt River at McDowell, Ariz.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 10	10.60	251	April 10	12.55	994
January 25	10.99	302	April 12	12.60	1,082
January 26	12.80	1,392	April 13	12.60	971
January 29	13.90	3,172	April 15	12.50	995
February 7	14.47	4,535	April 17	12.90	1,271
February 11	14.45	4,628	June 2	1.97	435
February 15	13.30	2,088	June 8	1.68	347
February 23	15.58	3,290	June 15	1.42	270
February 25	15.60	3,335	June 17	1.34	231
February 26	15.20	2,791	June 22	1.20	177
February 27	14.70	2,459	June 30	1.00	129
February 28	14.20	1,888	July 6	.88	100
March 1	14.10	1,664	July 13	.67	78
March 2	14.00	1,597	July 20	.60	66
March 4	14.20	1,711	July 27	1.60	329
March 5	4.20	1,687	August 10	2.28	357
March 8	13.90	1,817	August 17	2.30	329
March 9	14.30	2,502	August 31	1.84	245
March 11	14.90	3,157	September 7	1.53	171
March 12	14.40	2,634	September 14	1.69	198
March 13	14.15	2,045	September 21	1.55	152
March 14	13.80	1,942	September 28	1.36	122
March 16	13.35	1,541	October 5	1.30	118
March 18	13.10	1,427	October 12	1.40	151
March 19	13.00	1,351	October 19	1.42	142
Do	13.00	1,350	October 26	1.47	159
March 20	12.85	1,161	November 2	.88	183
Do	13.00	1,332	November 9	.83	173
March 21	12.90	1,198	November 16	.93	209
March 22	12.90	1,112	November 23	.90	194
March 25	12.85	1,210	November 30	.87	155
March 27	12.00	1,029	December 7	.85	180
March 29	12.60	893	December 14	.85	168
April 2	12.50	887	December 21	.79	168
April 8	12.50	1,016	December 28	.85	171
April 10	12.55	994	December 31	.83	157

Daily gage height, in feet, of Salt River at McDowell, Ariz., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.70	13.48	14.10	12.50	(a)	(a)	1.00	(a)	1.80	1.36	0.91	0.87
2	10.70	14.10	14.05	12.50	(a)	1.97	.96	(a)	1.74	1.36	.86	.86
3	10.70	13.50	14.10	12.50	(a)	1.93	.93	(a)	1.84	1.34	.83	.86
4	10.70	13.25	14.15	12.40	(a)	1.89	.89	(a)	1.77	1.33	.84	.86
5	10.69	13.23	14.13	12.35	(a)	1.85	.88	(a)	1.66	1.31	.82	.85
6	10.70	13.60	14.10	12.37	(a)	1.78	.88	(a)	1.61	1.41	.82	.85
7	10.70	14.40	13.98	12.40	(a)	1.70	.83	(a)	1.56	1.37	.84	.85
8	10.70	14.10	14.00	12.45	(a)	1.68	.81	(a)	1.51	1.39	.84	.84
9	10.70	13.90	14.30	12.50	(a)	1.64	.80	(a)	1.49	1.45	.83	.85
10	10.70	13.75	14.80	12.55	(a)	1.62	.80	2.28	1.46	1.46	.83	.85
11	10.78	14.75	14.90	12.60	(a)	1.58	.75	2.17	3.55	1.45	.82	.85
12	10.78	14.10	14.32	12.60	(a)	1.53	.70	4.80	2.05	1.40	.83	.86
13	10.78	14.18	14.05	12.60	(a)	1.52	.69	4.30	1.85	1.44	.86	.85
14	10.78	13.68	13.85	12.53	(a)	1.48	.69	3.80	1.69	1.45	.90	.86
15	10.68	13.40	13.65	12.50	(a)	1.42	.69	3.30	1.69	1.43	.86	.86
16	10.65	13.20	13.35	12.63	(a)	1.39	.68	2.80	1.71	1.42	.93	.86
17	10.70	13.25	13.23	12.98	(a)	1.36	.65	2.30	1.63	1.41	.92	.86
18	10.70	13.33	13.13	13.15	(a)	1.32	.63	(a)	1.61	1.42	.91	.83
19	10.70	13.83	13.00	13.13	(a)	1.30	.61	(a)	1.59	1.42	.92	.82
20	10.70	14.88	13.00	(a)	(a)	1.28	.60	(a)	1.52	1.43	.91	.80
21	10.65	14.80	12.90	(a)	(a)	1.25	.61	2.08	1.55	1.43	.92	.79
22	10.65	15.00	12.90	(a)	(a)	1.20	.70	2.10	1.52	1.43	.90	.83
23	10.70	15.48	12.85	(a)	(a)	1.18	.83	2.10	1.49	1.46	.89	.84
24	10.70	15.88	12.80	(a)	(a)	1.15	.90	2.42	1.43	1.46	.89	.85
25	10.95	15.43	12.85	(a)	(a)	1.13	1.05	1.95	1.45	1.47	.89	.86
26	12.70	15.10	12.85	(a)	(a)	1.10	1.65	1.86	1.45	1.47	.88	.85
27	13.23	14.68	12.78	(a)	(a)	1.07	1.60	1.79	1.44	1.48	.88	.85
28	13.35	14.18	12.70	(a)	(a)	1.05	2.00	1.78	1.37	1.49	.88	.85
29	13.90	......	12.68	(a)	(a)	1.02	(a)	1.74	1.36	1.53	.87	.85
30	14.22	......	12.58	(a)	(a)	1.01	(a)	1.75	1.36	1.59	.87	.84
31	14.00	......	12.50	......	(a)	......	......	1.84	......	1.77	......	.81

a No observations.

VERDE RIVER NEAR McDOWELL, ARIZ.

This station, established April 20, 1897, is three-fourths of a mile above the mouth of the river, and is described in Water-Supply Paper

No. 50, page 387. Records were not kept during 1900, but they were resumed in 1901. During 1901 the following measurements were made by F. P. Trott, J. F. Appleby, and J. C. Myrick:

List of discharge measurements of Verde River near McDowell, Ariz.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1801.	*Feet.*	*Sec.-ft.*
January 10	4.05	268	April 12	4.65	216
January 26	4.40	301	April 13	4.60	194
January 27	6.00	1,557	April 15	4.50	189
February 8	5.75	1,331	May 25	4.38	125
February 11	6.38	2,489	June 1	4.48	159
February 15	5.35	793	June 8	4.38	129
February 21	7.60	3,308	June 15	4.25	194
February 23	9.30	6,613	June 22	4.20	76
February 24	9.48	6,022	June 30	4.13	51
February 25	7.83	3,819	July 6	4.04	37
February 27	6.85	2,499	July 13	4.03	33
February 28	6.70	2,393	July 20	4.11	47
March 2	6.80	2,863	July 27	4.88	278
March 4	6.17	1,628	August 3	7.85	1,746
March 7	5.60	1,099	August 10	5.70	438
March 9	5.40	966	August 17	5.75	513
March 11	6.40	1,685	August 31	4.95	164
March 12	5.80	1,199	September 7	4.80	106
March 13	5.75	989	September 14	4.62	104
March 14	5.55	914	September 21	4.70	104
March 15	5.45	823	September 30	4.65	82
March 16	5.30	705	October 5	4.76	101
March 18	5.10	576	October 12	4.70	140
March 19	5.00	469	October 19	4.74	105
March 20	5.00	436	October 26	4.91	160
March 21	4.90	395	October 31	5.79	495
March 22	4.90	368	November 2	5.27	262
March 23	4.80	350	November 9	5.12	250
March 26	4.70	274	November 16	5.24	265
March 27	4.65	225	November 23	5.22	239
March 28	4.65	224	November 30	5.23	219
March 29	4.65	215	December 7	5.25	257
April 1	4.60	211	December 14	5.25	291
April 2	4.65	221	December 21	5.25	213
April 3	4.65	188	December 28	5.31	235
April 8	4.60	188	December 31	5.30	231
April 10	4.55	192			

Daily gage height, in feet, of Verde River near McDowell, Ariz., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.05	5.15	6.30	4.60	4.45	4.46	4.10	6.30	4.93	4.66	5.44	5.22
2	4.05	5.42	6.60	4.65	4.42	4.46	4.08	6.55	4.95	4.73	5.26	5.25
3	4.05	5.15	6.50	4.63	4.44	4.48	4.10	7.85	4.87	4.76	5.17	5.25
4	4.05	4.92	6.28	4.55	4.42	4.44	4.07	6.30	4.85	4.76	5.05	5.26
5	4.05	4.90	6.48	4.55	4.42	4.42	4.07	7.40	4.85	4.76	5.03	5.25
6	4.05	5.25	5.80	4.55	4.42	4.39	4.04	6.30	4.83	4.76	5.04	5.25
7	4.05	5.90	5.65	4.55	4.42	4.42	4.05	6.40	4.80	4.75	5.10	5.25
8	4.05	5.75	5.50	4.55	4.41	4.38	4.06	6.17	4.78	4.77	5.10	5.27
9	4.05	5.45	5.40	4.55	4.41	4.33	4.06	5.90	4.74	4.80	5.12	5.29
10	4.05	5.25	6.25	4.55	4.40	4.31	4.04	5.70	4.70	4.75	5.12	5.24
11	4.05	6.35	6.20	4.60	4.37	4.30	4.03	5.85	4.68	4.72	5.09	5.24
12	4.00	5.90	5.95	4.63	4.35	4.29	4.04	5.70	4.66	4.71	5.12	5.23
13	4.05	5.65	5.75	4.60	4.35	4.28	4.03	5.50	4.65	4.72	5.31	5.20
14	4.00	5.57	5.50	4.55	4.37	4.28	4.04	6.00	4.62	4.75	5.29	5.25
15	4.00	5.30	5.45	4.53	4.37	4.25	4.04	7.50	4.62	4.76	5.24	5.26
16	4.00	5.22	5.25	4.50	4.37	4.28	4.04	6.10	4.62	4.76	5.24	5.29
17	4.05	5.32	5.15	4.50	4.37	4.25	4.06	5.75	4.62	4.75	5.24	5.31
18	4.03	5.33	5.00	4.55	4.37	4.22	4.08	6.30	4.59	4.79	5.25	5.25
19	4.00	5.80	5.00	4.55	4.37	4.25	4.09	6.40	4.52	4.75	5.23	5.24
20	4.00	6.56	5.00	4.50	4.37	4.23	4.11	5.85	4.61	4.76	5.22	5.25
21	4.02	7.50	4.70	4.50	4.40	4.23	4.11	5.70	4.70	4.77	5.22	5.25
22	4.00	8.00	4.90	4.50	4.35	4.20	4.06	5.70	4.65	4.75	5.22	5.25
23	4.02	9.45	4.80	4.50	4.38	4.21	4.95	5.60	4.60	4.82	5.22	5.26
24	4.00	9.20	4.80	4.50	4.38	4.20	4.84	5.40	4.63	4.88	5.22	5.28
25	4.13	8.05	4.75	4.47	4.38	4.18	4.75	5.20	4.60	4.88	5.23	5.29
26	4.27	7.57	4.70	4.47	4.37	4.16	4.90	5.10	4.60	4.91	5.24	5.30
27	5.88	7.05	4.65	4.45	4.37	4.13	4.88	5.05	4.65	4.91	5.24	5.32
28	5.13	6.48	4.65	4.48	4.38	4.13	5.85	5.05	4.66	4.92	5.24	5.32
29	4.50	......	4.65	4.50	4.45	4.13	6.00	5.00	4.66	4.93	5.23	5.30
30	5.60	......	4.60	4.47	4.55	4.13	6.70	5.00	4.65	5.26	5.23	5.28
31	5.28	......	4.60	......	4.52	......	7.20	4.95	......	5.50	......	5.30

EXHIBIT 200

Estimated monthly discharge of Colorado River at Yuma, Ariz.

[Drainage area, 225,049 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1902.						
January	4,520	3,230	3,727	229,164	0.017	0.020
February	4,720	3,300	3,955	219,650	.018	.019
March	5,340	4,340	4,903	301,474	.022	.025
April	11,400	4,340	6,179	367,676	.027	.030
May	59,200	11,400	35,961	2,211,156	.160	.184
June	56,200	29,000	42,520	2,530,115	.189	.211
July	27,000	5,130	12,527	770,255	.056	.065
August	5,560	3,230	4,183	257,203	.019	.022
September	8,360	3,050	3,819	227,246	.017	.019
October	6,600	3,140	4,299	264,335	.019	.022
November	5,540	3,140	4,187	249,144	.019	.021
December	12,600	3,590	5,412	332,771	.024	.028
The year	59,200	3,050	10,973	7,960,189	.049	.666

COLORADO RIVER AT BULLS HEAD, ARIZ.

A gaging station was established at a point of rocks on Colorado River, known as the Bulls Head, by E. T. Perkins, engineer. The station is situated at the Bulls Head, 35 miles north of Needles, Cal., and is accessible only by wagon road up the Arizona side of the river. A cable was stretched across the river at this point on December 1, 1902. T. M. Whedbee, hydrographic aid, was assigned as observer. He resided at the engineering camp, which had headquarters at this locality.

The river was measured with a Price electric-current meter three times a week, and rod readings were taken daily. Mr. Whedbee is believed to be a reliable and accurate observer. The equipment consisted of a five-eighths-inch cable and a gaging car and tag wire. The station was maintained as long as the engineering camp remained at the Bulls Head, and then the material was removed and stored at the Needles, with the exception of the gage rod.

The gage is an inclined wooden rod divided into tenths of a foot. It is well painted and is fastened to the left rock bank of the river. A bronze bench-mark tablet is set on the Arizona side in the rock about 20 feet above low-water mark and about 50 feet downstream from the gage rod. The elevation of the bench mark is 530.523 feet

above sea level and the zero of the rod equals an elevation of 499.902 feet. The initial point for soundings is the left bank. The river channel is straight for about 1,000 feet above and 500 feet below the cable station and the current is rather swift. The banks are high and rocky, but the channel of the river is shifting silt. A determination was made of the value of "n" at this gaging station. It was found that "n" equaled 0.010.

Discharge measurements of Colorado River at Bulls Head.

Date.	Hydrographer	Gage height.	Discharge.
1902.		*Feet.*	*Second-feet.*
December 5	J. T. Whistler	3.00	5,786
December 10	L. M. Barnes	2.65	4,051
December 13	do	2.45	3,222
December 17	do	2.95	4,138
December 20	do	3.50	4,792
December 24	do	3.23	4,999
December 29	do	2.45	3,366
December 31	do	2.20	2,913

VERDE RIVER NEAR M'DOWELL, ARIZ.

A number of large irrigation enterprises have been planned, designed to divert water from the lower stretch of this river to irrigate lands north of Phœnix, but none has been constructed. The results of measurements of this river combined with those of Salt River show the amount of water available for the irrigable lands of Phœnix Valley. The dam of the Arizona Canal Company is located on Salt River immediately below the mouth of the Verde. The gaging station on the Verde is located three-fourths of a mile above its mouth and 30 miles northeast of Phœnix. It was established April 20, 1897. The station is equipped with a cable, car, and tagged wire. The gage consists of a 2 by 4 inch inclined rod fastened to posts driven into the east bank of the river about 400 feet below the gaging cable. The bench mark is on a cat's-claw tree (*Acacia*) about 100 feet southeast of the old gage, on a cottonwood tree, which is 60 feet below the cable. The elevation of the bench mark is 27.02 feet above gage datum. The channel of the river is similar to that of Salt River—sandy and liable to change during a slight rise, and a large number of measurements are necessary in order to accurately determine the discharge.

Discharge measurements of Verde River near McDowell, Ariz.

Date.	Hydrographer.	Gage height.	Discharge.
1902.		*Feet.*	*Second-feet.*
January 4	J. Fred Appleby	5.33	224
January 11	do	5.36	222
January 19	do	5.29	197
January 25	do	5.35	263
January 27	do	5.41	239
February 1	do	5.45	241
February 8	do	5.35	253
February 15	do	5.32	241
February 22	do	5.31	239
March 1	do	5.40	245
March 8	W. Richins	5.40	251
March 15	do	5.41	233
March 22	do	5.35	208
March 26	do	5.48	281
March 29	do	5.50	273
April 1	do	5.95	426
April 5	do	5.52	252
April 8	do	5.42	241
April 10	do	5.50	256
April 15	do	5.20	150
April 19	do	5.10	116
July 14	Frank P. Trott	4.47	37
July 19	do	4.58	42
July 26	do	5.00	148

Daily gage height, in feet, of Verde River near McDowell, Ariz.

Day.	Jan.	Feb.	Mar.	Apr.	July.
1902.					
1	5.33	5.44	5.40	5.93	....
2	5.34	5.43	5.42	5.93	....
3	5.34	5.43	5.42	5.68	....
4	5.33	5.40	5.43	5.63	....
5	5.33	5.39	5.44	5.51	....
6	5.33	5.39	5.42	....	....
7	5.39	5.40	5.40	5.42	....
8	5.35	5.34	5.40	5.44	....
9	5.34	5.36	5.37	5.55	....
10	5.32	5.38	5.40	5.49	....
11	5.36	5.36	5.40	5.42	....
12	5.35	5.35	5.47	5.39	....
13	5.36	5.38	5.43	....	....
14	5.35	5.38	5.42	5.27	....
15	5.33	5.32	5.41	5.20	....
16	5.29	5.32	5.41	5.17	....
17	5.29	5.31	5.41	5.15	....
18	5.29	5.33	5.41	5.11	....
19	5.29	5.36	5.41	5.10	....
20	5.31	5.34	5.40	....	....
21	5.32	5.32	8.39	....	....
22	5.33	5.31	5.35	....	....
23	5.33	5.33	....	....	4.90
24	5.33	5.32	5.35	....	4.85
25	5.36	5.37	5.40	....	7.44
26	5.45	5.42	5.52	....	5.00
27	5.41	5.39	5.47	....	....
28	5.38	5.36	5.49	....	....
29	5.39	....	5.49	....	....
30	5.45	....	....	....	....
31	5.43	....	5.42	....	....

SALT RIVER AT M'DOWELL, ARIZ.

Irrigation is practiced to a small extent on Salt River in what is known as Tonto Valley, but shortly after Tonto Creek joins it the river enters a canyon and continues in it until a short distance above the mouth of Verde River. At this point the river reappears from its canyon, and its course is thence across the Plains district until it enters Gila River at the northwest corner of Gila River Indian Reservation. From the mouth of Verde River down to Gila River a number of large canals divert the water of Salt River and serve the extensively irrigated lands in the vicinity of Phœnix on the north side and Mesa on the south side of the river. During ordinary seasons all of the water of Salt River is diverted, and at the present time there is a shortage in the summer months. The gaging station, established April 20, 1897, is located 4,000 feet above the mouth of the Verde and 30 miles northeast of Phœnix. The gage consists of a 2 by 6 inch scantling bolted to rocks on the south side of the river about 300 feet above the cable. The bench mark is a nail in a palo verde tree about 75 feet west of the north cable anchorage and is 17.33 feet above gage zero. The bed of the river is sandy and shifting, and it is necessary to make a large number of measurements in order to obtain an accurate estimate of the discharge.

The station was temporarily discontinued during 1900, but measurements were resumed in 1901.

Discharge measurements of Salt River at McDowell, Ariz.

Date.	Hydrographer.	Gage height.	Discharge.
1902.		*Feet.*	*Second-feet.*
January 4	J. Fred Appleby	0.82	154
January 11	do	.79	157
January 19	do	.82	153
January 25	do	.85	170
January 27	do	1.03	214
February 1	do	.99	179
February 8	do	.92	185
February 15	do	.90	180
February 22	do	.89	191
March 1	do	.97	194
March 8	W. Richins	.91	193
March 15	do	.87	194
March 22	do	.85	206
March 26	do	1.02	238
March 29	do	.96	229
April 1	do	.92	206
April 5	do	1.00	231
April 8	do	1.12	282
April 10	do	1.35	357
April 15	do	1.26	333
April 19	do	1.12	272
July 14	F. P. Trott	.13	56
July 19	do	.61	126
December 24	W. Richins	1.30	417

Daily gage height, in feet, of Salt River at McDowell, Ariz., for 1902.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	0.79	0.99	0.96	0.91	17	0.82	0.91	0.88	1.19
2	.79	.97	.96	.91	18	.82	.90	.88	1.14
3	.79	.94	.94	.91	19	.81	.90	.85	1.12
4	.83	.91	.93	.93	20	.83	.89	.85	
5	.82	.90	.92	.99	21	.83	.89	.85	
6	.81	.92	.92	1.03	22	.83	.89	.85	
7	.83	.93	.92	1.07	23	.83	.89	.89	
8	.81	.92	.91	1.14	24	.83	.89	.92	
9	.80	.92	.89	1.28	25	.85	.90	1.04	
10	.81	.91	.91	1.37	26	1.02	.93	1.01	
11	.78	.90	.88	1.40	27	1.03	.93	1.00	
12	.77	.90	.87	1.40	28	1.02	.96	.99	
13	.81	.90	.87	1.35	29	.98		.96	
14	.81	.90	.87	1.30	30	1.06		.93	
15	.81	.90	.87	1.24	31	1.03		.90	
16	.81	.91	.88	1.21					

Estimated monthly discharge of Salt River at McDowell, Ariz.

[Drainage area, 6,260 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1902.						
January	250	137	176	10,816	0.028	0.032
February	231	193	198	11,020	.032	.033
March	250	174	197	12,131	.031	.036
April 1 to 19			287	10,816	.046	.032

SALT RIVER AT RESERVOIR SITE, NEAR LIVINGSTONE, ARIZ.

The station, established February 7, 1901, by H. G. Heisler, is 15 miles west of Livingstone, Ariz. The rod is on the left bank of the river at the upper end of the gorge. Gagings are made from a traveling car suspended from a cable.

EXHIBIT 201

Mean daily discharge, in second-feet, of Salt River at Roosevelt, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	223	217	212	195	124	105	64	675	600	158	175	168
2	224	217	212	191	123	100	62	590	540	154	173	169
3	224	217	213	182	123	95	60	720	520	154	171	168
4	224	217	219	178	123	93	58	1,615	460	150	166	170
5	224	216	219	174	122	93	56	960	435	146	166	168
6	223	224	219	170	122	90	54	445	415	146	166	171
7	223	220	220	166	122	90	54	480	415	555	166	176
8	223	220	220	158	122	87	54	590	385	610	166	234
9	223	215	221	153	118	84	52	445	385	285	166	215
10	222	215	221	150	296	84	52	1,065	385	235	166	194
11	222	215	221	152	140	83	52	590	385	230	166	182
12	222	215	226	149	178	83	50	410	385	690	166	174
13	222	214	227	146	158	80	50	380	1,020	595	163	174
14	222	214	227	145	150	80	51	590	700	530	163	174
15	221	214	228	146	146	80	52	1,120	1,970	450	160	170
16	221	214	228	143	139	77	52	1,355	990	400	160	170
17	221	213	228	143	136	76	52	3,600	880	350	160	170
18	221	213	229	139	128	76	52	2,645	630	280	160	170
19	220	213	229	139	124	74	52	1,295	385	220	160	166
20	220	213	225	136	124	74	57	1,235	215	210	160	166
21	220	213	224	136	124	74	55	590	186	211	160	166
22	220	212	218	136	122	71	1,550	14,700	178	207	160	166
23	219	212	217	132	120	71	515	3,200	178	198	164	174
24	219	212	210	132	119	71	105	1,500	174	201	164	166
25	219	212	209	131	117	66	960	1,320	170	193	164	166
26	219	211	207	128	115	66	765	940	166	192	160	162
27	218	211	206	127	116	66	960	740	166	195	161	158
28	218	211	204	124	115	66	1,065	940	166	194	162	158
29	218	211	203	124	113	66	910	780	162	187	163	158
30	218	......	197	124	109	64	2,055	720	158	186	164	158
31	218	......	195	......	107	......	1,010	660	......	184	......	158

Estimated monthly discharge of Salt River at Roosevelt, Ariz., for 1904.

[Drainage area, 5,756 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	224	218	221	13,590	0.038	0.044
February	224	211	215	12,370	.037	.040
March	229	195	217	13,340	.038	.044
April	195	124	148	8,807	.026	.029
May	296	107	132	8,116	.023	.027
June	105	64	79.5	4,731	.014	.016
July	2,055	50	356	21,890	.062	.071
August	14,700	380	1,513	93,030	.263	.303
September	1,970	158	460	27,370	.080	.089
October	690	146	281	17,280	.049	.056
November	175	160	164	9,759	.028	.031
December	234	158	172	10,580	.030	.035
The year	14,700	50	330	240,900	.057	.785

NOTE.—The above estimates have been prepared by interpolation based upon the discharge measurements and gage heights.

SALT RIVER AT M'DOWELL, ARIZ.

This station was established April 20, 1897, by J. B. Lippincott. It is located one-third mile above the junction of the Salt and Verde rivers, 30 miles northeast of Phoenix, 15 miles northeast of Mesa, and 1¾ miles above the Arizona canal diversion dam. There have been three gages in use at this station, as follows:

Gage No. 1, set by J. B. Lippincott April 20, 1897, was a 2 by 6 inch timber bolted to the rocks on the south bank of the river about one-fourth mile above the cable, from which discharge measurements are made. This gage, which has since been removed, was used until November 30, 1899, when the station was temporarily abandoned. The bench mark is a nail in a palo verde tree about 75 feet west of cable anchorage on the north bank. Its elevation is 17.33 feet above the zero of the gage.

In 1901 observations were resumed, and gage No. 2 was established by J. F. Appleby. It consists of a 2 by 6 inch timber fastened to a tree on the north bank of the river three-fourths mile above the cable. The zero of the gage is 1,323.54 feet above sea level, and its bench mark is a nail in a root of the willow tree to which the gage is fastened. Its elevation is 1,328.69 feet above sea level and 5.10 feet above the zero of the gage. On April 2, 1903, high water in the Verde River backed up the water on gage No. 2 and changed the cross section by depositing sand.

Gage No. 3 was established May 19, 1903, by W. W. Schlecht. It consists of a 1 by 6 inch stadia rod spiked to a 2 by 4 inch timber and fastened to a tree on the south bank 1⅓ miles above the cable. The water surface at this gage is about 15 feet higher than at the mouth of the Verde River, and the zero of the gage is 1,336.27 feet above sea level. Three bench marks have been established for gage No. 3: First, a nail in a mesquite stump 200 feet east of Peters's corral. Its elevation is 1,363.2 feet above sea level and 26.93 feet above the zero of the gage. Second, a nail in a root of a mesquite tree on the top of the bank 50 feet northwest of the northwest corner of Peters's corral and about 75 feet from the gage. Its elevation is 1,356 feet above sea level and 19.73 feet above the zero of the gage. Third, a nail in the willow tree to which the gage is attached. Its elevation is 1,344.27 feet above sea level and 8.00 feet above the zero of the gage. The observer is W. Richins, who also makes the discharge measurements.

Discharge measurements are made by means of a cable and car. The south end of the cable is anchored to the rocks and the north end is run over an 8 by 8 inch standard 21 feet high. During low water discharge measurements are made by wading about 1,000 feet upstream from the cable where a tag wire has been placed. The initial point for soundings is 120 feet south of the standard under the cable at the north bank. The channel is straight for about 500 feet above and below the station. The current is swift. The right bank is about 3½ feet high at the water's edge and rises with a gradual slope for 400 feet. It is clean and subject to overflow. The left bank rises vertically for about 5 feet, when there is a small bench from which the rocks rise to a considerable height. The bank is clean and is not subject to overflow. The bed of the stream is composed of sand and is shifting, and it is necessary to make a large number of measurements in order to obtain an accurate estimate of the discharge.

The 1903 rating tables do not apply to the gage heights from April 2, 1903, until readings were begun on the new gage, May 19, 1903.

The observations at this station during 1904 have been made under the direction of C. G. Williams, district hydrographer.

Discharge measurements of Salt River at McDowell, Ariz., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.[a]	Discharge.
		Sq. feet.	Ft. per sec.	Feet.	Sec.-feet.
January 1	W. Richins	145	1.30	1.46	189
January 6	do	146	1.33	1.46	194
January 9	do	145	1.31	1.46	190
January 12	do	147	1.32	1.47	194
January 15	do	145	1.32	1.46	191
January 18	do	141	1.29	1.45	182
January 22	do	149	1.27	1.47	189
January 26	do	147	1.24	1.46	182
January 29	do	143	1.15	1.45	164
February 2	do	138	1.20	1.44	165
February 5	do	138	1.18	1.45	163
February 9	do	146	1.30	1.50	190
February 12	do	124	1.26	1.45	156
February 16	do	120	1.38	1.47	165
February 19	do	121	1.36	1.46	165
February 23	do	139	1.39	1.51	194
February 26	do	129	1.33	1.47	171
March 1	do	130	1.36	1.50	177
March 4	do	135	1.36	1.50	184
March 8	do	129	1.43	1.49	184
March 11	do	120	1.34	1.45	161
March 14	do	124	1.35	1.45	167
March 18	do	118	1.27	1.42	150
March 22	do	115	1.26	1.40	145
March 25	do	127	1.29	1.45	164
March 29	do	121	1.38	1.45	167

[a] Gage No. 3.

Discharge measurements of Salt River at McDowell, Ariz., in 1904—Continued.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	Ft. per sec.	Feet.	Sec.-feet.
April 1	W. Richins	115	1.32	1.42	152
April 5	do	125	1.38	1.46	173
April 8	do	117	1.27	1.40	148
April 12	do	114	1.24	1.37	141
April 15 [a]	do	88	1.43	1.33	126
April 19 [a]	do	87	1.39	1.32	121
April 22 [a]	do	85	1.28	1.29	109
April 26 [a]	do	88	1.36	1.32	120
April 29 [a]	do	84	1.27	1.29	107
May 3 [a]	do	82	1.32	1.29	108
May 6 [a]	do	82	1.25	1.28	103
May 10 [a]	do	83	1.29	1.28	107
May 13 [a]	do	96	1.49	1.37	143
May 17 [a]	do	99	1.57	1.39	155
May 20 [a]	do	86	1.39	1.32	120
May 24 [a]	do	84	1.35	1.28	113
May 27 [a]	do	82	1.28	1.24	105
May 31 [a]	do	78	1.18	1.21	92
June 3 [a]	do	73	1.12	1.16	82
June 7 [a]	do	67	1.13	1.12	76
June 10 [a]	do	67	1.05	1.10	70
June 14 [a]	do	62	1.12	1.13	70
June 17 [a]	do	59	1.02	1.06	60
June 21 [a]	do	51	1.00	1.02	51
June 24 [a]	do	49	1.01	1.01	50
June 28 [a]	do	51	1.11	1.05	57
July 1 [a]	do	47	1.04	1.01	49
July 5 [a]	do	50	1.10	1.05	55
July 8 [a]	do	48	1.03	1.03	49
July 12 [a]	do	48	1.04	1.03	50
July 15 [a]	do	43	.91	.94	39
July 19 [a]	do	42	.95	.95	40
July 22 [a]	do	47	1.15	1.03	54
July 23	do	578	6.59	4.25	3,810
July 26	do	295	2.03	2.17	598
July 27	do	859	3.85	4.40	3,307
July 29	do	293	1.54	1.90	450
August 2	do	336	1.98	2.25	664
August 5	do	392	2.27	2.65	891

[a] Measurement made 1,000 feet upstream from cable station.

Discharge measurements of Salt River at McDowell, Ariz., in 1904—Continued.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
August 9	W. Richins	257	1.98	2.00	510
August 12	do	279	1.88	1.90	525
August 16	do	298	2.15	2.07	642
August 19	do	646	3.87	3.60	2,499
August 23	do	2,273	5.72	8.40	13,010
August 26	do	526	2.17	3.60	1,142
August 30	do	464	2.14	3.40	994
September 2	do	413	2.44	3.60	1,010
September 6	do	264	1.57	2.40	416
September 9	do	215	1.35	2.07	290
September 13	do	631	5.22	4.92	3,292
September 16	do	370	2.19	2.70	811
September 20	do	167	1.56	1.90	260
September 30	do	128	1.27	1.72	162
October 4	do	139	1.28	1.75	178
October 7	do	127	1.27	1.72	161
October 11	do	177	1.78	1.95	315
October 14	do	233	1.98	2.23	461
October 18	do	173	1.72	1.97	297
October 25	do	145	1.57	1.83	228
October 28	do	139	1.40	1.79	194
November 1	do	138	1.37	1.78	192
November 4	do	136	1.38	1.77	187
November 11	do	124	1.41	1.74	175
November 15	do	122	1.48	1.76	181
November 18	do	118	1.37	1.74	163
November 22	do	129	1.31	1.76	170
November 29	do	136	1.26	1.76	172
December 6	do	144	1.25	1.78	181
December 9	do	143	1.57	1.88	225
December 13	do	133	1.51	1.86	201
December 16	do	142	1.44	1.86	205
December 20	do	124	1.34	1.83	166
December 23	do	124	1.46	1.82	181
December 27	do	136	1.45	1.85	197
December 30	do	124	1.46	1.82	181

Mean daily gage height, in feet, of Salt River at McDowell, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.46	1.43	1.50	1.42	a1.28	1.18	1.02	2.65	3.63	1.72	1.78	1.76
2	1.47	1.43	1.50	1.43	1.28	1.17	1.03	2.17	3.45	a1.72	1.78	1.76
3	a1.46	1.43	1.50	a1.44	1.29	1.15	1.03	1.97	3.18	1.72	1.77	1.77
4	1.46	1.44	1.50	1.45	1.26	1.13	1.04	2.83	a3.05	1.76	1.77	a1.78
5	1.46	1.44	1.49	1.45	1.27	a1.13	1.03	2.83	2.92	1.71	1.76	1.79
6	1.46	1.47	1.49	1.44	1.27	1.13	1.04	2.02	2.35	1.76	1.77	1.79
7	1.45	a1.50	1.48	1.41	1.26	1.12	1.04	2.90	2.20	1.72	1.77	1.84
8	1.46	1.52	1.48	1.40	a1.26	1.10	1.02	2.90	2.15	2.21	1.77	1.88
9	1.46	1.50	1.47	1.39	1.27	1.11	1.02	1.87	2.06	2.10	1.77	1.88
10	a1.46	1.47	1.45	1.37	1.28	1.10	a1.02	1.88	2.00	2.08	1.76	1.88
11	1.46	1.47	1.45	1.38	1.37	1.09	1.02	2.32	a1.95	1.92	1.74	a1.87
12	1.47	1.45	1.42	1.36	1.33	1.10	1.03	2.00	1.90	2.13	1.74	1.86
13	a1.46	1.45	1.45	1.36	1.36	1.14	.95	1.90	4.85	2.31	a1.75	1.86
14	1.46	a1.46	1.45	1.34	1.36	1.13	.94	3.30	2.30	2.22	1.76	1.85
15	1.46	1.47	1.44	1.33	1.46	1.09	.94	2.07	2.90	2.13	1.76	1.84
16	1.45	1.47	1.44	1.33	1.40	1.06	.93	d2.50	2.75	a2.08	1.75	1.86
17	a1.45	1.47	1.43	1.33	1.40	1.06	.95	d3.15	2.40	2.03	1.74	1.85
18	1.45	1.46	1.42	1.32	1.34	1.05	.95	4.27	a2.26	1.96	1.74	a1.84
19	1.46	1.46	1.41	1.31	1.34	1.04	.95	e3.55	2.13	1.91	1.74	1.83
20	1.46	1.46	1.40	1.30	1.32	1.03	.95	3.35	1.90	1.88	a1.74	1.82
21	1.46	a1.46	1.40	1.28	1.31	1.02	.98	3.51	1.84	1.86	1.75	1.82
22	1.47	1.47	1.40	1.29	a1.30	1.02	1.04	3.37	1.78	1.85	1.76	1.81
23	1.47	1.50	1.41	1.30	1.29	1.01	b3.40	8.65	1.80	a1.84	1.76	1.82
24	a1.46	1.47	1.43	a1.31	1.28	1.01	1.58	f5.50	1.80	1.84	1.76	1.84
25	1.46	1.47	1.45	1.32	1.28	1.01	1.28	f4.15	1.77	1.82	1.76	a1.84
26	1.45	1.46	1.45	1.31	1.25	1.01	1.25	3.45	1.76	1.81	1.76	1.84
27	1.46	1.46	1.45	1.30	1.24	1.05	c3.70	3.27	1.75	1.79	1.76	1.84
28	1.45	a1.48	1.45	1.29	1.24	1.05	2.37	4.00	1.73	1.79	1.76	1.83
29	1.45	1.49	1.44	1.28	1.24	1.03	1.98	3.62	1.73	1.79	1.76	1.82
30	1.45	......	1.43	1.27	1.22	1.02	4.85	3.35	1.72	1.80	1.76	1.82
31	a1.44	......	1.42	......	1.20	......	2.60	3.70	......	1.78	......	1.81

a Interpolated gage height.
b Freshet July 23—gage height 9 a. m., 4.5 feet; 11 a. m., 4 feet.
c July 27, gage height 11 a. m., 8 feet; 12 m., 5.2 feet; 2 p. m., 4 feet.
d Night of Aug. 16–17, gage height 8.7 feet.
e Aug. 19, 12 m., the gage read 4.4 feet.
f Night Aug. 24–25, gage height 9.5 feet.

NOTE.—All readings from gage No. 3.

Mean daily discharge, in second-feet, of Salt River at McDowell, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	189	161	177	152	105	85	51	1,050	1,070	162	188	171
2	193	162	179	157	105	84	52	600	1,010	162	190	170
3	191	160	182	162	108	79	52	415	760	161	186	176
4	192	161	184	168	99	76	53	1,115	700	184	187	181
5	193	160	182	170	101	77	51	1,070	640	154	181	187
6	194	172	182	165	100	77	52	410	395	184	187	186
7	190	185	180	153	98	76	52	1,240	335	161	187	210
8	191	194	180	148	99	71	47	1,310	320	460	187	230
9	190	190	174	145	103	73	48	420	287	397	187	225
10	190	174	165	140	107	70	48	450	267	389	181	222
11	190	168	161	144	137	66	48	840	250	297	169	213
12	194	156	153	138	128	66	50	600	236	415	169	204
13	191	157	165	137	140	74	39	520	3,200	515	175	201
14	191	160	167	130	142	70	38	2,060	510	455	181	196
15	191	164	162	126	174	63	39	645	970	400	181	192
16	186	165	160	126	157	58	38	1,040	850	368	172	205
17	184	166	155	125	158	60	40	1,820	575	337	163	199
18	182	164	160	121	135	58	40	3,670	485	293	160	193
19	185	165	147	118	131	55	40	2,420	400	265	161	187
20	186	168	145	114	120	53	40	2,120	260	249	161	181
21	186	172	145	107	118	51	45	2,360	225	239	167	181
22	189	178	145	109	116	51	56	2,140	190	235	173	175
23	188	191	149	113	115	50	2,340	13,700	203	230	173	181
24	184	178	157	116	113	50	320	2,200	204	232	173	193
25	183	174	164	120	114	50	130	1,640	188	222	173	192
26	179	168	165	117	107	50	100	1,030	182	213	172	192
27	177	167	165	113	105	57	2,150	900	177	198	172	191
28	169	172	166	108	104	57	720	1,500	166	194	172	186
29	164	175	164	104	103	53	510	1,150	167	194	172	180
30	165	......	159	102	96	51	4,650	994	162	200	172	181
31	163	......	154	......	89	......	1,020	1,170	......	188	......	175

Estimated monthly discharge of Salt River at McDowell, Ariz., for 1904.

[Drainage area, 6,260 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	194	163	185	11,380	0.030	0.035
February	194	156	170	9,779	.027	.029
March	184	145	164	10,080	.026	.030
April	170	102	132	7,855	.021	.023
May	174	89	117	7,194	.019	.022
June	85	50	63.7	3,790	.010	.011
July	4,650	38	418	25,700	.067	.077
August	13,700	410	1,697	104,300	.271	.312
September	3,200	162	513	30,530	.082	.091
October	515	154	269	16,540	.043	.050
November	190	160	176	10,470	.028	.031
December	230	170	192	11,810	.031	.036
The year	13,700	38	341	249,400	.055	.747

NOTE.—The above estimates have been prepared by interpolation based upon the discharge measurements and gage heights.

TONTO CREEK AT ROOSEVELT, ARIZ.

This station, established April 1, 1901, by H. G. Heisler, is located at the town of Roosevelt and about 12 miles west of Livingston. This station was called Tonto Creek near Livingston in reports previous to 1903.

The gage, a vertical rod fastened to a cliff of cemented gravel on the left bank, was about 3,500 feet above the mouth of the creek. Measurements were made by wading with meter during low water and by means of floats over a course of 25 feet during floods. The channel is straight for about 300 feet above and 1,000 feet below the station. The current above the station is swift at high stages and swift below the station. The right bank is high, and is not subject to overflow. The left bank is low, wooded, and liable to overflow. The bed of the stream is composed of sand and gravel and is shifting. This station was abandoned the latter part of August, 1904, owing to the destruction of the gage by a flood. All the water is measured at the Roosevelt station on Salt River, immediately below.

The observations at this station during 1904 have been made under the direction of C. G. Williams, district hydrographer.

Mean daily gage height, in feet, of Tonto Creek at Roosevelt, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	3.25	3.25	3.25	3.25	3.25	3.25	3.25	4.25
2	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.45
3	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.55
4	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.90
5	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.32
6	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.30
7	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.30
8	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.30
9	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.40
10	3.25	3.25	3.25	3.25	3.25	3.25	3.25	4.37
11	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.90
12	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.70
13	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.70
14	3.25	3.25	3.25	3.25	3.25	3.25	3.25	4.15
15	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.77
16	3.25	3.25	3.25	3.25	3.25	3.25	3.25	4.82
17	3.25	3.25	3.25	3.25	3.25	3.25	3.25	5.15
18	3.25	3.25	3.25	3.25	3.25	3.25	3.25	5.40
19	3.25	3.25	3.25	3.25	3.25	3.25	3.25	5.50
20	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.90
21	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.75
22	3.25	3.25	3.25	3.25	3.25	3.25	5.37	4.25
23	3.25	3.25	3.25	3.25	3.25	3.25	4.25	10.10
24	3.25	3.25	3.25	3.25	3.25	3.25	3.45	4.25
25	3.25	3.25	3.25	3.25	3.25	3.25	5.47	3.60
26	3.25	3.25	3.25	3.25	3.25	3.25	5.29	3.47
27	3.25	3.25	3.25	3.25	3.25	3.25	5.85	3.45
28	3.25	3.25	3.25	3.25	3.25	3.25	5.62	3.75
29	3.25	3.25	3.25	3.25	3.25	3.25	5.75	3.50
30	3.25		3.25	3.25	3.25	3.25	6.05	3.50
31	3.25		3.25		3.25		6.20	3.50

VERDE RIVER AT McDOWELL, ARIZ.

This station was established April 20, 1897, by J. B. Lippincott. It is located 30 miles northeast of Phoenix, 15 miles northeast of Mesa, 2⅛ miles above the Arizona Canal diversion dam, and three-fourths of a mile above the mouth of the river. Three gages have been in use at this station, as follows:

Gage No. 1 was established April 20, 1897, by J. B. Lippincott. It consisted of a vertical rod attached to a large cottonwood tree on the east bank about 60 feet below the cable. Readings were taken from this gage until November 11, 1899, when the station was temporarily abandoned. The bench mark is a point on a cats-claw (Acacia) tree about 100 feet southeast of the gage. Its elevation is 27.02 feet above the zero of the gage.

Gage No. 2 was established in January, 1901, by H. G. Heisler, and observations were resumed. It is an inclined 2 by 4 inch timber, fastened to the rocks on the west bank about 500 feet above the cable, the zero of the gage being 1,325.4 feet above sea level. Three bench marks have been established for gage No. 2. First, a nail in a mesquite tree about 6 feet below the cable anchorage on the east bank; its elevation is 1,345.5 feet above sea level, and 20.10 feet above the zero of the gage. Second, a nail in the cable standard at the east bank; its elevation is 1,341.3 feet above sea level, and 15.90 feet above the zero of the gage. Third, a mark on rock at the gage; its elevation is 1,330.4 feet above sea level, and 5.00 feet above the zero of the gage.

On account of water piling up at gage No. 2 during flood, gage No. 3 was established May 16, 1904, by C. G. Williams. It is a vertical 1¼ by 6 inch rod spiked to a 2 by 6 inch timber fastened to a willow tree on the east bank about one-half mile above the cable. The zero of the gage is 1,339.26 feet above sea level. Two bench marks have been established for gage No. 3. First, a nail in a large cottonwood tree on the top of the east bank near the gage; its elevation is 1,354.11 feet above sea level, and 14.85 feet above the zero of the gage. Second, a nail in the willow tree to which the gage is attached; its elevation is 1,347.26 feet above sea level, and 8.00 feet above the zero of the gage. The observer is W. Richins, who also makes the discharge measurements.

Discharge measurements are made by means of a cable, car, and tagged wire. At low water the channel is oblique to the gaging section and measurements are made by wading at a point 400 feet above the cable. The channel is straight for a distance of 300 feet above and below the station, and has a width at low water of 100 feet and at high water of 450 feet. The current is swift. The right bank is high, rocky, clean, and is not subject to overflow; the left bank is low, clean, and is subject to overflow. The bed of the stream is composed of sand and is shifting.

The observations at this station during 1904 have been made under the direction of C. G. Williams, district hydrographer.

Discharge measurements of Verde River at McDowell, Ariz., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
January 1	W. Richins	119	1.97	2.19	235
January 6	do	119	2.01	2.19	239
January 9	do	128	1.97	2.20	252
January 12	do	125	2.00	2.20	250
January 15	do	116	1.94	2.15	225
January 18	do	115	1.98	2.13	228
January 22	do	124	2.05	2.13	254
January 26	do	115	2.01	2.12	231

Discharge measurements of Verde River at McDowell, Ariz., in 1904—Continued.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Dis-charge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
January 29	W. Richins	112	2.01	2.10	225
February 2	do	112	2.03	2.10	227
February 5	do	117	2.05	2.10	240
February 9	do	112	2.11	2.10	236
February 12	do	105	2.28	2.06	239
February 16	do	102	2.16	2.00	220
February 19	do	100	2.22	2.00	222
February 23	do	97	2.24	1.99	217
February 26	do	93	2.27	1.95	211
March 1	do	94	2.34	1.92	220
March 4	do	84	2.19	1.85	184
March 8 [a]	do	85	1.58	1.80	134
March 11 [a]	do	90	1.74	1.82	157
March 14 [a]	do	91	1.80	1.87	164
March 18 [a]	do	100	1.97	1.92	197
March 22 [a]	do	99	2.07	1.92	205
March 25 [a]	do	96	2.31	1.99	221
March 29 [a]	do	95	2.02	1.88	192
April 1 [a]	do	89	1.97	1.83	175
April 5 [a]	do	84	1.81	1.79	152
April 8 [a]	do	84	1.67	1.74	140
April 12 [a]	do	75	1.53	1.65	115
April 15 [a]	do	75	1.45	1.64	109
April 19 [a]	do	74	1.31	1.60	97
April 22 [a]	do	75	1.37	1.63	103
April 26 [a]	do	77	1.32	1.62	102
April 29 [a]	do	75	1.28	1.59	96
May 3 [a]	do	76	1.24	1.58	94
May 6 [a]	do	77	1.38	1.62	106
May 10 [a]	do	71	1.31	1.52	93
May 13 [a]	do	71	1.42	1.53	101
May 17 [a]	do	99	2.12	1.82	210
May 20 [a]	do	75	1.80	1.49	135
May 24 [a]	do	70	1.50	1.36	105
May 27 [a]	do	66	1.38	1.31	91
May 31 [a]	do	66	1.37	1.27	90
June 3 [a]	do	63	1.29	1.23	81
June 7 [a]	do	62	1.29	1.21	80
June 10 [a]	do	62	1.29	1.21	80

[a] Measurement made at temporary station 400 feet upstream from cable station.

Discharge measurements of Verde River at McDowell, Ariz., in 1904—Continued.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Dis-charge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 14 [a]	W. Richins	56	1.16	1.16	65
June 17 [a]	do	55	1.13	1.14	62
June 21 [a]	do	53	.96	1.08	51
June 24 [a]	do	50	.86	1.02	43
June 28 [a]	do	52	.98	1.06	51
July 1 [a]	do	49	.96	1.02	47
July 5 [a]	do	48	.92	1.01	44
July 8 [a]	do	49	.94	1.02	46
July 12 [a]	do	50	.94	1.02	47
July 15 [a]	do	46	.87	.99	40
July 19 [a]	do	42	.76	.92	32
July 22 [b]	do	102	1.38	.50	141
July 26 [b]	do	347	2.89	2.02	1,003
July 27 [b]	do	1,233	5.23	5.30	6,450
July 29 [b]	do	449	2.98	2.33	1,340
July 31 [b]	do	1,178	5.15	5.42	6,070
August 2 [b]	do	409	2.77	2.32	1,133
August 5 [b]	do	383	2.94	2.10	1,125
August 9 [b]	do	319	2.59	1.75	826
August 12 [b]	do	519	3.88	2.83	2,014
August 16 [b]	do	276	3.05	1.55	841
August 19 [b]	do	370	3.36	1.95	1,244
August 23 [b]	do	815	6.36	5.10	5,184
August 26 [b]	do	377	3.55	2.55	1,340
August 30 [b]	do	435	3.89	2.50	1,693
September 2 [b]	do	319	2.94	1.95	938
September 6 [b]	do	207	2.47	1.50	513
September 9 [b]	do	160	2.24	1.05	359
September 13 [b]	do	339	3.27	1.95	1,109
September 16 [b]	do	224	2.26	1.50	506
September 20 [b]	do	146	2.10	1.15	307
September 30 [b]	do	87	2.03	.68	177
October 4 [b]	do	100	2.00	.72	200
October 7 [b]	do	94	1.87	.68	176
October 11 [b]	do	96	2.10	.75	202
October 14 [b]	do	94	2.15	.72	202
October 18 [b]	do	85	1.94	.70	165
October 25 [b]	do	97	2.08	.74	202
October 28 [b]	do	91	2.13	.75	194
November 1 [b]	do	93	2.07	.78	193
November 4 [b]	do	101	2.04	.79	206
November 11 [b]	do	95	2.11	.84	200
November 15 [b]	do	105	2.01	.87	211
November 18 [b]	do	104	2.05	.90	213
November 29 [b]	do	104	2.09	.95	217
November 29 [b]	do	108	1.99	.94	215

[a] Measurement made at temporary station 400 feet upstream from cable station.
[b] Gage heights from July 21 to December 31 taken from gage No. 3. Measurement made at cable station. All other gage heights from gage No. 2.

Discharge measurements of Verde River at McDowell, Ariz., in 1904—Continued.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
December 6 [a]	W. Richins	113	2.05	.98	232
December 9 [a]	do	121	2.34	1.05	283
December 13 [a]	do	114	2.25	1.02	256
December 16 [a]	do	106	2.08	1.03	221
December 20 [a]	do	116	2.15	1.06	249
December 23 [a]	do	118	2.22	1.07	262
December 27 [a]	do	111	2.06	1.04	229
December 30 [a]	do	111	2.17	1.08	241

[a] Gage heights from July 21 to December 31 taken from gage No. 3. Measurement made at cable station. All other gage heights from gage No. 2.

Mean daily gage height, in feet, of Verde River at McDowell, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.19	2.10	1.92	1.82	[a]1.57	1.25	1.02	2.95	2.07	0.68	0.78	0.95
2	2.19	2.10	1.92	1.81	1.57	1.24	1.02	2.32	1.90	[a].68	.79	.96
3	[a]2.19	2.10	1.89	[a]1.80	1.58	1.23	[a]1.01	2.10	1.75	.72	.78	.96
4	2.19	2.10	1.84	1.80	1.62	1.22	1.00	2.18	[a]1.71	.75	.79	[a].97
5	2.19	2.09	1.82	1.78	1.62	[a]1.22	1.01	2.18	1.67	.68	.79	.98
6	2.19	2.12	1.82	1.75	1.62	1.21	1.00	[c]1.90	1.37	.66	.84	.99
7	2.18	[a]2.11	1.81	1.74	1.60	1.20	1.01	[c]1.80	1.19	.68	.84	1.00
8	2.19	2.10	1.80	1.73	[a]1.57	1.21	1.01	1.55	1.15	.66	.84	1.04
9	2.20	2.10	1.79	1.72	1.54	1.21	1.02	1.77	1.05	[a].67	.85	1.05
10	[a]2.20	2.10	1.80	[a]1.70	1.52	1.20	[a]1.02	1.45	1.05	.73	.84	1.05
11	2.20	2.08	1.82	1.67	1.51	1.20	1.01	1.82	[a]1.05	.75	.84	[a]1.04
12	2.19	2.06	1.83	1.64	1.62	1.19	1.02	2.85	1.05	.73	.83	1.02
13	[a]2.17	2.05	[a]1.85	1.65	1.52	1.17	1.00	1.90	2.80	.72	[a].85	1.02
14	2.15	[a]2.03	1.87	1.63	2.28	1.16	.99	2.22	1.80	.71	.87	1.04
15	2.15	2.01	1.88	1.63	2.23	1.14	.97	2.05	1.65	.71	.88	1.03
16	2.13	2.00	1.91	1.61	1.91	1.13	.97	1.65	1.50	[a].72	.90	1.03
17	[a]2.13	2.00	1.92	[a]1.60	1.79	1.13	[a].95	3.80	1.40	.72	.90	1.03
18	2.13	1.99	1.92	1.59	1.67	1.11	.93	2.42	[a]1.28	.70	.90	[a]1.04
19	2.13	2.00	1.91	1.60	1.56	1.10	.92	2.43	1.17	.68	.91	1.05
20	2.13	2.01	[a]1.91	1.62	1.48	[a]1.08	.92	[c]2.30	1.15	.68	[a].92	1.06
21	2.13	[a]2.00	1.91	1.61	1.42	1.08	[b]1.45	1.90	1.09	.69	.93	1.07
22	2.13	2.00	1.92	1.63	[a]1.40	1.06	.45	2.85	.97	.72	.95	1.06
23	2.12	1.99	1.93	1.63	1.39	1.04	1.15	4.60	.88	[a].72	.94	1.06
24	[a]2.12	1.97	1.98	[a]1.62	1.36	1.02	.56	4.10	.80	.73	.93	1.07
25	2.13	1.97	1.99	1.60	1.35	1.01	.64	3.17	.78	.74	.94	[a]1.06
26	2.12	1.94	1.95	1.62	1.33	[a]1.02	2.02	2.65	.77	.75	.92	1.04
27	2.10	1.93	[a]1.92	1.64	1.30	1.03	4.85	2.42	.73	.75	.93	1.04
28	2.10	[a]1.92	1.89	1.63	1.30	1.06	2.20	[c]3.80	.72	.75	.94	1.06
29	2.10	1.92	1.87	1.59	1.31	1.04	2.35	2.40	.69	.75	.94	1.07
30	2.09	......	1.86	1.57	1.28	1.01	4.85	2.45	.68	[a].76	.94	1.08
31	[a]2.10	......	1.85	......	1.26	......	5.40	2.15	......	.78	......	1.08

[a] Interpolated gage height.
[b] Freshet July 21. Gage height 7 a. m., 2 feet; 12 m., 2.40 feet; 6 p. m., 0.9 feet.
[c] Gage height August 6, 7, 20, and 28 estimated.

NOTE.—Gage height January 1 to July 20 from gage No. 2; July 21 to December 31 from gage No. 3.

Mean daily discharge, in second-feet, of Verde River at McDowell, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	235	226	220	173	92	83	45	1,850	1,090	181	193	119
2	236	227	214	167	92	81	45	1,133	890	184	199	222
3	237	231	200	161	94	79	43	975	740	197	200	224
4	237	236	182	158	104	78	42	1,135	690	207	206	227
5	238	237	168	150	105	78	43	1,210	645	186	203	231
6	239	244	158	142	106	76	42	930	430	176	213	234
7	240	240	146	140	103	74	43	850	365	176	210	248
8	246	237	134	138	99	76	43	659	375	174	208	269
9	252	236	137	134	95	76	45	840	359	178	207	283
10	251	241	146	129	93	74	45	565	365	195	202	278
11	251	240	157	120	92	74	43	840	375	202	200	271
12	247	239	158	113	118	72	45	2,050	385	200	200	261
13	238	236	161	114	99	69	42	960	2,210	200	206	256
14	229	230	164	108	322	67	41	1,370	880	200	212	249
15	225	224	172	107	310	63	38	1,270	670	192	216	234
16	223	220	184	102	233	62	38	935	506	186	218	221
17	226	221	192	99	205	62	36	4,150	440	177	215	226
18	228	219	197	96	166	59	34	1,850	375	165	213	234
19	234	222	197	97	149	57	32	1,850	315	165	213	242
20	241	224	198	101	132	54	32	1,430	307	168	214	249
21	248	222	201	99	118	54	530	850	285	175	214	255
22	254	220	205	103	114	51	135	1,780	243	186	217	256
23	246	217	207	104	112	48	360	4,500	215	190	215	260
24	242	214	219	101	105	45	150	3,650	193	196	213	254
25	239	214	221	98	103	43	170	2,150	190	202	215	246
26	231	208	212	102	99	45	1,008	1,460	190	201	210	235
27	226	210	203	107	93	46	5,600	1,280	183	198	212	229
28	226	212	195	105	93	51	1,200	3,525	183	194	215	235
29	225	216	190	96	95	48	1,360	1,460	177	192	215	238
30	224	......	186	92	89	43	5,250	1,630	177	192	215	241
31	226	......	181	......	85	......	6,030	1,230	......	195	......	241

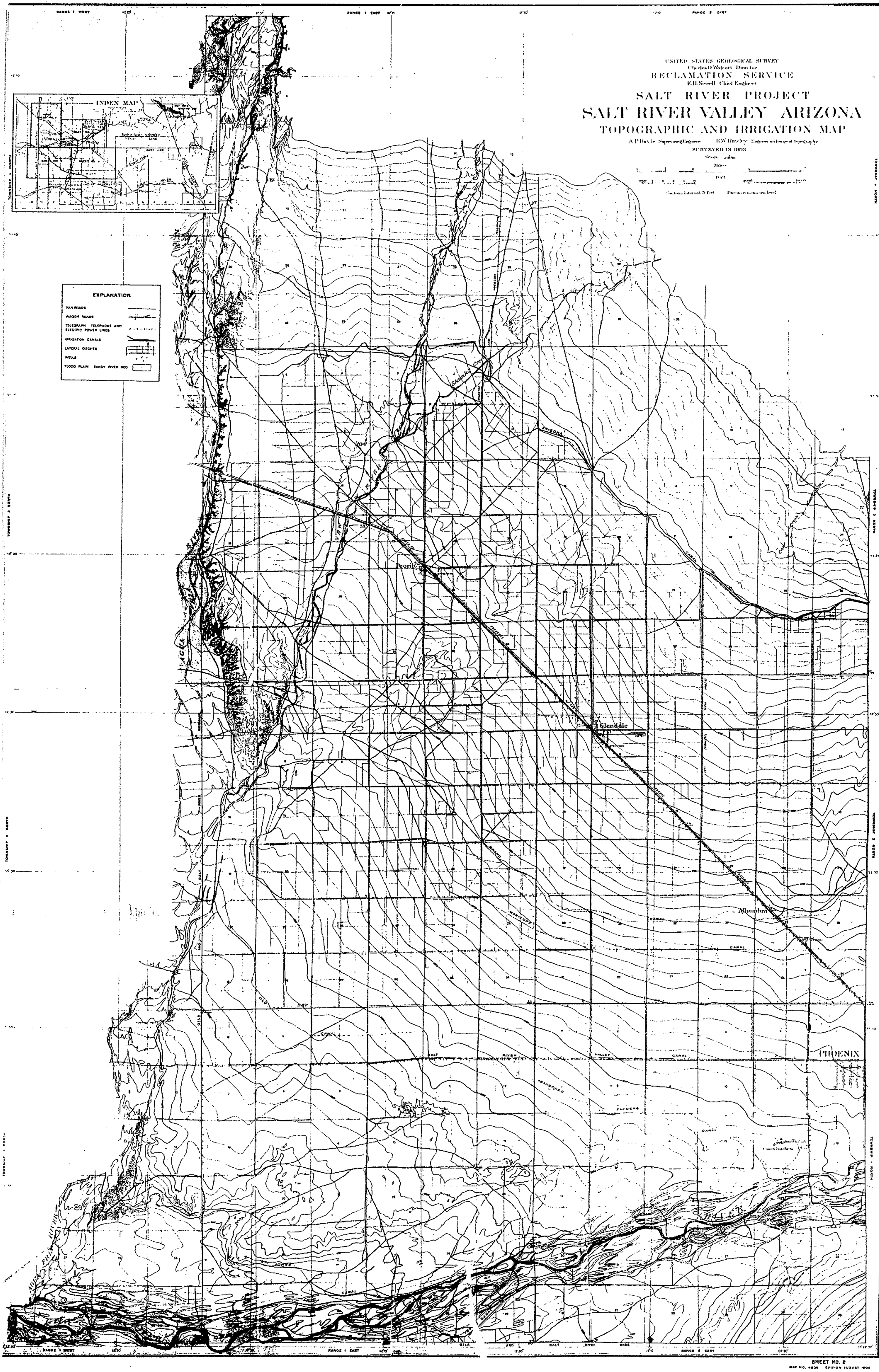
Estimated monthly discharge of Verde River at McDowell, Ariz., for 1904.

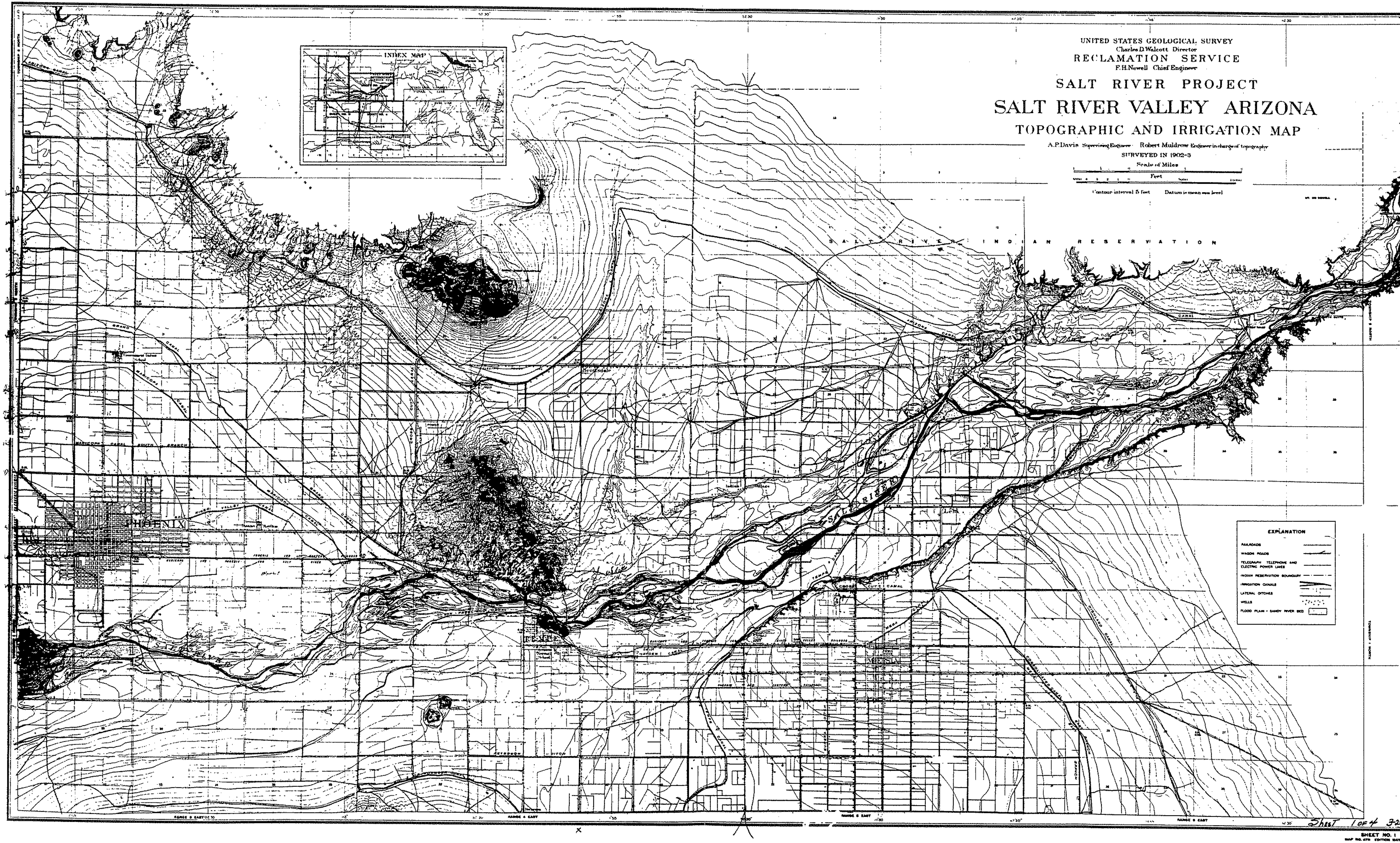
[Drainage area, 6,000 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	254	223	237	14,570	0.040	0.046
February	244	208	226	13,000	.038	.041
March	221	134	184	11,310	.031	.036
April	173	92	119	7,081	.020	.022
May	322	85	126	7,747	.021	.024
June	83	43	62.9	3,743	.010	.011
July	6,030	32	729	44,820	.122	.141
August	4,500	565	1,624	99,860	.271	.312
September	2,210	177	482	28,680	.080	.089
October	207	165	188	11,560	.031	.036
November	218	193	210	12,500	.035	.039
December	283	119	241	14,820	.040	.046
The year	6,030	32	369	269,700	.062	.843

NOTE.—The above estimates have been prepared by interpolation based upon the discharge measurements and gage heights.

EXHIBIT 202


UNITED STATES GEOLOGICAL SURVEY
Charles D. Walcott Director
RECLAMATION SERVICE
F.H. Newell Chief Engineer
SALT RIVER PROJECT
SALT RIVER VALLEY ARIZONA
TOPOGRAPHIC AND IRRIGATION MAP
A.P. Davis Supervising Engineer
R.W. Hawley Engineer in charge of topography
SURVEYED IN 1903
Miles
Feet
INDEX MAP
EXPLANATION
RAILROADS
WAGON ROADS
TELEGRAPH TELEPHONE AND ELECTRIC POWER LINES
IRRIGATION CANALS
LATERAL DITCHES
WELLS
FLOOD PLAIN SANDY RIVER BED
RANGE 1 WEST
RANGE 1 EAST
RANGE 2 EAST
TOWNSHIP 4 NORTH
TOWNSHIP 3 NORTH
TOWNSHIP 2 NORTH
TOWNSHIP 1 NORTH
Glendale
Alhambra
PHOENIX
SALT RIVER VALLEY CANAL
MARICOPA
CANAL
SHEET NO. 2
EDITION AUGUST 1904


UNITED STATES GEOLOGICAL SURVEY
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SALT RIVER PROJECT
SALT RIVER VALLEY ARIZONA
TOPOGRAPHIC AND IRRIGATION MAP
A. P. Davis Supervising Engineer Robert Muldrow Engineer in charge of topography
SURVEYED IN 1902-3
Scale of Miles
Feet
Contour interval 5 feet Datum is mean sea level
INDEX MAP
SALT RIVER INDIAN RESERVATION
PHOENIX
Scottsdale
Tempe
Mesa
EXPLANATION
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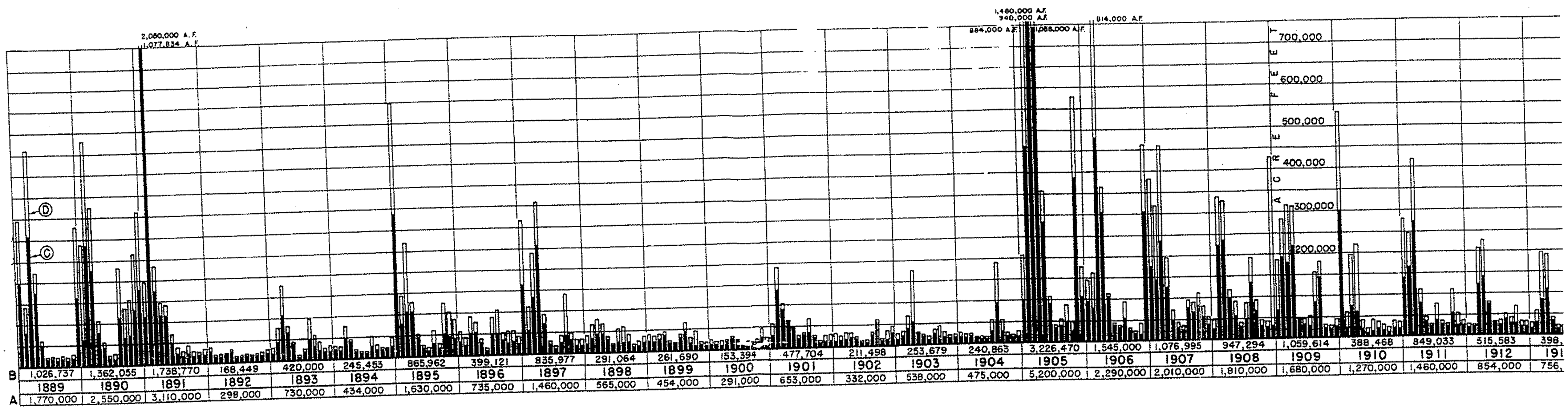
TELEGRAPH TELEPHONE AND ELECTRIC POWER LINES
INDIAN RESERVATION BOUNDARY
IRRIGATION CANALS
LATERAL DITCHES
WELLS
FLOOD PLAIN - SANDY RIVER BED
Sheet 1 of 4
SHEET NO. 1

EXHIBIT 203

COMBINED FLOW OF SALT AND VERDE RIVERS

SALT RIVER VALLEY WATER USERS' ASSOCIATION

HYDROGRAPHIC DIVISION



LINE A = LOWER FIGURES GIVE COMBINED FLOW OF SALT AND VERDE RIVERS IN ACRE FEET

LINE B = UPPER FIGURES GIVE COMBINED FLOW OF SALT RIVER AND TONTO CREEK IN ACRE FEET

C = QUANTITIES BLOCKED IN SOLID ARE SALT RIVER AND TONTO CREEK

D = SKELETON LINES NOT FILLED IN SHOW VERDE RIVER ADDED TO GIVE COMBINED FLOW

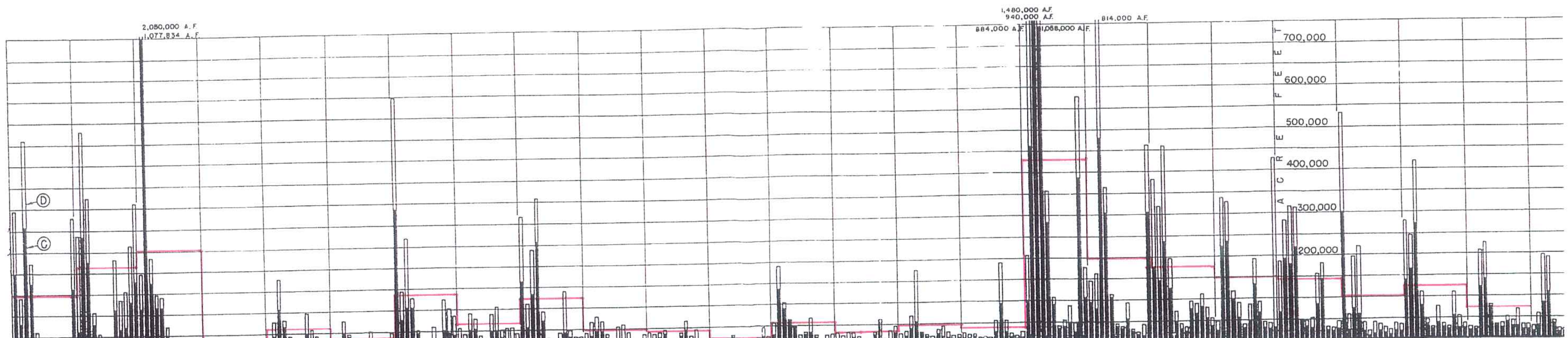
COMBINED FLOW RECORDS REVISED 1913 TO DATE

EXHIBIT 204

COMBINED FLOW OF SALT AND VERDE RIVERS

SALT RIVER VALLEY WATER USERS' ASSOCIATION

HYDROGRAPHIC DIVISION



	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	191
B	1,026,737	1,362,055	1,738,770	168,449	420,000	245,453	865,962	399,121	835,977	291,064	261,690	153,394	477,704	211,498	253,679	240,863	3,226,470	1,545,000	1,076,995	947,294	1,059,614	388,468	849,033	515,583	398,
A	1,770,000	2,550,000	3,110,000	298,000	730,000	434,000	1,630,000	735,000	1,460,000	565,000	454,000	291,000	653,000	332,000	538,000	475,000	5,200,000	2,290,000	2,010,000	1,810,000	1,680,000	1,270,000	1,460,000	854,000	756,

LINE A = LOWER FIGURES GIVE COMBINED FLOW OF SALT AND VERDE RIVERS IN ACRE FEET

LINE B = UPPER FIGURES GIVE COMBINED FLOW OF SALT RIVER AND TONTO CREEK IN ACRE FEET

C = QUANTITIES BLOCKED IN SOLID ARE SALT RIVER AND TONTO CREEK

D = SKELETON LINES NOT FILLED IN SHOW VERDE RIVER ADDED TO GIVE COMBINED FLOW

COMBINED FLOW RECORDS REVISED 1913 TO DATE

Red line is monthly average discharge computed and plotted by City of Phoenix.

EXHIBIT 205

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 2

WASHINGTON
GOVERNMENT PRINTING OFFICE
1897

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

IRRIGATION NEAR PHŒNIX, ARIZONA

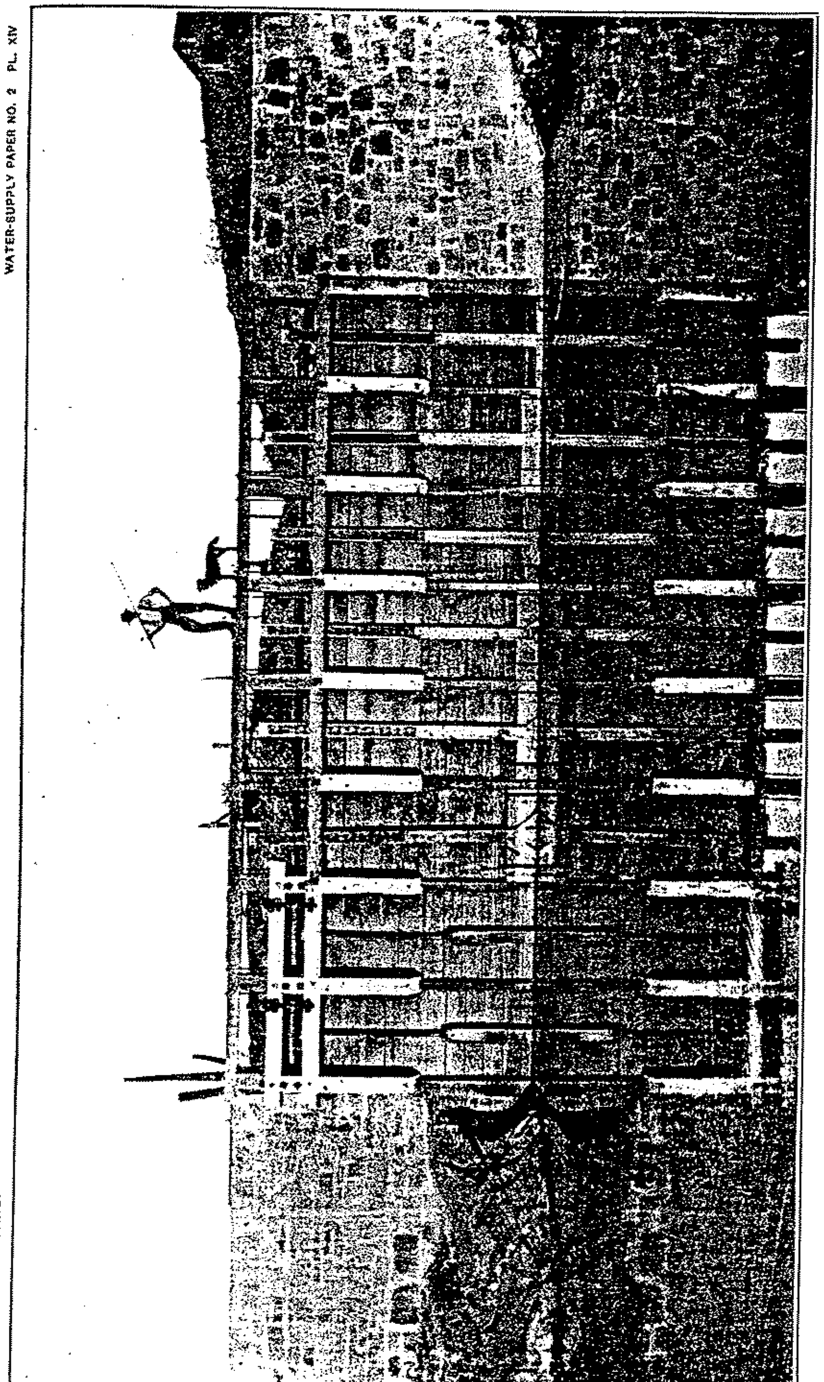
BY

ARTHUR POWELL DAVIS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1897

inches, or a little over two-fifths of a cubic foot per second. The water represented by a share supplies about 40 acres of land and is valued at present at about $250. The annual charge per share is $14. Considerable expense and annoyance was experienced for many years from the insecure head works of this canal, the farmers frequently being obliged to quit work in the busy season to restore their supply of irrigating water. Finally, in 1893, the Consolidated Canal Company was formed, which entered into a contract to build new head works and to deliver a specific quantity of water for a consideration at a designated point on the Mesa Canal for the use of the owners of that canal. This company built a shoal of large bowlders across the river, which withstands the floods of the river, but it gradually settled, at first into the sand and gravel of the river bed. As settlement proceeded it has been built up and constitutes a very fair means of diversion. At the south end of this shoal are built massive granite masonry abutments and wing walls, between which the canal flows through wooden gates directly into the mesa of bowlders and hardpan, through which it is constructed in a deep cut for a distance of over 2 miles, the maximum cut being about 26 feet. This heavy construction was performed by a huge dredge with a dipper capacity of 2 cubic yards of earth and having a lift of 26 feet. At the end of these 2 miles the Consolidated Canal follows for some distance the alignment of the Mesa Canal until it reaches a point about 3 miles northeast of Mesa City, which is designated as the point of delivery of the specific quantity of water for the irrigators under the Mesa Canal. At this point the water for the Mesa Canal Company is discharged into their old canal, and two branches are constructed by the Consolidated Canal Company, one starting southeast for irrigating purposes, and one running due west for about 2 miles until it reaches the edge of the mesa, just above the Tempe Canal, where a large power plant is constructed for electric lighting and power purposes, using the irrigating water to which the Tempe Canal is entitled and discharging it from the wheels into the Tempe Canal about $1\frac{1}{2}$ miles below its head. For some time the right to use the irrigating waters of the Tempe Canal was questioned, but this matter is now said to be adjusted. The eastern branch of the Consolidated Canal above mentioned is constructed on a light-grade line, in a general southerly direction, to the boundary of the Gila River Indian Reservation. By carrying the water of the Tempe Canal through the Consolidated Canal instead of through the sandy river bed, a considerable loss by evaporation is prevented, and the water available for irrigation is thereby increased. In this manner the Consolidated Canal obtains a right to some irrigation waters.

The Utah Canal was constructed in 1877 on the south side of the river, heading about 5 miles above the head of the Tempe Canal. It was constructed and is operated by the owners and occupants of the



ARIZONA CANAL HEADGATES.

from Salt River is double what it was in 1884, and consequently more than double the capacity of the river to supply in ordinary years, and still more beyond its capacity in dry years. But the condition of irrigation in Salt River Valley is not as bad as these figures would seem to imply. As above indicated, the adjudicated rights are probably greater than the areas actually irrigated in the years given, and cultivation has been discontinued on some of the tracts formerly irrigated. There is considerable competition for water among irrigators during the dry months, and this has been one cause of the abandonment of areas formerly cultivated.

ADJUDICATION OF WATER RIGHTS.

It will readily be seen by the foregoing that the various canals and ditches taking water from Salt River have an aggregate capacity much larger than the low-water flow of the river, which is in the neighborhood of 300 cubic feet per second, and the irrigable land under these canals is proportionately in excess of the water supply in the dry season.

These facts led to the institution of a suit before Judge Joseph H. Kibbey to determine the rights of the various proprietors, the trial of which was begun in March, 1890, and concluded in August of that year. The amount of evidence taken in the case is very voluminous, consisting of 6,000 pages of typewritten matter. The argument of the case was heard in February, 1891, and occupied fifteen days. Many interesting principles of the law relating to water rights were enunciated in this decision, relating to the method of acquiring water rights and the rights of the community concerning the reasonable use as opposed to the waste of water. This decision was published, but the pamphlet is now out of print, and a portion of the decision is here reprinted on account of its value and interest in connection with this subject.

JUDGE KIBBEY'S DECISION.

In 1848, and from that time until 1863, that part of the Territory of Arizona within which is the Salt River Valley was a part of the Territory of New Mexico, and there were expressly enacted by that Territory laws governing the appropriation and use of water for irrigation. In 1863 part of the then Territory of New Mexico was erected into a temporary government by the name of the Territory of Arizona, and the laws of New Mexico were, by the acts of Congress establishing the Territory of Arizona, made applicable to that Territory.

In 1864 the First legislative assembly of the Territory convened and enacted the code of laws commonly known and cited as the Howell Code. By article 22 of an act of that legislature, known and designated as the "Bill of Rights," it was provided that "all streams, lakes, and ponds of water capable of being used for the purposes of navigation or irrigation are hereby declared to be public property, and no individual or corporation shall have the right to appropriate them exclusively to their own private use, except under such equitable regulations and restrictions as the legislature shall provide for that purpose." This act went into force on the 1st day of January, 1865. This provision has been incorporated in